Multinational experience, absorptive capacity and knowledge exploitation
A comparative analysis of the electronics and chemical industries[(*)]

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Abstract

Using evidence from a novel data-set on international operations in which the world's largest electronics and chemical corporations were involved in 1993-97, this paper examines how multinational experience affects inter-firm linkage creation. Remarkable similarities and differences emerge across industries in this respect. On the one hand, *specific multinational experience*, measured by the extent and nature of a firm's presence in a given country, appears to positively impact on commitment intensive international operations, such as mergers and acquisitions, in *both* electronics and chemical industries. This result is consistent with a "knowledge based view" of the firm, combined with a "dynamic transaction cost" approach. On the other hand, *generic multinational experience*, measured by the extent and nature of a firm's global operations, positively affects the creation of more "exploratory", non-equity linkages, in the electronics industry *and not* in the chemical industry. We speculate that the different impact of generic experience on linkage creation in the case of electronics vs. chemical firms is due to a number of structural diversities which affect the process of knowledge absorption and exploitation in the two industries. Implications are drawn for EU public technology policies for measures concerning the promotion and selection of inward foreign direct investments in the examined industries.

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1. *Introduction*

This paper focuses on the nature and determinants of multinational firms' strategies of linkage creation. These strategies encompass a wide range of operations, including quasi-market transactions such as licensing agreements, more complex collaborative ventures such as joint ventures and strategic alliances, and integration modes represented by mergers and acquisitions. Within this context, specific attention is given to the role played by "multinational experience" – i.e. the extension, geographic spread, and duration of firms' presence in foreign countries – in setting up alternative strategies of access to complementary resources.

The term "multinational experience" identifies a multi-faceted concept whose different aspects should be disentangled and analysed in some details in order to capture their implications on linkage creation processes. Previous literature offers various insights which may be useful in this analysis.

On the one hand, several contributions have emphasised that linkage creation is affected by multinational companies' knowledge of the structural and behavioural characteristics of countries and regions in which they are active. This stock of knowledge, which is associated with an extensive and long term presence in each of a firm's foreign locations, can be named "specific multinational experience". The basic idea is that multinational firms' acquaintance with local contexts is a key asset increasing their ability to understand user needs and to tap into local sources of application-specific knowledge. This will increase the effectiveness and likelihood of linkages with local firms (Cantwell 1995, Vaccà and Zanfei 1995). This line of argument is consistent with a more general view of the firms as a knowledge based institution, which constructs capabilities through the interaction between internal and external learning processes (Richardson 1972, Teece 1986, Teece et al 1994, Coriat and Dosi 1998). In a similar vein, other international business contributions have argued that historically determined networks of formal and informal relationships among multinational corporations and local firms and institutions influence the organisation of their transactions (Forsgren and Johanson 1992, Andersson and Forsgren 1995). Complementary insights are being developed also in market entry strategies literature (Gomes-Casseres 1989, Mutinelli and Piscitello 1998, Hennart and Larimo 1998). According to these studies, acquaintance with a specific host country can be expected to reduce uncertainty on local contexts, this will reduce the risks of, and increase the (net) expected pay-off associated to, commitment-intensive modes of organising external linkages. Combining the different streams of literature we have just recalled, it turns out that what we called specific experience will not only increase the likelihood of asset seeking linkage creation (as suggested in the literature adopting a knowledge based view of the firm); but it will also enhance commitment intensive linkages, such as joint ventures and, even more so, mergers and acquisitions (as argued by dynamic transaction costs literature).

On the other hand, several scholars have stressed the potential advantages associated to the geographic dispersion of firms' activities. This concept has been operationalised by either measuring the width of multinational firms' internal networks of affiliates (number of affiliates, number of countries reached with some activity); or the relative weight of foreign production, sales and/or R&D and patenting of firms (Dunning 1996, Ietto-Gillies 1998, UNCTAD 1999). We may identify this concept with the term "generic experience", as it captures a firms' overall, global distribution of a firm's production units: what matters from this view-point is how spread is the multinational network, and not so much how big and/or embedded the nodes of the network are. Of course, many authors do integrate their analysis of geographic dispersion of firms' activities with the consideration of how significant the multinational presence is in given markets, sometimes with considerable analytical details (Cantwell and Iammarino 1998, Ietto-Gillies et al 1999). However, distinguishing this generic dimension of multinational experience highlights that geographic dispersion of multinational activities may *per se* be a source of advantages, even when knowledge of specific markets is not so high. The advantages deriving from the extension and geographic spread of activities relate to the possibility of exploring and selecting among a wide range of knowledge sources and of technological opportunities, thus establishing a spatially (and sectorally) diffuse system for the creation of new competencies (Dunning 1993, 1998, Cantwell and Piscitello 1999, Zander 1999, Patel and Vega 1999). Collaborative agreements, being less commitment intensive than joint ventures, and even less so as compared to M&As, are by and large a more flexible and reversible means to gain access to heterogeneous and dispersed external assets and opportunities. By contrast, adopting commitment intensive strategies (e.g. acquisitions) to carry out such exploratory and learning activity could be by far too costly and resource consuming when dealing with a high number of heterogeneous markets. This view is consistent with a more general understanding of strategic alliances as "an attractive organisational form for an environment characterised by rapid innovation and geographical organisational dispersion in the sources of know how" (Teece 1992 p.20).

To summarise, we may thus assume that *specific experience* can be associated mainly with the ability to utilise knowledge for context-specific needs, and to extract context-specific information which can eventually be generalised for applications in different contexts. This can be expected to generate linkage creation opportunities. By the same token, specific experience, increasing firms' acquaintance with local firms, will reduce the risks associated with commitment intensive linkages. G*eneric experience* can be associated with the ability to absorb and select ideas and knowledge assets stemming from a variety of sources, and to exploit them on a broader scale[1]. Given the dispersion and variety of opportunities and firms involved in these

[1] We have derived this juxtaposition between generic and specific experience from a similar one introduced by Arora and Gambardella (1994) in a different context. In their analysis of the evolution of pharmaceutical industry, the authors have suggested to distinguish what they define "ability to utilise" and "ability to judge", each deriving from different knowledge assets of the firm and influencing behavioural patterns.

asset seeking and knowledge augmenting activities, non equity collaborative ventures tend to be preferred to commitment intensive linkages.

The analytical framework we have briefly sketched will be utilised for the study of two macro-sectors which play a key role in both internationalisation processes and in knowledge generation and diffusion: the electronics and chemical industries. This will help us examine the interactions between the experience factors above and sector specific aspects.

Using negative binomial, we shall test the impact of multinational experience on the frequency with which firms choose different forms of external linkages (mergers and acquisitions, strategic alliances, and joint ventures). Evidence will be drawn from a novel data-set on international operations in which the 94 world's largest multinational enterprises of the examined industries were involved over the 1993-1997 period. We shall show that, when controlling for a number of firm and country specific variables, experience factors have a different impact on linkage creation in the two industries. As we shall see in greater details, the basic difference is that, while specific experience increases the likelihood of commitment intensive linkages in both sectors, generic experience has a positive and significant impact only on electronics industry. We speculate that this difference is largely due to the nature of technological trajectories and of other structural factors characterising the two industries.

The remaining sections of this paper are organised as follows. Section 2 describes our sample of firms and data sources. Section 3 illustrates the structure and recent evolution of innovation and internationalisation processes of in the examined industries, largely based on the information we gathered on the sample firms. Section 4 outlines the characteristics of our econometric analysis and specifies explanatory and control variables. Section 5 discusses the results of our econometric tests. Section 6 concludes the paper and draws some public policy implications of our analysis.

2. Sample and data

Our empirical investigation refers to a sample composed by all the European, North American, and Japanese manufacturing firms operating in the electronics and chemical sectors listed by Fortune 500 (1990 classification). A total of 94 companies are considered. Thirty-two companies are European, forty-one are from North America (including 1 Canadian) and twenty-one are Japanese. Based on the Fortune list, firms were re-classified according to their core business using Dun & Bradstreet (D&B) data on the distribution of their affiliates and sales by SIC code. Forty of these companies have their core business in the chemical sector (of which 9 in industrial chemicals, 18 in petrochemicals, 9 in pharmaceutical and 4 in other chemical activities) and 54 in the electronics sector (9 in telecommunications, 18 in computers, 4 in semiconductors, 9 in consumer electronics, 14 in other electronics sectors). See table 1a and Appendix 3 for more details on the distribution of our sample firms by sector and area of origin.

Data on international operations of these firms in 1993-1997 are drawn from *ARGO* (Agreements, Restructuring and Growth Operations), a database which uses information from *Predicasts F&S Index* and *IAC-Prompt*[2]. From this source we organised the available information on international ventures by firm, country of origin and destination, type and technological content of operations. We then counted the number of dyadic relationships between each of our sample firms and other firms and institutions from countries different from the home country, over the 1993-1997 period. For operations involving more than 2 partners we counted each single relation between our sample firms and foreign firms. A total of 55 countries were considered, covering 23 industrialised countries and the 32 LDCs that scored highest in terms of per capita GDP in 1994, and for which we have data on control variables.

We complemented these data with the number of subsidiaries, the overall number of affiliates, their age sales and employees, as recorded in D&B's *Who Owns Whom*, 1998 Edition. All these data were organised by firm and by destination country to obtain different measures of multinational experience as specified in details in sections 3 and 4.

Econometric elaborations were conducted using a number of control variables obtained from different sources, which are illustrated in section 4 and described in details in Appendix 1.

3. Market structure, innovation and internationalisation of the examined industries[3]

Before discussing the methodology and results of our statistical exercise, it is worth describing some of the main features of the sample firms we are considering. We shall show their main similarities and differences in terms of size, R&D intensity and innovative activity, and degree of internationalisation. This way of characterising firms will help understand the evolution of market structure, innovation and international processes in the examined industries, and will set the background for the econometric analysis of sections 4 and 5.

As regards *firm size*, chemical companies appear to be larger than electronics ones, with average sales per firm being over 60% higher in the chemical case. The largest average size can be observed in the case of the petro-chemical sub-sector. Also, sales per employee is more than double in chemical firms as compared to electronics. This holds true for all industries belonging to the chemical macro-sector. Again the petrochemical sector has the highest values (the sales per employee ratio for petrochemicals is twice the chemicals average and almost four times as

[2] The database was initiated at Iefe-Università Bocconi, Milan, and has been re-organised and updated with the collaboration of a number of researchers at Cesit-Custom, Università di Urbino, and at LIUC,Castellanza. The authors wish to mention Daniele D'Alba, Marco Giarratana, Sandro Sergiacomo and Claudia Siligeni for their useful research assistantship in the set-up of, and elaboration on, this database. Claudia Beretta and Andrea Ferri helped in the construction of complementary data-sets.

[3] We are grateful to Fabrizio Cesaroni and Myriam Mariani for sharing their knowledge of the Chemical industry.

high as the electronics average). This is consistent with the conventional knowledge of the chemical industry being very capital intensive, with significant fixed costs and scale economies (Aftalion 1989, Lane 1993).

Furthermore, *innovation intensity* is also very different, both between and within the two macro-sectors. More precisely, electronics firms seem to invest relatively more in R&D, but differences within the chemical macro-sector are striking. In fact, while firms which have their core business in industrial chemicals and pharmaceuticals have a very high R&D expenditure over sales, petrochemical firms spend less than one third the chemical average, and less than one tenth the pharmaceutical level. Interestingly enough, if we look at the output of innovation process, the results are different. Even though electronics firms invest more in R&D, on average 50% more than chemical firms, their 1970-92 score of US patents is about 30% lower than in the case of chemical firms, as a proportion of total employees. Possible explanations are: the fact that knowledge tends to be more codified in the chemical industry than in the electronics industry, and innovation can be more effectively appropriated through patents (Arora and Gambardella 1998); and the relatively higher role played by user-producer interactions, and by tacit knowledge in the electronics industry (Steinmueller 1992, Torrisi 1998), which make protection of inventions less effective (as in the case of software) and lowers the propensity to patent in this sector.

As shown in table 1d, both groups of firms appear to be characterised by a high *degree of internationalisation*, as measured by a variety of indicators based on the *1992 stock of affiliates* of each of the sample firms. These can therefore be considered as measures of firms' historical patterns of internationalisation. We here refer to the number of foreign subsidiaries, the number of countries where the firms had at least one subsidiary, the relative importance of foreign sales and employees over total revenues and employment, and the average age of affiliates, measured by the number of years of operation since their establishment. The only significant difference across the two macro-sectors is the relative higher age of chemical subsidiaries. This is not surprising, given that the electronics industry is a relatively young industry as compared to the two hundred years old chemical sector (Aftalion 1989). It is also interesting to note that the petrochemical industry comes again as an extreme case, this time being the sector where internationalisation is the lowest. The opposite applies for pharmaceuticals, on the one hand, and computer industry on the other.

Tables 2a-d provide a description of the *geographical distribution of our sample firms' stock of international activities in 1992.* Not surprisingly, the bulk of international affiliates is concentrated in Western Europe. What is remarkable is the degree of this concentration: European firms appear to have established over 70% of their affiliates in Western Europe. Smaller shares of affiliates are concentrated in South Eastern Asia (especially attractive for consumer electronics, telecommunications and semiconductors) and in North America, where less than 10% of European firm's affiliates were located, on average, in 1992. Also North

American companies have concentrated in Europe the highest share of affiliates (67.2% in both industries), and have distributed the remaining international activities in South Eastern Asia (10% in Chemicals and 12% in Electronics, with much higher shares in telecommunications and semiconductors), and only a minor 5-6% within the NAFTA area. Japanese firms appear to have distributed their affiliates more evenly across geographic areas. Western Europe attracts the highest number of Japanese firms' affiliates too, but the share is significantly lower than in the case of EU and North American firms (42% in chemical industry and 51% in electronics). It is also worth mentioning the relative importance of Latin America in the Chemical industry, especially for North American firms, both in terms of subsidiaries and of employees; and the strong weight of Eastern European employment for European electronics companies.

We should finally turn to a brief description of the *patterns of international operations in which our firms were involved over the 1993-97 period*. Data are drawn from ARGO database, which records a total of 6870 operations. One fifth of these operations have a prevailing technological content, 2294 are Joint Ventures (JV), 3637 are non-equity Strategic Alliances (SA), and 936 are Acquisitions and Mergers (AM). We shall attempt a more rigorous statistical exercise on these data in section 5. Suffice here to notice a few stylised facts (see tables 3a-c and tables 4a-d).

First, some differences emerge in the frequency of the different *modes of organising linkages* in the examined industries. Joint Ventures are much more common in telecommunications and in industrial chemicals than in the other sectors. A striking diversity emerges in the frequency of Strategic Alliances (SA) across industries. Electronics firms were involved in more than twice as many SA per dollar of revenues, as compared to chemical firms. A significant exception is represented by pharmaceutical companies which have a higher involvement than average. A remarkable diversity also emerges in the case of Acquisitions & Mergers (AM), which are more common in the chemical industry. The strong involvement of electronics firms in SAs is consistent with the results of previous studies on these emerging patterns of internationalisation (cf. Duysters and Hagendoorn 1996); while the high number of AMs in chemicals reflects the development of a "market for firms" which has characterised the late 1980's and early 1990's in the process of restructuring and downsizing of plants all over the world (Arora and Gambardella 1998).

Second, there are diversities across sectors in the use of *international technical linkages*. It is apparent that most technical operations take the form of strategic alliances (almost 90% of total technological operations are strategic alliances: 1144 as opposed to 162 joint ventures), which is consistent with our view of SAs as more apt for the exploration of technological alternatives. Overall, however, technical operations are less frequent than non technical ones (less than one third of total SAs and less the 10% of total Joint Ventures recorded have a technological content), due to the rather strict definition we gave of these operations. In fact, we labelled as technical only those operations which had a *prevailing* technological content. The highest share of these operations is concentrated in the electronics industry: electronics firms set up more than three times the number of technical alliances per dollar of revenues, as compared to chemical firms. Once again, there are exceptions: pharmaceuticals enter more technical SA than average, and the same can be said for telecommunications and semiconductor firms, while the opposite applies for petrochemicals. Correspondingly firms active in petrochemical industries appear to use strategic alliances for purposes different from technological development, such as production, distribution, and marketing. On average, they establish more than twice as many non-technological alliances than industrial chemical or pharmaceutical firms.

Third, interesting patterns emerge in the *geographical distribution of 1993-97 international operations*. A comparison of these patterns, illustrated in tables 4a-c, with the distribution of the stock of affiliates in 1992, shown in tables 2a-d, provides useful insights on the on-going evolution of internationalisation processes in the examined sectors. European firms appear to have considerably increased their globalisation efforts. The share of 1993-97 European firms' intra-Europe Joint Ventures and Strategic Alliances is on average 25%, i.e. lower than their share of operations involving North American firms (over 40% on average, with higher percentages in the case of SAs), and approximately the same share of those involving South East Asian firms (especially in the case of JVs). The weight of intra-European operations is generally much lower than the share of the firms' affiliates located in Western Europe in 1992 (over 70%). European firms' mergers and acquisitions are almost equally distributed between Europe and North America (40% and 35% respectively). When considering the operations of non-European firms, Western European countries appear to attract the largest share of mergers and acquisitions (over 40% in both industries).

These patterns reflect the evolution of international operations in a delicate phase of Europe's integration process, i.e. the post 1992 phase. It appears that the Single Market perspective has been by and large consistent with the geographic dispersion of international activities of European firms: while the "European Fortress" has continued to attract, and has possibly enhanced, inward foreign direct investments (AM operations), it has not reduced incentives to set up inter-continental operations, and alliances in particular. Indeed, the EU single market perspective seems to have spurred these global operations, especially involving partners active in the most advanced regions of the world. As Dunning (1997 p.153) has observed: " The perceived effects of EC92 are encouraging EC-owned firms to conclude alliances with Japanese and North American firms to protect or advance not just their European, but their global, competitive position. This is particularly the case in high-technology sectors, where the fixed costs of innovation, production and marketing are becoming so huge that firms can only survive by capturing regional or global markets, or by sharing these costs with other firms".

As a matter of fact over 50% of SAs of European firms have involved North American partners in both sectors, and this share increases to over 60% in the case of pharmaceutical and computer firms. It is also noteworthy that strategic alliances involving non-European firms and European partners is very high in chemical industries (over 58% of SAs involve European and non-

European partners), with a very high incidence of operations in the pharmaceutical industry and of US-European partnerships; while in electronics it is below 30%. The asymmetry between the weight of inter-continental alliances in the portfolio of European firms' agreements as opposed to the weight of these alliances in non-European firms' portfolio signals a significant weakness in Europe's electronics industry. On the one hand, it appears that alliances with non European partners are a vital need for European firms, which are increasingly looking outside the boundaries of the Old Continent. On the other hand, non-European firms (by and large US companies) do not need as much to resort to European partners: in fact, alliances with Western Europe are only a relatively minor share of their portfolio of alliances.

To conclude this section, it may be useful to summarise some important differences in the structure and behaviour of Western European vs. North American or Japanese firms. European firms are larger, in terms of sales and even more so in terms of employees. The largest differences between European and non-European firms emerge in the chemical industry, which is still undergoing significant restructuring processes. European firms also have a higher R&D intensity but a lower propensity to patent relative to North American and Japanese firms. Finally, European firms appear to be very internationalised, when considering both the total stock of foreign affiliates in 1992 and the total number of international operations in 1993-97. As already noted, the largest share of this 1992 stock of affiliates of European firms is concentrated in Western Europe. At the same time, we have highlighted that European countries are not the main destination countries for most of European firms' international operations in the 1993-97 period, with the relevant exception of mergers and acquisitions (but the share of intra-Europe AMs is also decreasing), thus signaling a significant change in the patterns of internationalisation in the examined industries.

It is within this evolving context that we now proceed to the analysis of how multinational experience has affected the linkage creation process.

4. Econometric analysis of the determinants of linkage creation

4.1 Dependent variables and econometric model

The econometric exercise carried out in this paper is based on separate regressions of different dependent variables which measure different types of external linkages: international, non equity strategic alliances SA_{ik}, international joint ventures $JV_{ik,}$, and international acquisitions and mergers AM_{ik}. In the case of SAs it was also possible to distinguish between operations with prevailing technological content, and all other "non technological" operations. We used the notation T after the acronym of the operation (i.e. SAT_{ik}) to identify technical alliances.

Our dependent variables are obtained as the cumulative number of operations (however defined according to the specifications above) developed by firm *i* with other company(ies) of country *k* over a five year period (from 1993 to 1997), with country k being different from firm *i*'s country of origin. Therefore, they are, by construction, discrete and non-negative. In addition, with both *i* and *k* being large (*i*=94 and *k*=54), more than 80% of observations take the value zero.

When variables have this nature, we can "improve on the least squares and the linear model, with a specification that accounts for these characteristics." (Greene 1997, p. 933). A class of econometric models has been developed just for this purpose: the models for event counts[4]. Among the count data models, the negative binomial is particularly suited for our purpose[5], since it accounts for the unobserved heterogeneity that normally characterises cross-sectional data. For the analytical formulation of the regression model, of the log-likelihood function utilised for estimation, and of elasticity that can be derived from the estimated parameters, see the appendix in the end of this paper.

4.2. Explanatory and control variables

We tested, with controls, the impact of our firms' multinational experience on their own recourse to JVs, SAs, and AMs in 55 countries over the 1993-97 period.

See appendix 1 for a description of dependent and independent variables utilised in our regressions, and tables 5a-b for, descriptive statistics and correlation matrices.

4.2.1 Multinational experience

As anticipated earlier, *multinational experience* can be specified in a number of variables which capture different aspects of this factor. First, we considered the number of subsidiaries of our sample firms in each of 55 sample countries $SUBS92_{ik,}$, as a proxy of the extension of TNCs' multinational web in a given country.

Second, we utilised the age of affiliates, $SUBSAGE_{ik}$, measured by the average number of years from the establishment of a firm's subsidiaries in a country in 1992, as a measure of experience accumulated by the TNC in the country over time.

Third, we introduced the relative size of affiliates, measured by ratio between employees of the affiliates in country *k* and total employees of the TNC abroad, EMP_INT_{ik}, as a measure of how "thick" the company's presence is in a given country as compared to its overall international network.

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[4] There are now many applications of count data regression models which use cross-section, time series or panel data. A classical example is the relationship between R&D and the number of patents of a firm examined by Hausman et al . (1984). For an extensive review of the theory and applications of this class of models, see Cameron and Trivedi (1998).

[5] In table 6a-b we present also the results of a likelihood ratio test for the Poisson vs the Negative Binomial specification. The null hypothesis is rejected at the 99% confidence.

We consider the three measures above (SUBS, SUBSAGE, and EMP_INT) as a proxy of *specific experience* of the TNC. Several studies have utilised somewhat similar measures. For instance, Gomes-Casseres (1989) proposed an index of "familiarity with host country" based on how often his sample's MNEs entered one country before another in a given period, and introduced it in his regressions as a determinant of entry mode strategies. We consider this choice more arbitrary than counting the number, size, and age of subsidiaries in each market, which more exactly measures the nature and extension of a MNE's presence in, and acquaintance with, host countries. One recent study (Hennart and Larimo 1998) produced regressions using the number of years of presence of affiliates in the host country as a regressor to explain ownership structure of foreign direct investments. Their effort that was eased by the fact that they considered only one destination country, for which plenty of statistics are available (the US). An alternative method would be to weigh the number of subsidiaries by their age. This practice has been followed by Padmanabhan and Cho (1999), who claim that their indicator captures both the contribution of frequency and length of foreign operations. We prefer to keep the two effects distinct, in order to abe able to asses the contribution of the two aspects of multinational experience to the propensity to engage in different modes of external linkages.

Furthermore, we produced other indicators of *generic experience*. We utilised a measure of companies' exposure to foreign markets, as identified by the number of countries in which they had at least one affiliate in 1994 ($TNCSPREAD_i$). This index of multinationality was used by several authors, among which Kogut and Singh (1988) and Caves and Mehra (1986).
Another indicator of generic experience is the one we named $TNCINDEX_i$, that is the average of international employees and of international sales (as a proportion of total employees and total sale). This is very similar to the indicator proposed by Ietto-Gillies (1998) and reproduced by UNCTAD (1998). We consider this the equivalent, at a global level, of our EMP_INT_{ik}. The transnationality index thus identifies how "thick" multinational presence is allover the world.

In order to control for further exogenous sources of heterogeneity we introduced the following control variables.

4.2.2 Company variables

R&D intensity (RD_INT_i), calculated at the firm level, should account for the innovativeness of companies, a factor that is often considered in the literature as a determinant of international production (Pearce 1997), and of joint ventures in particular (Hennart and Larimo 1998).
Global (consolidated) sales, SAL_i were introduced to control for the size of firms. Dummies for sub-sectors and for the areas of origin of the firm were also used.

4.2.3 Recipient country variables

The total number of applications to the US patent office filed by national firms, institutions and individuals were considered as a percentage of GDP ($PATGDP_k$). This is usually considered a good proxy of technological infrastructures and of the overall level of competencies accumulated by firms a given country, i.e. of "location specific technological advantages". According to Dunning (1998), such location specific advantages should not only attract foreign investors, but they should also influence the way TNCs' ownership advantages are augmented and utilised.

The average education attainment (in terms of schooling years) in the total population over 25 in country *k* is introduced as a measure of human capital endowments of host economies ($HUMAN_k$). This measure was introduced by Barro and Lee (1993) and has the advantage of focusing on the *stock* of human capital. Other measures utilised in the literature either focus on current flows of human capital (e.g. school enrolment ratios) or do reflect specific skill levels (e.g. adult literacy rate or secondary education attainment ratio). In international economics literature, Borensztein et al. (1998) utilise the same specification we do in their analysis of the effects of foreign direct investments on economic growth. There is a general agreement in the literature on multinational spillovers that the level and efficiency of host countries' infrastructures, especially education and training of local workforce, should positively impact on linkage creation (Dunning 1993).

The total number of subsidiaries of the sample firms (different from *i*) in country *k*, SUBSK_I, is thought to capture some location advantages connected to agglomeration economies in countries where consistent foreign operations of competing firms have already been set.

Per capita Gross Domestic Product (GDP_k) is taken into account to control for the degree of development of host countries. This measure should also capture, *inter alia*, the effect on international operations of the advancement of other infrastructures (different from education and training institutions, which are more directly taken into account by Human). It also accounts for the richness of markets as an attractor of international operations (Zejan 1990).

We also controlled for the size of local market in terms of total population, POP_k, i.e. a measure of what we may consider the "potential" market of a country, especially when considered "in combination" with per capita GDP (Kobrin 1976).

The pace of economic development was measured by simple annual growth rate of per capita GDP over 1980-1987 ($GGDP_k$).

Furthermore, we took account of trade barriers using $OWTI_{k.}$, i.e. the so called "Own-import weighted tariff rates on intermediate inputs and capital goods", as specified by Barro and Lee (1993). International production abroad, via FDI or AG, are traditionally considered a strategy to bypass trade barriers (cf. *inter alia*, Gomes-Casseres 1989), even though this argument has received mixed support from evidence.

Finally, a control was introduced for the sector composition of the recipient countries. This variable was calculated as the share of electrical machinery value added (ISIC 383) as a percentage of value added in manufacturing (VA_k), for electronics firms; and as the share of chemical value added (ISIC 26) in the case of chemical firms. Gomes-Casseres (1989) and

Davidson and McFetridge (1985) utilise a similar measure for their analyses, referred to a broader set of industries, to account for local firms' ability to supply valuable manufacturing capabilities to multinationals entering a market.

4.2.4 Relation specific country variables

We included also two variables that capture different aspects of the relationship existing between the country of origin, *n*, of firm *i*, and the destination country, *k*.

A rough measure of geographic distance between firm *i* 's country of origin and the host country ($DISTANCE_{nk}$) is utilized to account for transportation costs (Pearce 1997) and for the costs of monitoring intra-firm activities (cf. Davidson and McFetridge 1985, whose indicator of geographic distance is very similar to the one adopted in this paper).

Finally, the ratio between salaries paid in country *k* and those paid in firm *i* 's country of origin ($WAGEDIFF_{nk.}$) is introduced to account for labour cost factors. As in the case of sector composition, we used each firm's sector salary. When the ratio is greater than one, we then interpret that wages in firm *i*'s sector are higher in the host country than in the home country. The same indicator was utilised by Swedenborg (1979). Much like trade barriers, positive wage differentials (WAGEDIFF greater than 1) are traditionally considered to negatively affect multinationals’ production decisions, especially in LDCs. However, it is a spurious measure, which can also capture the qualitative level of workforce.

5. Discussion of results

Regressions were run separately for the two macro-sectors of electronics and chemical firms, in order to capture the interactions between experience factors and industry specificities, which we expect to be relevant. Results are shown in details in table 6a-b and will be discussed below[6]. The same explanatory and control variables were utilised when carrying out our econometric exercises with different dependent variables, each identifying alternative modes of organising linkages: Acquisitions &Mergers (AM), Joint ventures (JV), Strategic Alliances (SA). In the case of SAs we were able to separate the aggregate of alliances with prevailing technological content (SAT), and ran regressions using this as a dependent variable.

5.1 Impact of multinational experience on linkages

The main findings can be summarised in the following diagram:

[6] In table 6 we present the estimated coefficients $\hat{b}_j$ ’s. When regressors are expressed in log terms, coefficients can be interpreted as elasticities. In all other cases coefficients are usually interpreted as the percentage change in the dependent variable, induced by a unit change in the regressor (i.e. they are semielasticities). These will be sufficient for most of our discussion. In order to obtain elasticities (when regressors are not expressed in log scale) one may multiply the coefficient by the sample mean of the independent variable (see the Appendix for more on the interpretation of estimates).

	Electronics				*Chemicals*			
	AM	JV	SA	SAT	AM	JV	SA	SAT
›s92					++			
›sAge	++							
p_Int	++	++			+			
:Spread			++	++				
:Index				++				+

Key: see Appendix 1 for variable description

++ positive and significant at 95% confidence or higher
\+ positive and significant at 90% confidence
-- negative and significant at 95% confidence or higher
\- negative and significant at 90% confidence

The comparison between the two sets of regressions highlights significant differences and a few similarities. The main similarity concerns the positive and significant impact of what we called "specific experience" as a determinant of AMs in both industries. It thus appears that specific experience is associated with a high degree of “commitment” to local markets and a high degree of “control” of MNEs over foreign counterparts. This confirms the intepretation we suggested in section 1, as a result of combining a competence-based view of the firm and a dynamic transaction cost approach. In fact, following the former view, specific experience could be considered as a factor facilitating mutual acquaintance between multinationals and local firms. Local activities will also imply some knowledge of local rules, norms of conduct, and values which influence the behaviour of economic agents, including labour force and capital market institutions (Rosenzweig and Nohria 1994). This will increase the subsidiary's ability to interpret and absorb tacit, context-specific knowledge their counterparts are endowed with (Vaccà 1994). As a result, the effectiveness and likelihood of linkages between multinationals and local firms will also increase. Following the latter view, i.e. the one we have named: dynamic transaction cost view, we can also explain the choice of organisational modes adopted. As suggested inter alia by Gomes-Casseres (1989), specific experience is associated to commitment intensive linkages. In fact, when firms already have experience of a specific country, they will face low uncertainty about the characteristics of the market, of knowledge sources and of local counterparts’ behaviour. This will lower the cost and risk of, and increase the expected payoff of, strategies of foreign market penetration which require high, irreversible fixed costs, such as mergers and acquisitions.

An additional consideration which helps explain the positive impact of specific experience on AMs in the chemical macro-sector is related to the particularly large firm-size and to the high levels of fixed costs (see section 3). This could be a powerful factor preventing firms from creating new linkages, unless there is low uncertainty about the market and, more generally, about the local context. Besides, the long and painful restructuring which the chemical and petrochemical industries have undergone in the 1980's and 1990's has given a significant impulse to mergers and acquisitions, and has determined the downsizing of large multinational firms, particularly the ones with excess capacity (e.g. with too many plants in a single country with shrinking demand).

Turning to electronics, it is quite interesting to observe that specific experience has a positive and significant impact also on joint ventures, i.e. a strategy associated to intermediate levels of commitment between AMs and SAs. Once again, our knowledge of structural and behavioural characteristics of the examined industry helps to interpret this result: specific experience can be a fundamental gear to the solution of application specific problems and will generally favour user-producer interactions which play a fundamental role in the electronics industry. Given the number and complexity of applications problems they are continuously dealing with, electronics firms are more likely to interact with users through collaborative ventures than via mergers and acquisitions (Steinmueller 1992, Ernst 1997). User-producer interactions are becoming more and more relevant in chemical industries (particularly industrial chemicals and in pharmaceuticals) as highlighted in recent studies (Arora and Gambardella 1998); however, one may presume this factors is not as relevant yet in this sector as it already is in electronics.

A remarkable difference emerging from our comparative analysis is the quite different role played by "generic experience" in linkage creation processes of the two industries. The results are quite neat in the case of electronics: generic experience appears to have a positive and significant impact on non equity, strategic collaborations, and not on hierarchical-control modes of organising linkages (AMs in particular). And this is even more apparent when we focus on non equity technical alliances (SAT). A possible explanation is that an extensive and effective global network of affiliates will provide firms with a wide variety of market and technological opportunities stemming from different countries. As argued earlier (section 1), collaborative agreements, being less commitment intensive than joint ventures, and even less so as compared to M&As, are by and large a more flexible and reversible means to gain access to, and exploit these opportunities and to gain access to heterogeneous and dispersed external assets.

In a similar vein, one can also explain why generic experience is a key factor favouring technical alliances in the examined industry. In fact, on the one hand, an extensive network of subsidiaries all over the world can enable a TNC to gain access to a variety of technical alliances as a means to search for, and capture, new ideas and economically valuable knowledge (Cantwell 1995, Zanfei 1999). On the other hand, having access to a large number and variety of foreign markets firms are enabled to spread the fixed costs associated to technology development over larger volumes of sales (Becattini and Rullani 1993). In other words, generic experience increases the opportunity to enter “exploratory operations”, and augments the payoff that can be expected from technical alliances in particular [7].

Quite different from the examined patterns of the electronics industry, generic experience appears to have no impact at all on linkages in the chemical industry. The interpretation of this result requires that we acknowledge some important industry specific characteristics. A tentative explanation could rest on the following observations. First, some sub-sectors of the chemical industries, namely industrial chemicals and petrochemical industries, have been strongly influenced by the development of specialised suppliers of chemical engineering services, and have been involved in a number of collaborative ventures with them for the acquisition of "standardised" process technology and for the setting up and upgrading of production plants (Lane 1993, Arora and Gambardella 1998). These linkages do not seem to involve a significant interaction between the suppliers of technology (which may be either specialised engineering firms or other large, diversified chemical companies) and the buyers of new processes. In fact, the technologies being transferred are by and large a "commodity". This might help explain why the availability of extensive networks of affiliates on a global scale does not appear to be a fundamental asset in linkage creation: the supply agreements we have mentioned, which represent an important share of SAs in the examined industry, do not seem to require that the buyer has absorptive capacity nor that it is able to explore technological or market opportunities. In other words, generic experience is not so useful under these circumstances. This interpretive line also helps understand why the number of technical alliances is so low in the chemical sector as a whole. It remains that competence seeking strategies (and technical alliances in particular) are much more relevant in sub-sectors characterised by a higher R&D intensity, such as the pharmaceutical industry. We intend to carry out a more detailed analysis of these sub-sectors in future research, and we expect that experience factors will play a more significant role in the evolution of these industries.

Second, the high levels of fixed costs and of economies of scale in the chemical industry might have important implications for the development of SAs in the examined sector. In fact, this could *per se* spur firms active in the most scale intensive industries to develop SAs and JVs as cheaper substitutes for AMs, especially when excess capacity problems emerge. This implies that SAs tend to be substitutes for, and not complementary to, the accumulation of affiliates over time. Indeed, SAs and JVs have been important organisational tools utilised in the process of restructuring in which chemical and petro-chemical firms were involved in the late 1980's and early 1990's. Again, there is evidence that acquisitions have increased a lot even in the presence of a growing recourse to joint ventures and strategic alliances in other chemical sub-sectors. This

[7] One should not conclude that innovation is associated only to generic experience and/or to technical alliances. Knowledge of local contexts is a key asset in the application and adaptation of technology, while commercialisation and marketing agreements are fundamental mechanisms in its economic exploitation. Besides, it is well known that through application and usage, learning processes can occur, especially when dealing with technology characterised by a high systemic complexity (Rosenberg 1982). What is being suggested here is that generic experience produces a differential ability to enter alliances which have a *prevailing technical content*.

is the case of the pharmaceutical industry, particularly as a consequence of the emergence and diffusion of biotechnology (Arora and Gambardella 1990). However, this is not a general rule in the chemical industry.

5.2 Impact of control variables

A few additional remarks should be made on control variables. First, table 6 shows that host countries' patenting activities (PATGDP) and human capital endowments (HUMAN), which we used as the main proxies of location specific advantages, in terms of technology and educational infrastructures, both positively and significantly affect strategic alliances linkages (SAs) in both industries. Both these factors have a positive and significant impact also on JVs and AMs in the electronics industries, and not in chemical industries. We could also observe that in the chemical industry firm-level R&D intensity does not have the same positive and significant impact which can be observed in the electronics sector. Indeed, RD_INT often has a negative impact in the chemical industries.

The observations above, concerning the different role played by the "technological quality" of firms and of destination countries in the two industries, are probably revealing of the higher complexity of innovative scenarios within the chemical macro-sector. As already noted, many operations involving the transfer of standardised technology and low application specific capabilities, as it is often the case in petro-chemicals, co-exist with alliances and acquisitions for the access to strategic scientific and technological assets, as in the case of pharmaceuticals and biotechnology.

Indeed, the key role played by human capital as an attractor of FDIs with high development potential for host economies has been emphasised in recent works with reference to many industries in LDCs (Borensztein et al. 1998) and also with a specific focus on the electronics industry (Castellani and Zanfei 1998). Our evidence is by and large consistent with this view, although with the already made *caveats* for the chemical industries. Especially when considering high technology industries, host economies should pursue a combination of foreign capital attraction and selection, and of investments for the development of local infrastructures in general, of human capital and of technical competencies in particular. This policy mix – and not merely a set economy-wide functional interventions – can be a fundamental means for the creation of backward and forward linkages in the host economy, potentially generating externalities for local (as well as foreign) economic activity. By contrast, insufficient and/or inadequate human capital could determine a shortage of local production abilities as well as a lack of variety of goods in the local markets, which will increase the likelihood that multinationals displace local activities and will generate limited or no backward and forward linkages at all (Rodriguez-Clare 1996). This will in turn induce vicious circles of dependence from imports of key inputs, devaluation of national currency, and worsening terms of trade (Dunning and Cantwell 1988).

6. *Concluding remarks*

Our study provides a detailed analysis of the role played by multinational experience in shaping firms' linkage creation processes in the electronics and chemical industries in the 1990's. While specific experience appears to have had a positive and significant impact on mergers and acquisitions in both industries, generic experience has affected strategic alliances in the electronics industry and not in the chemical industries. Interpretive approaches developed in previous literature help explain these results; but they need to be corrected and integrated to take sector-specific characteristics into account.

First, the impact of *specific experience* factors can be explained in terms of the ability to utilise knowledge for context-specific needs, which is generally associated with an extensive and long-term presence in a given country. This experience factor *per se* favours the creation of linkages with local firms. This view can be usefully integrated with dynamic transaction cost considerations, according to which specific experience reduces the risks associated with commitment intensive linkages. The importance of experience as a risk reducing factor is enhanced by the high fixed costs which characterise chemical industries in particular. The relevance of specific experience as a factor favouring the effective application of knowledge to specific contexts is apparent in the case of electronics industries, where user-producer interactions and learning by using play a crucial role.

Second, *generic experience* can be associated with the ability to absorb and select ideas and knowledge assets stemming from a variety of sources, and to exploit them on a broader scale. This asset seeking and exploiting activity can be better organised by means of flexible and less commitment intensive operations, such as strategic alliances and joint ventures. This interpretation seems to fit rather precisely the actual patterns of linkage creation in electronics industry, and not so much in the chemical industries. Sector specificities seem to impact a lot here. The birth and evolution of a market for process technology and engineering services in the chemical industry possibly plays a role in reducing the importance of experience factors. In fact, standardised process technology are increasingly available for chemical and petrochemical plants, reducing the need for absorptive and selective capacity in the international markets (while it increases the need for application specific abilities). In addition, the size of fixed costs in chemical industries with excess capacity problems (this is the case of petrochemical firms in particular) have induced firms to consider strategic alliances and joint ventures as substitutes for, and not as complements to, direct investments. Altogether, these sector specific factors contribute to lower the impact of generic experience on linkage creation processes in the chemical industry. Other industries, and even other chemical sub-sectors (e.g. pharmaceuticals), where product and process technologies are less standardised, fixed costs less significant, and no excess capacity problems have emerged, will probably have a greater need for *both* absorptive/selective capacities; *and* utilisation/contextualisation abilities.

The results of this analysis can have implications for technology policy and for policies concerning the promotion and selection of inward foreign investments. In fact, national and regional policies should carefully look at the interaction between the sector-specific evolution of markets and technologies on the one hand, and internationalisation patterns on the other. In principle, a key role is played by *both* the nature of TNCs' presence in a given country or region, *and* their overall ability to mobilise and transfer relevant knowledge on a global scale.

On the one hand, firms' overall subsidiary accumulation (i.e. generic experience) increases their absorptive capacity, thus improving their ability to search for, evaluate and select technological and market opportunities, whose timely exploitation would increase their competitive advantage. On the other hand, acquaintance with local contexts (i.e. specific experience) enhances foreign firms' propensity to commit to local markets, and to enter intense forms of interaction with local partners and institutions. This can provide key opportunities to apply and commercialise technology as well. Through adaptation and commercialisation further stimuli and innovative ideas can emerge, and this will increase the need to resort to collaborative ventures in order to effectively exploit opportunities emerging from local contexts.

According to the structural and technological features of industries being considered, either or both the characteristics of inward investments should be emphasised. We have shown that both generic and specific experience play a fundamental role in linkage creation in electronics industry; while generic experience is not relevant in shaping linkages in chemical industries. Of course, the evolution of industries can change the balance between generic and experience factors in linkage creation processes.

From the view-point of host-countries and/or "host-regions", this implies that a "systemic approach" is adopted in the promotion and selection of inward-investments. According to this approach, in each industry, individual foreign investment projects need to be evaluated taking into account the their connections and interdependencies with other investment projects in the same and in other countries. In fact, the portfolio of national and global investment projects affects the nature and intensity of linkages which will be generated by multinational presence. Multinational experience thus influences also the possibility for other firms, including local ones, to enter networks of asset seeking and knowledge augmenting linkages. As a consequence, inward investments can be seen as fundamental gears for the internationalisation and for the competitive enhancement of local firms as well. However, there is no reason to expect that inward investments in one country generate linkages involving only nor primarily firms active in the same country or region: multinational presence in one country can open up linkage opportunities between local firms and other companies originating from a different country, region or continent, thanks to the mediation of the transnational corporation and its affiliates. This is consistent with the patterns of geographic dispersion of international operations of

European electronics and chemical firms in 1993-97, which we have observed in spite of the geographic concentration of the 1992 stock of inward investments in Europe (see section 3). Multinational firms' investment inflows in Europe have received a significant impulse from EU integration and unification policies, especially over the past decade; this has intensified the creation of new platforms for the development of linkages on a local and global scale. It is now up to European firms and institutions to capture this opportunity.

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Appendix 1 - Variables and sources

VARIABLE NAME	DESCRIPTION	SOURCE
I	Company (see Appendix 1)	
N	Home country of firm I	
K	Home country for firm J $\forall J \neq I$	
DEPENDENT VARIABLES		
JV_{ik}	Number of joint ventures of firm i with partners of country k in 1993-97	ARGO
SA_{ik}	Number of international strategic alliances and cross-licensing operations of firm i in country k in 1993-97	ARGO
AM_{ik}	Number of acquisitions of and merger with firms from country k operated by firm i 1993-97	ARGO
SAT_{ik}	Number of strategic alliances with prevailing technological content of firm i with partners of country k in 1993-97	ARGO
EXPLANATORY VARIABLES		
Measures of TNC experience		
$SUBS92_{ik}$	Number of foreign subsidiaries of firm i in country k in 1992	Dun&Bradstreet
$SUBSAGE_{ik}$	Average age of subsidiaries of firm i in country k in 1992	Dun&Bradstreet
EMP_INT_{ik}	Employment intensity of subsidiaries of firm i in country k, expressed as ratio of local employment on total employees in foreign affilaites	Dun&Bradstreet
$TNCSPREAD_i$	Number of foreign countries where firm i had at least one subsidiary in 1992	Dun&Bradstreet
$TNCINDEX_i$	Average of the ratios: sales of foreign subsidiaries to sales of all subs; employment in foreign subsidiaries to total employment	Dun&Bradstreet
OTHER CONTROL INDEPENDENT VARIABLES		
Company variables		
RD_INT_i	R&D intensity (R&D/Sales) of firm I	Fortune
SAL_i	Sales of firm i, 1992 (billions of US$)	Fortune
Recipient country variables		
$HUMAN85_k$	Average schooling years in 1985 in the total population over 25 (divided by 100)	Barro-Lee (1993)
$PATGDP_k$	U.S. Patent application from country *k* as a share of GDP	World Development Indicators
$SUBSK\_I_k$	Number of subsidiaries in country *k* of sample firms different from *i*	ARGO
GDP_k	Real GDP per capita in country k, 1992 (millions of current US$)	Penn World Tables Mark 5.6
POP_k	Total population of country k, 1992 (millions of inhabitants)	Penn World Tables Mark 5.6
$GGDP_k$	Annual Growth Rate of per capita GDP of country k, 1980-84	Penn World Tables Mark 5.6
VA_k	Value Added in Electrical Machinery (ISIC 383) (Chemicals (ISIC 26) in country k as a share of Value Added in Manufacturing (ISIC 300) in the same country, 1992 (current US$)	UNIDO Industrial Statistics
$OWTI_k$	Own-import weighted tariff rates on intermediate inputs and capital goods	Barro-Lee (1993)
Relation specific country variables		
$WAGELE_{nk}$	Relative electronics wage differentials: average wages in electronics (chemicals) paid in the host county as a share of average wages in electronics (chemicals) paid in the home country	UNIDO Industrial Statistics
$DISTANCE_{nk}$	Takes value 1 if the host country k is in the same geographic region of the home country of firm i; 2 if it is in region which is bordering to the home region; 3 if it is not bordering. For the 13 European firms, DISTANCE=1 for operations with firms from other European countries; =2 with firms from Eastern Europe/Africa and Middle East; =3 with firms from other regions; for the 19 North American firms, DISTANCE=1 when the recipient country is in North America; =2 when it is in Latin America and =3 in all the other cases).	Davidson and McFetridge (1985) use the same criteria

Appendix 2 - The negative binomial regression model

Several formulations of the negative binomial regression model have been proposed. The most common implementation is the following (Greene 1997):

$$E[y_{ik} \mid \mathbf{x}_{ik}] = m_{ik} = \exp(b'\mathbf{x}_{ik} + e_{ik}) = l_{ik} \exp(e_{ik})$$

Where β is the vector of parameters, y_{ik} is our dependent variable, x_{ik} is the vector of regressors and exp(ε) is a gamma distributed disturbance with mean 1.0 and variance 1/α. The introduction of this disturbance allows the variance to differ from the mean[8]. The resulting conditional probability distribution is

$$\Pr(y = y_{ik} \mid e) = \frac{e^{-l_{ik}\exp(e)}\, l_{ik}^{\,y_{ik}}}{y_{ik}!}, \; y = 0,1,2,\ldots..$$

Integrating ε out of this expression produces the unconditional distribution of y_{ik}.

$$\Pr(y = y_{ik}) = \frac{\Gamma(q + y_{ik})}{[\Gamma(q) y_{ik}!]u_i^q (1 - u_i)^{y_{ik}}}, \text{ where } u_{ik} = \frac{q}{(q + l_{ik})} \text{ and } q = 1/a \;^{9}$$

After some algebra (see Cameron and Trivedi 1998; Greene, 1997) we obtain the log-likelihood function which has been used for estimation:

$$\ln L_{ik} = \ln \Pr(y_{ik} = j) = \sum_{m=0}^{j-1} \ln(q + m) - \ln y! + q \ln u_{ik} + y_{ik} \ln(1 - u_{ik})$$

It is worth noting that in the present formulation, the coefficient b_j equals the proportionate change in the conditional mean when the j^{th} regressor changes by one unit. This follows from the fact that

$$\frac{\partial E[y \mid \mathbf{x}]}{\partial x_j} = b_j \exp(b'\mathbf{x} + e) = b_j E[y \mid \mathbf{x}], \text{ and hence } b_j = \frac{\partial E[y \mid \mathbf{x}]}{\partial x_j} \frac{1}{E[y \mid \mathbf{x}]} \text{ which, in fact, is a}$$

semielasticity. Then, a parameter estimate $\hat{b}_j$ of 0.1 indicates that a change in the j^{th} regressor x_j by one unit, produces a 10% change on the dependent variable y. These coefficients are not free of the scale of x_j. One method to solve this problem is to standardise the $\hat{b}_j$ by the sample mean of x_j, and use

$$x_j = \hat{b}_j \bar{x} = \frac{\partial E[y \mid \mathbf{x}]}{\partial x_j} \frac{\bar{x}}{E[y \mid \mathbf{x}]}, \text{ which is a measure of elasticity of } E[y \mid \mathbf{x}] \text{ with respect to } x_j \text{ (Cameron}$$

and Trivedi, 1998).

There are two cases in which this scaling procedure is not necessary. First, when regressors enter logarithmically coefficients are already elasticities. This follows from the fact that the conditional mean take the following form:

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8 In fact, the NB arises an extension of the Poisson regression model, which is carachterized by the equality of the conditional mean and variance (defined as equidispersion):

$$\mathrm{E}[y_{ik} \mid \mathbf{x}_{ik}] = \mathrm{Var}[y_{ik} \mid \mathbf{x}_{ik}] = l_{ik} = \exp(b'\mathbf{x}_{ik}).$$

9 It is easy to show that $Var(y_{ik} \mid \mathbf{x}_{ik}) = E(y_{ik} \mid \mathbf{x}_{ik})[1 + aE(y_{ik} \mid \mathbf{x}_{ik})]$, and α measures the extent to which the variance is greater than the mean. For this reason, α is called the overdispersion parameter

$$E[y \mid \mathbf{x}] = \exp(b_1 \ln(x_1) + \mathbf{x}_2^{'} b_2) = x_1^{b_1} \exp(\mathbf{x}_2^{'} b_2)$$

In this case, a coefficient $\hat{b}_j$ of 0.1, indicates that a 1% change in x_j, produces a 10% change in $E[y \mid \mathbf{x}]$.

Second, when a regressor enters in percentage terms (and hence its value ranges between –1 and +1), a 0.01 variation in the regressor is indeed a unit percentage change in the value taken by the variable being observed. Then a coefficient of 0.1 indicates that a 1% change in the regressor produces a 0.1% change in $E[y \mid \mathbf{x}]$.

Appendix 3 - Sample firms

Acronym	Name	Core Business	Country of Orign	Area of Origin	Sales 1992	R&D / Sal	Pat / Empl	Subs 1992	Tnc Spr	TncInd	JV	SA	AM
	Chemicals												
akzo	AKZO NOBEL NV	Chem	4net	we	9,607	5.5%	2.3%	286	26	27.0%	25	17	25
amehp	American Home Products Corporation	Pharma	1usa	na	7,874	7.0%	5.4%	94	25	23.0%	1	4	7
amoc	Amoco Corporation	Petro	1usa	na	25,280	1.2%	4.7%	25	11	3.1%	51	65	16
atric	Atlantic Richfield Company Inc	Petro	1usa	na	17,503	0.5%	8.9%	30	14	6.1%	19	26	14
basf	BASF	Chem	4ger	we	28,578	4.6%	6.0%	135	33	36.4%	42	28	23
bayer	BAYER	Chem	4ger	we	26,443	7.5%	9.2%	105	32	26.7%	46	39	26
bridge	Bridgestone Corporation	OthCh	9jpn	jpn	13,787	na	2.3%	23	15	52.5%	9	2	17
bripe	The British Petroleum Co. PLC	Petro	4uk	we	58,696	0.9%	3.4%	151	23	47.2%	51	88	10
chev	Chevron Corporation	Petro	1usa	na	37,464	0.6%	8.9%	32	6	8.3%	22	31	8
dow	Dow Chemical Company, The Inc	Chem	1usa	na	18,971	6.8%	14.4%	45	27	30.6%	37	12	23
dupont	Du Pont, E. I. De Nemours and Company	Chem	1usa	na	37,208	3.4%	9.8%	110	30	26.5%	47	33	16
elf	Elf Aquitaine	Petro	4fra	we	37,981	2.3%	2.8%	178	27	50.5%	22	73	6
eni	ENI SPA	Petro	4ita	we	40,366	1.4%	0.9%	79	21	30.2%	8	11	2
exx	Exxon Corporation	Petro	1usa	na	103,160	0.6%	6.2%	122	23	35.9%	35	27	2
fina	PETROFINA SA	Petro	4bel	we	16,776	na	1.1%	86	14	73.6%	4	14	4
glaxo	Glaxo Wellcome PLC	Pharma	4uk	we	7,210	0.5%	3.0%	79	32	22.9%	11	39	11
good	Goodyear Inc	OthCh	1usa	na	11,785	2.8%	2.7%	53	31	30.0%	5	1	8
hoech	Hoechst	Chem	4ger	we	29,443	6.3%	5.9%	190	37	42.5%	70	56	43
ici	Imperial Chemical Industries PLC	Chem	4uk	we	21,291	5.4%	6.3%	115	25	34.7%	43	17	38
idem	Idemitsu Kosan Co. Ltd.	Petro	9jpn	jpn	15,663	na	8.6%	17	9	8.5%	0	2	0
j&j	Johnson & Johnson Inc	Pharma	1usa	na	13,753	8.2%	3.0%	114	33	38.8%	10	2	4
japen	Japan Energy Corp.	Petro	9jpn	jpn	10,566	1.3%	na	17	6	18.5%	5	6	0
merck	Merck & Co, Inc	Pharma	1usa	na	9,662	11.5%	9.8%	35	18	17.7%	10	21	9
mich	Michelin	OthCh	4fra	we	12,623	na	0.3%	95	21	79.9%	19	3	11
mitsu	Mitsubishi Chemical Corporation	Chem	9jpn	jpn	9,471	5.2%	4.4%	29	14	16.5%	21	10	1
mob	Mobil Corporation	Petro	1usa	na	56,877	0.6%	9.0%	81	23	33.2%	44	46	13
nipoil	Nippon Oil Co. Ltd.	Petro	9jpn	jpn	22,816	0.6%	5.7%	9	6	7.1%	25	11	3
norsk	NORSK HYDRO ASA	Chem	5nor	we	9,372	1.2%	0.6%	82	11	24.4%	39	28	12
nova	Novartis AG	Pharma	5swi	we	26,156	10.5%	21.2%	143	21	54.7%	26	77	47
p&g	Procter & Gamble Company Inc	OthCh	1usa	na	30,433	3.1%	2.9%	88	30	20.2%	13	3	11
phill	Phillips Petroleum Company Inc	Petro	1usa	na	11,933	0.8%	29.1%	14	6	8.1%	18	16	4
reps	REPSOL, S.A.	Petro	4spa	we	18,176	na	na	29	9	4.6%	11	9	14
rhone	Rhone-Poulenc S A	Pharma	4fra	we	15,473	7.3%	3.9%	178	33	64.8%	58	42	24
roche	Roche Holding AG	Pharma	5swi	we	9,243	15.8%	5.8%	69	22	43.9%	16	28	15
shell	Shell	Petro	4net	we	98,935	0.9%	4.0%	366	31	57.3%	121	137	56
smith	Smithkline Beecham PLC	Pharma	4uk	we	9,213	9.2%	5.9%	100	26	52.3%	14	64	15
squibb	Bristol-Myers Squibb Company Inc	Pharma	1usa	na	11,156	9.7%	6.8%	45	22	12.7%	2	21	8
tex	Texaco Inc	Petro	1usa	na	36,812	0.7%	12.4%	48	14	22.9%	29	32	11
tot	Total	Petro	4fra	we	25,869	0.7%	0.8%	135	20	47.2%	43	78	25
usx	Usx Corporation	Petro	1usa	na	16,186	0.3%	na	9	4	1.7%	1	7	0
	Electronics												
abb	Asea Brown Boveri Ltd.	Oel	5swi	we	29,109	8.2%	2.4%	623	36	59.0%	66	16	28
alc	Alcatel Alsthom Cie Generale D Electric	Tlc	4fra	we	30,529	6.6%	1.2%	184	32	64.5%	42	78	8
alps	Alps Electric Co. Ltd.	Oel	9jpn	jpn	3,426	1.6%	5.6%	17	11	46.9%	2	4	0
amp	AMP Incorporated	Sem	1usa	na	3,337	8.2%	13.7%	32	24	21.4%	3	2	3
apple	Apple Computer Inc	Cmp	1usa	na	7,086	8.5%	0.8%	34	21	41.5%	21	32	0
att	AT&T Corp	Tlc	1usa	na	64,904	5.0%	4.1%	28	19	1.4%	70	77	14
bce	BCE Inc	Tlc	2can	na	17,214	6.0%	1.4%	28	10	7.0%	57	120	14
bul	Bull	Cmp	4fra	we	5,734	8.7%	2.0%	65	26	60.6%	14	47	3
can	Canon Inc.	Cmp	9jpn	jpn	15,349	5.2%	13.4%	83	25	50.1%	4	20	3
cbs	CBS Corporation	Oel	1usa	na	12,100	1.3%	9.8%	28	15	2.5%	26	16	4
cdc	Control Data Corp.	Cmp	1usa	na	517	29.0%	na	16	11	93.1%	0	3	1
compaq	Compaq Computer Corporation	Cmp	1usa	na	4,132	4.2%	1.2%	41	20	30.1%	2	31	1
dec	Digital Equipment Corporation	Cmp	1usa	na	14,027	12.5%	0.7%	61	36	84.4%	11	53	2
emer	Emerson Electric Co Inc	Oel	1usa	na	7,706	3.2%	1.8%	173	23	18.6%	3	0	4
erics	LM ERICSSON	Tlc	5swe	we	8,394	13.9%	1.0%	36	16	41.0%	44	97	7

fujitsu	Fujitsu Ltd.	Cmp	9jpn	jpn	27,911	9.2%	2.2%	166	26	37.1%	37	128	15
gec	The General Electric Co.	Tlc	4uk	we	10,200	7.2%	2.3%	111	21	17.3%	22	21	4
har	Harris Corporation	Tlc	1usa	na	3,004	4.1%	4.3%	42	20	28.4%	13	9	3
hit	Hitachi Ltd.	Oel	9jpn	jpn	16,427	9.9%	4.3%	143	23	18.6%	60	94	9
honey	Honeywell Inc	Oel	1usa	na	61,466	4.9%	8.0%	98	24	34.6%	9	9	3
hp	Hewlett-Packard Company Inc	Cmp	1usa	na	6,254	5.0%	2.6%	59	26	38.3%	24	97	7
ibm	International Business Machines Corp.	Cmp	1usa	na	65,096	10.0%	4.2%	156	30	33.0%	70	135	11
intel	Intel Corporation	Sem	1usa	na	5,985	13.0%	1.9%	29	20	24.5%	8	77	2
kyo	Kyocera Corporation	Sem	9jpn	jpn	3,546	5.1%	0.7%	39	13	52.5%	2	5	1
litt	Litton Industries, Inc	Oel	1usa	na	5,693	3.2%	3.7%	16	10	5.7%	0	0	4
mats	Matsushita Electric Industrial Co. Ltd.	Cel	9jpn	jpn	57,481	5.5%	3.0%	111	28	16.2%	44	42	7
mot	Motorola, Inc	Tlc	1usa	na	13,341	9.8%	5.9%	60	30	35.3%	34	89	7
ncr	NCR Corporation	Cmp	1usa	na	7,139	0.5%	na	23	17	23.6%	3	10	0
nec	NEC Corporation	Cmp	9jpn	jpn	28,376	7.2%	3.3%	61	21	17.3%	49	105	5
nokia	NOKIA OYJ	Tlc	5fin	we	4,190	5.5%	0.7%	44	14	99.2%	20	83	8
oki	Oki Electric Industry Co. Ltd.	Cmp	9jpn	jpn	5,156	6.4%	3.1%	18	13	25.7%	9	13	0
oli	ING. C. OLIVETTI & C.	Cmp	4ita	we	6,508	5.8%	na	39	16	28.6%	20	10	1
omr	Omron Corp.	Oel	9jpn	jpn	3,752	6.7%	3.3%	40	20	68.9%	3	7	0
phil	PHILIPS ELECTRONICS	Cel	4net	we	33,270	6.2%	4.9%	215	30	34.8%	55	158	34
pion	Pioneer Electronic Corporation	Cel	9jpn	jpn	4,729	4.9%	9.7%	33	14	51.1%	17	16	6
pit	Pitney Bowes Inc	Cmp	1usa	na	3,434	3.0%	5.9%	17	12	7.6%	2	1	0
racal	Racal Electronics PLC	Tlc	4uk	we	2,916	4.7%	1.0%	49	16	25.7%	3	15	6
rayt	Raytheon Company Inc	Oel	1usa	na	9,119	3.2%	3.1%	33	8	5.0%	3	7	1
rico	Ricoh Co. Ltd.	Cmp	9jpn	jpn	8,269	5.3%	7.2%	110	25	33.3%	4	24	3
rock	Rockwell International Corporation	Oel	1usa	na	10,910	4.6%	6.0%	14	9	2.4%	14	11	5
sanyo	Sanyo Electric Co. Ltd.	Cel	9jpn	jpn	12,338	5.4%	1.8%	44	16	19.8%	11	9	9
schnei	Schneider SA	Oel	4fra	we	11,594	3.1%	1.3%	99	31	60.2%	3	6	0
sharp	Sharp Corporation	Oel	9jpn	jpn	12,067	6.3%	7.1%	23	15	22.5%	2	22	4
siem	Siemens	Oel	4ger	we	51,402	10.7%	2.9%	274	30	56.7%	168	265	56
sony	Sony Corp.	Cel	9jpn	jpn	32,023	5.8%	3.5%	148	29	66.7%	39	96	6
tdk	TDK Corporation	Oel	9jpn	jpn	4,247	4.7%	3.2%	28	15	47.0%	0	2	2
thom	Thomson SA	Cel	4fra	we	13,405	5.9%	3.4%	135	21	44.7%	32	65	21
thorn	E M I Group PLC	Cel	4uk	we	6,877	0.6%	1.4%	108	24	31.7%	5	9	9
ti	Texas Instruments Incorporated	Sem	1usa	na	7,470	6.3%	8.1%	21	18	30.7%	20	33	3
tosh	Toshiba Corp.	Cel	9jpn	jpn	37,472	5.4%	6.2%	77	20	25.9%	41	117	1
Unis	Unisys Corporation	Cmp	1usa	na	8,422	6.4%	9.7%	36	24	23.8%	3	18	1
Wang	Wang Laboratories Inc	Cmp	1usa	na	1,910	6.9%	1.2%	28	16	60.7%	3	1	4
Xex	Xerox Corporation	Cmp	1usa	na	18,089	5.1%	7.2%	74	23	37.1%	3	4	7
Zen	Zenith Electronics Corporation	Cel	1usa	na	1,271	4.3%	5.7%	5	3	46.5%	1	2	0

Key: Chem= Industrial Chemicals; Petro=Petro-chemicals; Pharma=Pharmaceuticals; Othch=Other chemicals, including rubber, soaps and detergents; Cmp= Computer, software and office equipment; Tlc=Telecommunications equipment; Sem= Semiconductors and electronic components; Cel= Consumer electronics; Oel=other electronics, including electrical appliances, instruments and parts of electrical and electronics appliances

Tables 1-4: see file Dyn1199c.xls (Excel97 format)

Table 5a Correlation matrix and descriptive statistics - Chemical Firms

	Subs92	Avgage	Empikint	Tncspr	Tncind	R_Dint	Logsal	Deu	Chem	Pharma	Petro	Subsk_I	Human85	Patgdp	Logpop	Logg
Subs92	1.000															
Avgage	0.336	1.000														
Empikint	0.400	0.182	1.000													
Tncspr	0.166	0.311	0.003	1.000												
Tncind	0.145	0.168	0.002	0.482	1.000											
R_Dint	0.010	0.100	0.004	0.301	0.314	1.000										
Logsal	0.099	0.047	-0.002	0.162	0.162	-0.452	1.000									
Deu	0.153	0.118	-0.005	0.377	0.607	0.196	0.049	1.000								
Chem	0.058	0.063	0.005	0.313	-0.063	0.108	-0.050	0.207	1.000							
Pharma	0.008	0.106	0.003	0.293	0.152	0.651	-0.464	0.087	-0.290	1.000						
Petro	-0.037	-0.183	-0.008	-0.585	-0.212	-0.665	0.501	-0.156	-0.487	-0.487	1.000					
Subsk_I	0.541	0.351	0.470	-0.017	-0.006	0.002	-0.006	-0.009	-0.004	-0.004	0.005	1.000				
Human85	0.165	0.137	0.205	0.001	0.007	0.002	0.000	0.012	0.001	-0.001	0.001	0.302	1.000			
Patgdp	0.076	0.020	0.110	0.008	0.009	0.003	0.003	0.013	0.001	0.003	-0.002	0.110	-0.071	1.000		
Logpop	0.128	0.092	0.197	0.001	0.006	0.003	-0.001	0.010	0.002	0.001	-0.002	0.203	-0.175	0.460	1.000	
Loggdp	0.253	0.281	0.189	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.490	0.572	-0.172	-0.394	1.0
Ggdp	0.043	0.083	0.022	0.001	0.001	0.000	0.001	0.001	0.000	0.001	-0.001	0.105	0.029	0.129	0.082	0.1
Owti	-0.132	-0.142	-0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.257	-0.378	0.020	0.294	-0.5
Ceva	-0.061	-0.115	-0.039	-0.002	-0.001	0.000	-0.001	-0.001	-0.001	0.000	0.000	-0.134	-0.299	-0.050	-0.037	-0.1
Wagediff	0.225	0.262	0.149	-0.038	-0.087	-0.071	-0.015	-0.068	-0.004	-0.031	0.032	0.470	0.392	-0.005	-0.212	0.7
Distance	-0.252	-0.218	0.003	-0.164	-0.268	-0.086	-0.020	-0.441	-0.092	-0.037	0.068	-0.130	-0.099	0.064	0.134	-0.1
Mean	1.686	9.021	0.017	21.775	0.323	0.044	9.900	0.475	0.225	0.225	0.450	140.882	7.071	5.928	9.588	8.9
Std.Dev.	5.274	15.037	0.074	9.190	0.203	0.037	0.664	0.500	0.418	0.418	0.498	224.254	2.231	5.962	1.815	0.6
Skew.	9.6	2.2	7.5	-0.2	0.6	0.9	0.6	0.1	1.3	1.3	0.2	2.7	0.2	2.9	0.0	-
Kurt.	159.8	10.6	69.7	1.9	2.7	3.4	2.8	1.0	2.7	2.7	1.0	11.5	2.2	13.8	3.1	
Min	0	0	0	5	0.017	0.003	8.883	0	0	0	0	0	3.046	0.004	5.293	7.1
Max	123	154.250	0.917	38	0.813	0.159	11.544	1	1	1	1	1242	12.141	35.618	13.966	9.7
Cases	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	21

Table 5a Correlation matrix and descriptive statistics -Electronics Firms

	Subs92	Avgage	Empikint	Tncspr	Tncind	R_Dint	Logsal	Deu	Cmp	Tlc	Cel	Subsk_I	Human85	Patgdp	Logpop	Loggd
Subs92	1.000															
Avgage	0.254	1.000														
Empikint	0.351	0.215	1.000													
Tncspr	0.209	0.221	-0.001	1.000												
Tncind	0.068	0.031	0.000	0.289	1.000											
R_Dint	0.027	0.015	0.000	0.138	0.432	1.000										
Logsal	0.158	0.122	-0.001	0.587	-0.231	-0.139	1.000									
Deu	0.142	0.123	-0.001	0.294	0.299	0.031	0.104	1.000								
Cmp	-0.046	0.044	-0.001	0.119	0.128	0.208	-0.139	-0.214	1.000							
Tlc	-0.022	-0.004	0.000	-0.031	-0.016	0.054	0.037	0.329	-0.316	1.000						
Cel	0.028	-0.013	0.000	0.017	0.022	-0.169	0.154	0.097	-0.316	-0.200	1.000					
Subsk_I	0.404	0.361	0.384	-0.007	0.003	-0.001	0.000	-0.011	0.001	-0.005	0.002	1.000				
Human85	0.151	0.184	0.131	0.003	0.004	-0.001	0.003	0.009	-0.002	0.000	0.004	0.299	1.000			
Patgdp	0.059	0.021	0.093	0.003	0.001	0.002	-0.001	0.014	-0.001	0.009	-0.005	0.115	-0.080	1.000		
Logpop	0.096	0.076	0.170	0.002	0.003	0.001	0.002	0.008	-0.003	0.004	0.001	0.205	-0.181	0.457	1.000	
Loggdp	0.222	0.333	0.173	0.000	0.001	0.000	0.000	0.002	-0.001	0.001	0.001	0.490	0.570	-0.188	-0.400	1.00
Ggdp	0.050	0.089	0.059	0.000	0.000	0.001	-0.001	0.002	0.000	0.002	-0.002	0.104	0.028	0.125	0.080	0.12
Owti	-0.115	-0.157	-0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.257	-0.378	0.027	0.297	-0.59
Ceva	0.104	0.150	0.146	-0.002	-0.001	0.001	-0.003	0.001	0.001	0.004	-0.003	0.223	0.113	0.126	0.100	0.21
Wagediff	0.198	0.357	0.131	-0.040	-0.032	-0.012	-0.018	-0.046	-0.014	0.016	0.021	0.535	0.467	-0.011	-0.108	0.73
Distance	-0.180	-0.164	-0.051	-0.131	-0.135	-0.013	-0.048	-0.445	0.097	-0.144	-0.047	-0.032	-0.015	0.042	0.047	-0.06
Mean	1.466	6.545	0.018	21.277	0.364	0.064	9.165	0.240	0.333	0.166	0.166	143.012	7.066	5.866	9.581	8.90
Std. Dev.	5.382	11.879	0.068	7.277	0.223	0.041	1.018	0.427	0.471	0.372	0.372	228.072	2.227	5.855	1.810	0.64
Skew.	16.2	2.7	6.8	0	0.7	3	-0.1	1.2	0.7	1.8	1.8	2.7	0.2	2.9	0	-0.
Kurt.	438.9	13.3	61.4	2.5	3.3	16.4	3.1	2.5	1.5	4.2	4.2	11.3	2.2	14.5	3.1	3.
Min	0	0	0	4	0.014	0.004	6.248	0	0	0	0	0	3.046	0.003	5.293	7.15
Max	178	109	0.944	37	0.991	0.290	11.083	1	1	1	1	1242	12.141	35.617	13.965	9.79
Cases	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	2916	291

Table 6a - Determinants of linkage creation for a sample of 40 chemical firms, 1993-1997, Negative binomial r

Variable	Mean	JV Coeff.	JV t-ratio	JV P-value	SA Coeff.	SA t-ratio	SA P-value	AM Coeff.	AM t-ratio	AM P-valu
Constant		-20.268	-7.609	***	-26.350	-10.491	***	-20.288	-7.579	***
SUBS92	1.686	0.006	0.283		0.000	0.029		0.035	2.666	***
SUBSAGE	9.021	0.001	0.138		0.003	0.647		0.008	1.472	
EMP_INT	0.017	1.673	1.444		1.224	1.539		1.520	1.649	*
TNCSPREAD	21.770	-0.013	-0.781		-0.004	-0.307		0.004	0.251	
TNCINDEX	0.323	1.111	1.840	*	-0.246	-0.384		-0.979	-1.607	*
R_DINT	0.044	-10.128	-3.017	***	-7.724	-2.284	**	1.374	0.325	
(Log)SAL	9.900	0.678	3.433	***	0.817	5.247	***	0.597	2.895	***
DEU	0.475	0.049	0.245		0.351	1.495		0.422	2.340	**
CMP	0.225	1.002	3.229	***	2.154	3.252	***	-0.031	-0.098	
TLC	0.225	0.532	1.693	*	3.036	4.517	***	-0.224	-0.675	
CEL	0.450	0.063	0.154		2.288	3.386	***	-0.829	-1.875	*
SUBSK_I	140.900	0.0004	0.851		0.0011	3.572	***	0.0007	2.051	**
HUMAN85	7.071	0.043	0.896		0.220	4.695	***	-0.002	-0.049	
PATGDP	5.928	0.015	1.352		0.030	2.637	***	0.004	0.271	
(Log)POP	9.588	0.715	10.914	***	0.654	11.844	***	0.600	7.296	***
(Log)GDP	8.910	0.423	1.763	*	0.628	2.612	***	0.812	3.142	***
GGDP	0.015	9.520	2.063	**	-5.439	-1.302		-25.629	-6.249	***
OWTI	0.129	0.317	0.636		0.327	0.791		1.525	3.134	***
VA	0.206	1.808	2.018	**	0.639	0.655		-4.147	-3.564	***
WAGEDIFF	0.541	-0.037	-0.129		0.765	3.874	***	0.513	1.859	*
DISTANCE	2.477	-0.002	-0.022		-0.081	-0.888		-0.110	-1.044	
a		2.948	9.959	***	1.500	-		2.030	6.351	***
N. of observations		2160			2160			2160		
N. of iterations		32			26			34		
Log likelihood function		-1340.526			-1224.625			-924.6602		
Restricted log likelihood		-1652.048			-1411.168			-1023.303		
LR Test (?^{2}(1))[a]		623.0446***			373.0848***			197.2865***		

***: 99% confidence; **: 95% confidence; *: 90% confidence

[a] Likelihood Ratio Test for H_0: Model is Poisson; H_1: Model is Negative Binomial

Table 6b - Determinants of linkage creation for a sample of 54 electronics firms, 1993-1997, Negative binomial

Variable	Mean	JV			SA			AM		
		Coeff.	t-ratio	P-value	Coeff.	t-ratio	P-value	Coeff.	t-ratio	P-value
Constant		-26.311	-12.990	***	-32.309	-16.692	***	-17.949	-4.881	***
SUBS92	1.466	0.015	1.147		0.001	0.103		0.010	0.754	
SUBSAGE	6.545	0.008	1.389		-0.007	-1.637		0.012	2.264	**
EMP_INT	0.018	1.768	2.778	***	0.845	0.990		2.002	2.001	**
TNCSPREAD	21.280	-0.002	-0.213		0.028	2.576	***	0.005	0.248	
TNCINDEX	0.365	-0.443	-1.371		-0.016	-0.062		-0.663	-1.214	
R_DINT	0.065	8.718	4.086	***	12.016	9.194	***	8.183	2.586	***
(Log)SAL	9.165	0.825	9.254	***	0.589	8.282	***	0.603	5.224	***
DEU	0.241	0.264	1.605		-0.159	-0.999		0.646	2.352	**
CMP	0.333	0.020	0.134		0.165	1.191		-0.399	-1.535	
TLC	0.167	0.614	3.729	***	0.722	5.045	***	0.027	0.114	
CEL	0.167	-0.090	-0.486		-0.093	-0.545		-0.103	-0.410	
SUBSK_I	143.000	0.0006	2.238	**	0.0009	3.534	***	0.0017	5.184	***
HUMAN85	7.066	0.080	2.139	**	0.227	6.343	***	0.239	4.881	***
PATGDP	5.866	0.016	1.609		0.032	3.432	***	0.007	0.321	
(Log)POP	9.582	0.883	13.218	***	0.738	12.089	***	0.500	4.303	***
(Log)GDP	8.909	0.717	3.596	***	1.538	7.650	***	0.175	0.442	
GGDP	0.015	9.990	3.078	***	11.804	2.823	***	-10.507	-1.338	
OWTI	0.129	0.512	1.451		2.265	6.478	***	1.408	2.212	**
VA	0.080	9.219	5.033	***	7.732	5.144	***	8.477	3.407	***
WAGEDIFF	0.520	-0.660	-2.845	***	0.067	0.302		-0.045	-0.114	
DISTANCE	2.630	-0.363	-3.568	***	-0.310	-3.887	***	-0.315	-2.314	**
a		1.670	8.901	***	1.700	-		1.373	4.599	***
N. of observations		2916			2916			2916		
N. of iterations		27			26			27		
Log likelihood function		-1366.027			-1725.201			-670.1495		
Restricted log likelihood		-1595.276			-2244.952			-703.4940		
LR Test (?^{2}(1))[a]		458.4971***			1039.502***			66.68902***		

***: 99% confidence; **: 95% confidence; *: 90% confidence

[a] Likelihood Ratio Test for H_0: Model is Poisson; H_1: Model is Negative Binomial