Explaining the growth of strategic R&D alliances by European firms

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Abstract This paper first develops an explanation for the increasing popularity of strategic technology alliances, both globally, and by EU firms. It then evaluates, using data over the period 1980-1994, how private, non-subsidised cooperative agreements in R&D by EU firms has evolved, paying particular attention to the growth of intra-EU activity relative to extra-EU agreements (i.e., EU-US and EU-Japan alliances). Essentially, EU firms' partnering habits reflect the need to seek strong partners regardless of nationality within a given industry, although intra-EU partnering enjoyed a brief popularity during the latter half of the 1980s.

The single European market (SEM) initiative, through its various stages of economic cooperation until the establishment of the European Union, can arguably be said to be one of the most important socio-economic developments of this century. At the heart of much of this activity has been a belief that cooperation by institutions and firms across the various European countries represents a means by which the technological and economic gap between the US and Europe after the Second World War might be narrowed. As Peterson (1991) has pointed out, although technological collaboration has constantly remained high on the agenda of European policy makers, pan-European R&D activities have only systematically been developed by policy makers since the 1980s. Several initiatives by the European Commission have been implemented over the past two decades in an attempt to bolster the competitiveness of European firms, particularly in high technology sectors.

In addition to these Europe-specific changes, though, there have been several changes in the global economy which are generally described under the rubric of 'globalisation'. These developments have also impacted significantly on the growth of cross-border economic activity in general, as well as the increasing popularity of alliance activity in particular.

In this paper, we first seek to explain the reasons for the increasing importance of alliance activity, and the growth of a special class of alliances, that of strategic technology partnering (STP) or R&D alliances, paying special attention in our discussion to the role of European integration. In addition, we focus on explaining the need to acknowledge the strategic reasons for their growing popularity, in addition to the cost-minimising ones. Second, we intend to evaluate the extent to which private (i.e., non-subsidised) cooperative agreements in R&D by EU firms has evolved, paying particular attention to the extent to which economic integration and globalisation may have influenced intra-EU activity relative to extra-EU agreements (i.e., EU-US and EU-Japan) over the period 1980-1994. Given the crucial nature of technology development to the competitiveness of firms, we wish to enquire

whether in fact the SEM initiative has had a significant effect on the propensity of EU firms to collaborate in R&D type activities, with special attention to information technology, new materials and bio-technology. Our analysis is somewhat anecdotal and qualitative, and utilises data from the MERIT-CATI data base, which contains records of over 10,000 instances of strategic technology partnering (see appendix).

Cross-border activity and European integration

The SEM initiative has been judged to be reasonably successful, in terms of encouraging intra-European economic activity -at least in terms of trade and FDI - although there have been some reservations expressed about the qualified nature of these gains, given the inter-relation between the two. For instance, there has been an increase in trade in particular sectors that are sensitive to non-tariff barriers that were to be scrapped by 1993, as firms have sought to improve their efficiency through the rationalisation of production in order to achieve economies of scale. However, as Hughes (1992) has argued, US and Japanese firms have been equally well positioned as EC firms to exploit the SEM initiative. She points out that the only way firms can take advantage of scale economies is by the relocation and readjustment of production activities, something which US and Japanese firms have also undertaken in response to the SEM initiative. Indeed, as numerous have shown[1], there has been a growing amount of FDI inflows during the run-up period to 1993 as non-EU firms have established (or consolidated) their presence within the EU partly in the fear of a 'fortress Europe' as well as to exploit potential benefits of a vibrant, single market of 300-odd million consumers.

In terms of FDI, Dunning (1997a, 1997b) in a survey of inward FDI into the EU, concluded that a) FDI into the EC since the early 1980s has grown faster than in most other parts of the world; b) the geographical and industrial distribution of inward FDI stocks have changed to reflect a certain level of rationalisation, with the more labour intensive aspects moving to the periphery (Portugal, Spain and Greece); and with the bulk of technology and information sensitive sectors remaining in the 'core' countries of the EU; c) intra-EC FDI and Japanese FDI inflows have outpaced US inward FDI. He also observed that overall, the spatial distribution of production activities has not undergone a major shift.

The current paper aims to throw some light into the third area that has been expected to promote the growth of intra-EU economic activity, that of industrial collaborative activity, or strategic alliances. In particular, we focus on understanding the behaviour of a rather

[1] See Dunning (1997a and 1997b) for a review.

important subset of cooperative agreements, that of R&D alliances, or strategic technology partnering (STP). In this paper we use R&D alliances and STP as synonyms, which refers to strategic alliances where innovative activity is at least part of the agreement. By strategic alliances we refer to inter-firm cooperative agreements which are intended to affect the long-term product-market positioning of at least one partner (Hagedoorn 1993).

Although it is clear that there has been an explosion in the propensity of European firms to undertake strategic alliances, to what extent can this be attributed or explained by the SEM initiative? To what extent can changes in the propensity to undertake alliances be attributed to SEM-specific factors, rather than changes that can be ascribed more generally to the phenomenon of globalisation? Can we apply our understanding of European integration as applied to trade and FDI to explain collaboration in general, and R&D cooperation in particular?

This is an area that has received considerable attention: the European Commission, through its framework programmes has encouraged R&D collaboration by public and private EU based institutions, significantly relaxing its prohibition on anti-competitive agreements where they are related to technology development (Urban and Vendemini 1992). In addition, under the auspices of programmes such as ESPRIT, RACE, BRITE and BRIDGE, it has provided considerable subsidies to collaborative R&D. This paper focuses on examining the growth in non-subsidised EU strategic technology alliances - that is, those R&D alliances that are not established directly through the programmes of European Commission.

The growth of alliance activity

The worldwide growth of alliance activity has been described (Dunning 1995, 1997c, Narula and Dunning 1998b) as being a distinctive feature of globalisation. Globalisation as used here refers to the increasing cross-border interdependence and integration of products for goods, service and capital. Dunning (1995, 1997c) goes further to propose that we are moving to a new age where flexible economic arrangements find increasing favour, in what he describes as one of alliance capitalism, shifting from the older paradigm of hierarchical capitalism where economic activity was conducted through hierarchies.

The exact means and nature of this shift, as well as the implications of alliance capitalism and globalisation are a matter of some debate, and have been addressed elsewhere (e.g., Landes 1998, Rodrik 1997, Dunning 1998). In the context of the present paper, we are interested in understanding what the implications of these changes are to the growth of EU alliances. European integration, it can be posited, is a sub-process within globalisation, one

that is driven by economic imperative, simply emphasising de facto economic integration by globalisation through de jure political and economic integration initiatives. In other words, the growth of cooperative agreements by EU firms illustrates the growth of alliance activity worldwide, with the SEM-related developments being somewhat secondary to those due to the forces of globalisation.

Nonetheless, simply by invoking globalisation one cannot explain the growth of this form of economic activity. As posed by Kay: "if cooperation is such a good thing…..why did firms generally wait until recently before pursuing such activities so enthusiastically"? (Kay 1997: 177)

One of the fundamental reasons for the growth in alliances lies in the reduction of transaction costs. These have occurred due to, inter alia, (1) the introduction of new space-shrinking technologies (particularly information and computer technologies, which have reduced cross-border communication, information and organisational costs; (2) the harmonisation of regulations and barriers as a result of growing economic liberalisation. These have been further enhanced by the establishment of supra-national regional and inter-regional agreements such as NAFTA, and the EU, as well as multilateral protocols and agreements under the auspices of the WTO, WIPO, etc. These agreements have, ceteris paribus, reduced the risks of shirking as the costs of monitoring and enforcing cross-border alliances have fallen. The harmonisation of regulations within the SEM initiative, in such a view represents a more advanced version of this activity, and further lowers transaction costs for firms within the Union. If this were the primary reason determining the growth of alliance activity, and if the European economy were dominated by EU firms, it might be argued that these costs reductions accrue to a greater extent to intra-EU alliances, than to extra-EU agreements. However, as implied by Hughes (1992) and Ramsay (1995), many of the major foreign-owned MNEs already present (and in many cases, firmly embedded) in the EU economy would accrue the same benefits as EU firms. As Narula and Hagedoorn (1999) have shown, there are no significant country-specific differences in the propensity to engage in alliances. As such, it is more likely that the benefits of integration will result in lower costs for all firms regardless of nationality, and regardless of the organisational mode employed. However, there continues to be a considerable bias of MNEs towards the home country: it can thus also be argued that, ceteris paribus, greater absolute cost-reductions might occur for EU firms since the extent of their European value added activity is generally higher and the significance of their European operations much larger to their total worldwide activity. This reasoning might suggest that ceteris paribus, EU firms should derive a larger benefit when

engaging in collaboration with other EU firms as a result of European integration relative to collaboration involving non-European firms.

We emphasise that our argument heretofore focuses on comparing the benefits of one organisational mode between nationalities. Kay (1991, 1997) and others have suggested however, that full internalisation will have also proportionally fallen, thereby still making quasi-internalisation as a second best option. However, while reduced transaction costs might lead firms which otherwise might have considered full internalisation to undertake collaborative agreements, this assumes that these firms were already interested in international expansion. Firms that might not have had the resources to engage in overseas activity on their own, would now also be able to consider it, since a collaboration could require fewer resources than it might otherwise have done before integration. In other words, this line of reasoning would suggest ceteris paribus, the number of firms undertaking alliances within the EU would have increased since the 1980s in response to integration.

In addition to this objection, though, transaction costs provide only a partial explanation for the growth in alliances, and only suggests why one group may derive greater benefits from collaboration than other groups. It does not answer why firms increasingly prefer quasi-hierarchical arrangements to fully-internalised ones. If transaction cost theory were to provide a complete explanation, the decline in costs due to either globalisation or integration should lead to at least the similar extent of benefits for traditional hierarchical arrangements. In answering this, it is important to reflect on the presence of the word 'strategic' in strategic alliances. What differentiates a strategic alliance from a customer-supplier network is the underlying motive of the cooperation (Narula and Hagedoorn 1999). The primary motivation for a customer-supplier network is that it is primarily cost-economising in nature, while strategic alliances embody a second motivation, which is strategic in nature. By 'strategic' they suggest that such agreements are aimed at long-term profit optimising objectives by attempting to enhance the value of the firm’s assets.

Several reasons exist for the growth in popularity of cooperative agreements which embody a strategic element. One explanation is based on the increased competition due to liberalisation of markets and the globalised nature of the operations of firms. Such increased competition has led to a low-growth scenario over the past two decades or so, and firms need to seek cheaper sources of inputs or divert sales from slow or negative growth markets (Buckley and Casson 1998). Such changes often need to be undertaken with rapidity. Declining transaction costs associated with contractual or quasi-internalised relationships in addition to falling profits margins has led to a dis-integration of certain firms in particular

industries, as they seek flexibility and lower risk, which have hitherto preferred vertical integration. Indeed, some notice has been made of the process of dis-investment, that, coincidentally or not, appears to have become quite commonplace during the last decade (Benito 1997).

In addition though, the emergence of new technological sectors (such as biotechnology) and the growing technological convergence between sectors (such as computers and automobiles, or new materials with transportation) have also played an important role. The cross-fertilisation of technological areas has meant that firms need to have a increasing range of competencies (Granstand et al 1997). This encourages the use of alliances to seek complementary assets. As has been emphasised by others (e.g., Kogut 1988), the use of M&A is not a viable option where the technology being sought is a small part of the total value of the firm. Greenfield investment does not represent a viable option either, in most instances, as the time and costs of building new competencies from scratch may be prohibitive. It should be noted that in some instances alliances are used as a precursor to M&A (Hagedoorn and Sadowski 1996). In connection with this, there has also been a growing cost of development, and of acquiring the resources and skills necessary to bring new products and services to market. Increasing the market size, and the sharing of costs and risks associated with staying on the cutting-edge of technology creates strong motivation to undertake alliances, no matter how much firms may prefer to go it alone.

Last but not least, there are the game-theoretic considerations. As Kay (1997) explains, 'it is necessary to engage in networks with certain firms not because they trust their partners, but in order to trust their partners' (Kay 1997: 215). In addition, there is the follow-my-leader strategy, as originally highlighted by Knickerbocker (1973). Firms seek partnerships in response to similar moves made by other firms in the same industry, not always because there are sound economic rationale in doing so, but in imitation of their competitors.

The special case of Strategic alliances to conduct R&D

Our focus in this paper is on strategic technology partnerships or R&D alliances, which focus on cooperative arrangements where technological innovation is at least part of the agreement. These alliances are of a different and special nature: this is the one aspect of value adding activity that continues to be highly centralised and internalised, even in a domestic scenario. In general, while production activities have gradually been increasingly internationalised, there has been relatively little internationalisation of R&D (see e.g., Patel and Pavitt 1991, Dunning and Narula 1995, Archibugi and Michie 1995). Nonetheless, it is worth noting that

there has been some growth in the technological development activities of MNEs relative to its level 20 years ago, and these changes indicate two trends worthy of note. First, in addition to overseas R&D activities associated with demand side factors, there has been a growing extent of foreign R&D activities by firms in response to supply-side factors (Florida 1997, Kuemmerle 1997). Second, there has been a growing use of external or quasi-external technological sources. Tidd and Trewhella (1997) suggest that the most important external sources of technology are: universities, consortia, licensing, customers and suppliers, acquisitions, joint ventures and alliances and commercial research organisations. Although there is little systematic and thorough analysis of this process, companies such as Philips and Akzo-Nobel are currently attempting to externally source 20% of their technology needs (van Hoesel and Narula 1999). Indeed, there is a direct relationship between how much R&D a firm does internally, and its external acquisition of technology - Veugelers (1997) demonstrates that there is a positive relationship between external technology sourcing and internal R&D. Indications are that collaborative arrangements to undertake R&D are becoming ever more popular, having tripled in significance since the early 1980s (Gugler and Pasquier 1996).

Its special characteristics require certain important caveats to be noted. To begin with, there is a fundamental difference in the definition of R&D alliances and non-R&D alliances. Traditionally alliances have been defined as agreements which have a long-term and formal aspect which link aspects of their businesses (Porter and Fuller 1986). Strategic technology partnering, as used here, refer to agreements that are intended to undertake specific tasks and are generally terminated at the completion of these tasks, and are by definition short- (and often fixed-) term in nature.

There are other important considerations due to the special nature of R&D alliances. First, it is important to note that there is a strong causality between size and the propensity to engage in STP, given the need to have sufficient resources to undertake R&D (Hagedoorn and Schakenraad 1994). Second, trade barriers, as we have noted in the previous section have not played a major role in inhibiting the relocation of R&D, except where such R&D is associated with production (i.e. adaptive R&D). Stand-alone R&D facilities, which are common in knowledge-intensive sectors, are often located due to supply-related considerations. Such activities have not necessarily been affected by the decline in transaction costs due to the SEM initiative - skilled human capital and knowledge (in either tacit of non-tacit form), has long enjoyed relatively restriction-free freedom of movement across borders. Although certain improvements such as the common patenting system, and the harmonisation of regulations

may lowered costs in general, the benefits of lowered communication costs (due inter alia to ICTs) have occurred on a global level.

Therefore, the reduction in trade barriers may affect both exporting and foreign direct investment through wholly owned subsidiaries, R&D alliances are largely unaffected by these. While it is true that firms engaged in asset-exploiting activities such as production or sales have a broader choice of options that include wholly owned subsidiaries and arms-length technology acquisition, some of these options are simply not available to firms that are seeking to undertake R&D. First, because technology is tacit by nature, and as far as technology development is concerned, even more so. Arms-length transactions are simply not as effective, particularly in technology-intensive sectors or new, 'emerging' sectors, even if markets for these technologies were to exist. The further away these technologies are from the market (i.e., more research oriented than development-oriented) the less likely that technology can be obtained through market mechanisms. Besides, its partly-public good nature prevents prospective selling firms from making technologies available for evaluation, and without doing so, the prospective buyer is unable to determine its worth. Markets therefore, are liable to fail in their ability to function.

The choice of partner in R&D alliances can be international or domestic. Why do firms prefer in certain instances to partner with a foreign firm rather than a domestic firm? This is related to the question of why firms do not undertake all the R&D at their home location in the first place. The literature suggests that this is due to both supply and demand issues. The demand issues are well-known, and are generally associated with adaptive R&D in response to specific market conditions. More recently attention has been drawn to the supply issues. Firms are seeking to utilise immobile assets, which may be either firm-specific or location specific. In the case where they are firm-specific, they are often associated with clusters of firms, and country-specific characteristics. It is well acknowledged that location advantages are idiosyncratic and path-dependent, and the nature of innovatory activities in a given location are associated with the national systems of innovation (Edquist 1997, Lundvall 1992). The nature of the benefits arising from a non-cooperative arrangement require physical proximity to the firm or cluster, in order to seek indirect technology spillovers, which can be a highly costly, uncertain and random procedure that requires a long-term horizon. In the case of basic research, for instance, this might occur through the hiring of researchers that hitherto worked for a competitor. Where such immobile assets are country- but not firm-specific, they may be embodied in aspects of the national systems of innovation. Whether the advantage being sought is firm- or country-specific, the establishment of a greenfield

laboratory is a feasible option, but involve high costs of start-up, and considerable time. In fields where innovation is rapid, it may not provide a fast-enough response. The use of M&A is even less attractive, as Kay acknowledges, where the area where the complementary resources sought only cover a small area of the firm's interests. Even where a firm wishes to acquire a R&D facility, it is generally not possible to do so, except in rare circumstances.

It is true, nonetheless, that there are also strategic limitations to the use of alliances. First, there is a danger that an alliance may represent a precursor to M&A. Indeed, Hagedoorn and Sadowski (1996) show that 2.6% of strategic technology alliances lead to M&A, a figure that is quite significant given the high percentage (estimates vary between 50 and 70%) of alliances that are terminated before completing their stated objective.

Why would a potential partner wish to collaborate with another which has limited or as-yet-undemonstrated resources to offer? First, because of the nature of innovation, the only way to determine the nature of a potential partner's research efforts is to examine them. One way it can do so is by engaging in some form of mutual hostage exchange, which an alliance provides. Second, even where the partner's resources prove to be of a limited or inappropriate nature, and the alliance is terminated prematurely, information about its former partner's competencies are then available to either firm in future periods, should it require competencies similar to those on offer by its ex-partner. Third, as Hagedoorn and Duysters (1997) have argued, while selecting partners that are well-established players in existing technologies may represent profit maximising situation, it is optimal only in a static environment. In a dynamic environment, where there is a possibility of technological change (or even a change in technological trajectories), having ties to a wide group of companies, including companies that have yet to demonstrate their value, represents a higher learning potential.

Strategic technology alliances are not only undertaken by firms seeking complementarily or resources. As Narula and Dunning (1998b) note, firms may also engage in alliances in order to co-opt the competition. Take the situation where two firms in the same industry are pursuing an important new breakthrough. Neither can be certain that they will win the race to innovate. As such, it may be in their best interest to collaborate, thus ensuring both that they are jointly 'first': half a pie may be considered better in conditions of uncertainty while there is a probability that there may be none at all.

Let us put this into the context of the current paper. The evidence on strategic technology partnering points to the fact that the need for complementary assets and the reduction of risk have become increasingly important as these are global phenomena, while

open markets may have aggravated the use of need to co-opt and block competitors, since firms are obliged to restructure to strengthen or even maintain their competitive position, either through aggressive or defensive means. Indeed, such a restructuring of EU industry has occurred since the early 1980s in response to the impending single market agreement (Dunning 1997a). Much of the EU-subsidised R&D programmes was aimed at achieving this renewed competitiveness, and indeed, was undertaken in earnest by most firms with a view to being able to compete on equal terms with other EU firms as well as US and Japanese firms by 1993. Indeed, Hagedoorn and Schakenraad (1991) show that there was a concurrent rise in non-subsidised and subsidised R&D during the later half of the 1980s.

It is important to note that the definition of strategic technology alliances as used in the MERIT-CATI database includes both equity and non-equity agreements. As such, while we have made general comments about the choice between markets, hierarchies and quasi-hierarchies, there is a significant difference between various organisational modes of STP. Broadly speaking though, it is possible to consider these as being of two major groups - equity-based agreements and contractual, non-equity based agreements. It is significant to note that the choice of alliance mode is determined by the technological characteristics of sectors of industry (Hagedoorn and Narula 1996). Equity agreements are preferred in relatively mature industries while contractual alliances are more common in so-called high-tech industries.

There is, however, another dimension that is worth noting. There has been a decline in the use of equity agreements on a global basis, whereby the percentage of equity STP has fallen steadily from 46.9% in 1980-1984 to 26.1% during the period 19890-1994 (Narula and Hagedoorn 1999). A similar tendency has been noted for all alliance groupings by region (Narula and Hagedoorn 1997). This points to an important issue which relates to the process of learning. Given the novelty of R&D alliances, it can be hypothesised that firms prefer to undertake more hierarchical arrangements, but as they have acquired experience with this from of technological innovation, they have gradually switched to more flexible, but inherently riskier agreements. The effect of industry-specific trends is also quite apparent - these changes have occurred across industries, rather than countries; although it is true that there are differences between countries, they are not significant.

European R&D alliances, have demonstrated a similar tendency, and indeed, the fact that these patterns demonstrate industry-wide trends rather than national suggests that the same process of learning about the mechanics of alliance formation and management apply to

all firms regardless of nationality. It also highlights the need of firms, again regardless of nationality to partner with the most appropriate firms regardless of national origin.

Examining the evidence

What of the trends of European firms in undertaking strategic technology partnering? Figure 1 is a plot of the number of newly established STP agreements by regional pairings. For instance, in the case of European-Japanese STP, we count how many alliances contain at least one Japanese and one European partner. The data shows that in the case of intra-EU alliances, between 1980 and 1984, there were a total of 270 alliances, and over the proceeding 5 years this number almost doubled to 534. Between 1990 and 1994, the level of intra-EU partnering dropped to its pre-1985 extent. In the case of EU-US alliances, the trend is somewhat different. Although there was a sharp increase in transatlantic partnering activity in the mid 1980s, the level of this activity (on an aggregate basis) continued unabated until 1993, with a sharp increase in the latest year. In the case of EU-Japanese alliances, the level of activity has remained at more or less the same level over the entire 15 year period for which data is available. Table 1 examines the trends for the UK, France and Germany and shows the change over time in their alliance activity with the seven most significant industrial countries of partner firms between 1980 and 1994. These trends tell a similar story[2].

What do these data imply? First, that European industry began to undertake a much more serious view of alliances in the mid 1980s, with a doubling of activity over a short period. This can be in part be attributed to three things. First, that the process of economic integration had by this time been seen to be a reality. Second, European firms had begun to realise by the mid-1980s that they were technologically lagging in new core high technology sectors such as information technology, and leading European had begun to cooperate by this period (Mytelka and Delapierre 1987, Mytelka 1995). This cooperation in R&D was further enhanced by encouragement from the European commission around this same period, with the

[2] The data in Table 1, while indicative of similar trends to figure 1 and figure 2, cannot be directly compared. This is because of the method of counting.: An alliance between, say, a US and German firm would count as one alliance if we count US-EU alliances or US-German alliances. However an alliance between a German, French and US firm would be counted as a US-French alliance and a US-German alliance, although on a aggregate basis (i.e., US-EU alliances), it would represent a single alliance.

commission establishing a 'Big 12 roundtable' to develop proposals for new collaborative R&D projects (Peterson 1991). Although our data excludes information from EU-subsidised projects, the availability of funds through the establishment of EU subsidised R&D programmes (which expanded to include other non-IT national champions which were major consumers of IT products such as Volvo, Aerospatiale and Volkswagen) further enhanced the intra-EU collaborative efforts of European companies. It is indeed no coincidence that the launch of the EC's framework programme and Eureka occurred around the same time as the surge in alliance activity. In other words, European firms, driven by the need to improve their competitive position in the face of increasing competition on a global basis, sought to improve their technological advantages through collaboration, a process which was further encouraged through financial and legal support from the European Commission. It is worth noting that it is exceedingly difficult for governments to determine, where R&D collaboration is concerned, which projects within a large company's research portfolio actually benefits from the R&D subsidies (Narula and Dunning 1998a).

Third, given the realities of the SEM initiative, the need to become competitive within the European context required a certain level of restructuring on the part of the various individual EU firms. Although while Kay, Ramsay and Hennart's (1996) argue that intra-EU collaboration was inhibited because potential partners are also potential competitors, the fact is that this is also one of the primary attractions of partnering: strategic partnering also affords firms a chance to (temporarily) pre-empt competition, in addition to allowing the partners to evaluate the capabilities of the partner firm. Indeed, Hagedoorn and Schakenraad (1993) found that over the period 1980 to 1989 the subsidised R&D networks and private R&D networks were started almost simultaneously, and that the intensity of private R&D cooperation could be predicted by the intensity of subsidised R&D cooperation.

The subsequent decline of the number of new alliances in the 1990s, as predicted by Kay (1991), is quite dramatic. We postulate that this reflects the result of re-structuring of European industry, in part through the series of M&A that occurred in the run-up to the single market (e.g., Nixdorf by Siemens, ICL by Fujitsu, Plessey to Siemens-GEC) as well as the re-positioning of firms' technological profiles (e.g., the exit of Philips from computers, its entry of the telecommunications sector with AT&T) (Mytelka 1995).

The second reason for the decline in intra-EU alliances may have to do with the growth of extra- EU alliances. As Table 1 and Figure 1 both show, the propensity for EU firms to engage in alliances with Japanese and US firms also increased in the mid-1980s. This reflects in part the desire for Japanese and US firms to seek strategic positions within

European industry prior to 1992 to avoid any question of being excluded from 'fortress Europe'. In addition, there had been some attempt to spur transatlantic R&D cooperation though the strategic defence initiative (SDI) programme of the US government in the mid 1980s (Carton 1987). Perhaps most significantly of all, however, was that EU firms were primarily spurred to partner with US and Japanese firms given their technological lead that US firms possessed, in information technology and bio-technology, and to a lesser extent, new materials, while Japanese firms had a technological lead in information technology and new materials. In other words, EU firms would be interested in partnering with firms regardless of nationality, depending primarily on their relative competitive positions in the industry, or the presence of significant clusters at given locations. Figure 2 shows trends in STP by the three core technological areas- biotechnology, information technology and new materials for which data is available, further subdivided by geographic groupings. EU firms prefer to engage in transatlantic STP, particularly in sectors such as bio-technology where there is a considerable technological gap with the US. Two other reasons can be presented as plausible explanations. First, the decline in the number of new intra-EU agreements may be because the rules regarding the participation of non-EU firms in EU-subsidised consortia was relaxed. Second, as suggested by Mytelka (1995) in relation to the European IT sector, the EU 'big 12' failed to act in a orchestrated way, due to a lack of consensus on strategy.

This relates to our earlier discussion on the motives for STP since firms are often engaged in partnerships to access resources that they are unable to acquire as easily by going it alone. These resources may be either firm-specific, or even location specific, associated with the national systems of innovation of a region or a country. For instance, centres of agglomeration of economic activity exist, and firms may wish to collaborate with other firms located there in order to accrue externalities that derive therefrom. More importantly, however, companies will prefer to partner with technology or market leaders, regardless of where they might be located, or what their nationality is. Furthermore given the increasing tendency for the cross-fertilisation of technologies, firms prefer to collaborate than develop a simultaneous expertise in several seemingly unrelated technologies. A second aspect of motive is that firms may simply engage in alliances to so-opt a competitor. It is well known, for instance, that firms do not always have recourse to patenting as a means to protect new and rapidly evolving technologies, and must rely on secrecy or by co-inventing with a potential competitors (Levin et al 1987). In other cases, by co-invention, firms are able to determine that they will jointly have 'won' the race to innovate (Narula and Dunning 1998a). Other less R&D-specific reasons also exist. For instance, Veugelers (1996) notes that

European firms are more active in alliances in industries in which they lack a comparative advantage, but are more defensive in sectors where they have a comparative advantage. Furthermore, weak EU firms actively seek strong partners, and strong EU firms ally with weak partners. Given that most of the EU firms in the bio-technology and information technology sector do not enjoy a significant competitive advantage, it is not surprising therefore, that a majority of STP by these companies are with Japanese and US firms.

Conclusions

The effect of the SEM initiative has been studied from both the FDI and the trade perspective, and as far as these two modalities of undertaking economic activity are concerned, it has been judged as a qualified success. Relatively little has been said about strategic technology alliances, an area which the European Commission has explicitly sought to promote. This has been the focus of this paper.

We have tackled two main issues. First, we have attempted to highlight why cooperative agreements that involve R&D activities differ in nature from those involving purely 'mainstream' activities such as production and marketing. Most importantly, we have attempted to explain why strategic alliances represent first best option, especially where firms are internationalising their R&D for supply-side reasons. What we have tried to illustrate is that in the case of R&D activity, cooperative arrangements may be a more efficient means to conduct transactions than hierarchical arrangements, where non-static circumstances prevail and the activity undertaken is governed by uncertainty and a high degree of tacitness.

Second, we have analysed data from the MERIT-CATI database on private (non-subsidised) strategic technology partnering by European firms. While intra-EU cooperation did in fact increase during the second half of the 1980s, this level was not sustained through the early 1990s. Instead, EU firms have shown a continued propensity to undertake EU-US and EU-Japanese R&D collaboration, particularly in the information technology, bio-technology and new materials sectors.

In addressing these two issues we have inadvertently also addressed an area of controversy, which relates to the efficacy of the framework programmes. This relates to pioneering work by Neil Kay (1991) and subsequent contributions of Ramsay (1992) and Kay Ramsay and Hennart (1996). Kay's original analysis predicted that strategic alliances by European firms would not increase due to the SEM, despite expectations of the European Commission to the contrary. While our data does indeed confirm his prediction, our analysis and theoretical reasoning suggest a different interpretation.

The basic reasoning of the Kay article is that alliances are in fact a last resort. Although one cannot say with certainty that they are now a first resort in all cases, the evidence on alliances would seem to indicate that in certain instances, particularly that of technological innovation in emerging and rapidly evolving sectors, they are oftentimes a preferred option over wholly owned activities, including greenfield investments or M&A. R&D alliances have two important features which distinguishes them from marketing or production-based alliances. First, R&D alliances are designed with a fixed- (generally short-) term horizon. Second, R&D activities cover only a small part of the value adding activities of firms.

In addition, we do not believe that transaction costs alone explain R&D alliances. While Kay agrees with the need to consider strategic issues, his work suggests that 'good fences makes good neighbours'. However, if firms were to go it alone, they forgo the opportunity to observe what the other firms in the same industry are up to. This goes for firms that have proven abilities in a given area of specialisation, as well as firms that are not. In addition, where new technologies are concerned, there is an increasing need to seek a broad range of competencies in unrelated fields. Firms generally have limited resources and cannot possibly engage in vertical and horizontal integration to internalise all their needs. As we have noted earlier, there is an growing tendency to focus on a few selected core technologies, rather than vertically integrate. By engaging in alliance activity rather than internalisation, as Buckley and Casson (1998) have noted, firms are thus able to be more flexible, and can respond to low growth scenarios and, at the same time, optimising returns. In addition, to the benefits of flexibility, the need for complementary assets, market power and economies of scale, there are other reasons which are peculiar to strategic technology partnering. First, firms have to monitor the activities of their competitors, since at the frontier, it is difficult to determine who might be the winner in the race to innovate. Alliances allow firms to do so, and it allows firms that are engaged in conducting similar research, to pre-determine (if they so desire) the winner by agreeing to jointly win the race to innovate. Second, at the technology frontier, it is optimal to partner with all sorts of companies, even those that without demonstrated track record (Hagedoorn and Duysters 1997). This line of research suggests there is some value in the adage, 'hold your friends close, and your enemies even closer'.

Although our paper does not analyse the framework programmes, in our reading, the evidence both here and elsewhere would suggest that the underlying objective was not to encourage cooperation per se. The underlying objective, rather, was to encourage

collaboration in the run-up to the SEM so as to allow EU industry to restructure in order to better face the competitive milieu of the single market in the post 1992 scenario. In that the prediction of the commission was wrong that the popularity of intra-EU alliances would continue at the same levels after 1992, we agree with the view held by Kay and associates. We also agree, that in a post-1992 scenario, it does indeed make sense to partner, ceteris paribus, with non-EU firms rather than other EU firms, particularly since firms from these countries are technologically superior to EU firms in some of the core technologies.

We do however also believe that the decline of intra-EU STP in the 1990s is an unforeseen consequence of the rejuvenation of European competitiveness. One of the consequences, perhaps unintended, has been that the major European players have repositioned themselves so as not compete directly amongst each other. This, it would seem, is as a direct result of the slimming-down and restructuring that firms such as Philips and Siemens have undertaken as well as the result of the failure of cooperative activities such as the 'big-12 roundtable'. The framework programmes need to be seen in the overall impact, rather than the success or failure of particular instruments, although it is true that certain aspects (such as cooperative activity) of the framework programmes were more unsuccessful than others.

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APPENDIX

THE COOPERATIVE AGREEMENTS AND TECHNOLOGY INDICATORS (CATI) INFORMATION SYSTEM

The CATI data bank is a relational database which contains separate data files that can be linked to each other and provide (des)aggregate and combined information from several files. The CATI database contains three major entities. The first entity includes information on over 10,000 cooperative agreements involving some 4000 different parent companies. The data bank contains information on each agreement and some information on companies participating in these agreements. We define cooperative agreements as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only those inter-firm agreements are being collected, that contain some arrangements for transferring technology or joint research. Joint research pacts, second-sourcing and licensing agreements are clear-cut examples. We also collect information on joint ventures in which new technology is received from at least one of the partners, or joint ventures having some R&D program. Mere production or marketing joint ventures are excluded. In other words, our analysis is primarily related to technology cooperation. We are discussing those forms of cooperation and agreements for which a combined innovative activity or an exchange of technology is at least part of the agreement. Consequently, partnerships are omitted that regulate no more than the sharing of production facilities, the setting of standards, collusive behaviour in price-setting and raising entry barriers - although all of these may be side effects of inter-firm cooperation as we define it.

We regard as a relevant input of information for each alliance: the number of companies involved; names of companies (or important subsidiaries); year of establishment, time-horizon, duration and year of dissolution; capital investments and involvement of banks and research institutes or universities; field(s) of technology[3]; modes of cooperation[4]; and some comment or available information about progress. Depending on the very form of cooperation we collect information on the operational context; the name of the agreement or project; equity sharing; the direction of capital or technology flows; the degree of participation in case of minority holdings; some information about motives underlying the alliance; the character of cooperation, such as basic research, applied research, or product development possibly associated with production and/or marketing arrangements. In some cases we also indicate who has benefited most.

The second major entity is the individual subsidiary or parent company involved in one (registered) alliance at least. In the first place we assess the company's cooperative strategy by adding its alliances and computing its network centrality. Second, we ascertain its nationality,

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[3] The most important fields in terms of frequency are information technology (computers, industrial automation, telecommunications, software, microelectronics), biotechnology (with fields such as pharmaceuticals and agro-biotechnology), new materials technology, chemicals, automotive, defence, consumer electronics, heavy electrical equipment, food & beverages, etc. All fields have important subfields.

[4] As principal modes of cooperation we regard equity joint ventures, joint R&D projects, technology exchange agreements, minority and cross-holdings, particular customer-supplier relations, one-directional technology flows. Each mode of cooperation has a number of particular categories.

its possible (majority) owner in case this is an industrial firm, too. Changes in (majority) ownership in the eighties were also registered. Next, we determine the main branch in which it is operating and classify its number of employees. In addition, for three separate subsets of firms time-series for employment, turnover, net income, R&D expenditures and numbers of assigned US patents have been stored. The first subset is based on the Business Week R&D scoreboard, the second on Fortune's International 500, and the third group was retrieved from the US Department of Commerce's patent tapes. From the Business Week R&D Scoreboard we took R&D expenditure, net income, sales and number of employees. In 1980 some 750 companies were filed; during the next years this number gradually increased up to 900 companies in 1988, which were spread among 40 industry groups. The Fortune's International 500 of the largest corporations outside the US provides amongst others information about sales (upon which the rankings are based), net income and number of employees.

Table 1: Strategic technology partnering by the three largest EU countries

STP by German firms with companies from:	1980-84	85-89	90-94
UK	9	29	21
France	11	26	21
Netherlands	10	25	16
Italy	5	13	7
USA	51	108	163
Japan	22	33	41

STP by UK firms with companies from:	1980-84	85-89	90-94
Germany	9	27	18
France	10	31	24
Netherlands	9	27	8
Italy	5	13	8
Japan	117	159	121
USA	69	139	140

STP by French firms with companies from:	1980-84	85-89	90-94
Germany	9	24	21
UK	10	31	24
Netherlands	5	24	15
Italy	14	17	14
Japan	23	27	27
USA	58	69	100

Source: MERIT-CATI dataset

Figure 1: Number of new STP per year by EU firms, 1980-1994

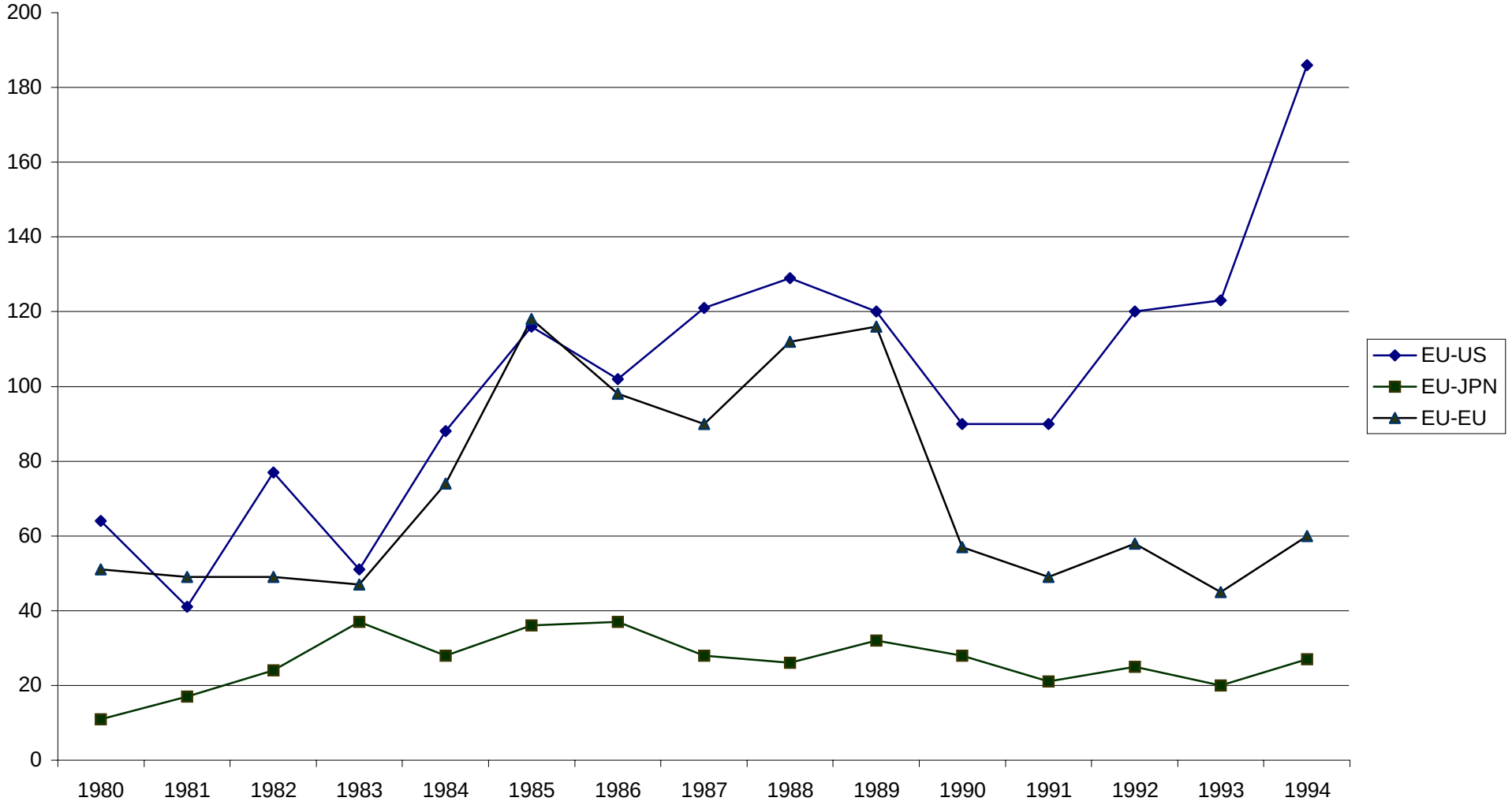

Figure 2: STP by EU firms, by core sectors and regional groupings