

MERIT-Infonomics Research Memorandum series

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2003-001



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Globalisation and trends in international R&D alliances

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07 January 2003

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Globalisation and the growth of international R&D alliances

Abstract: The growth of collaborative activity is greatly influenced by the process of globalisation. This paper focuses on the narrow area of collaborative R&D activity, and takes a 'macro' view of the effects of these developments. Globalisation has affected the need of firms to collaborate, in that firms now *seek* opportunities to cooperate, rather than identify situations where they can achieve majority control. The use of collaboration is particularly acute in capital-intensive and knowledge-intensive sectors. These are also the sectors where firms have expanded internationally fastest, as they need to compete in various markets simultaneously, but also to exploit and acquire assets and technology that may be specific to particular locations. The increasing similarity of technologies across countries and cross-fertilisation of technology between sectors, coupled with the increasing costs and risks associated with innovation has led firms to consider R&D alliances as a *first-best* option in many instances. This has important welfare implications and impinges directly on the industrial competitiveness of locations.

1 Introduction

Firms are not restricted just to a dichotomy of choices – either staying at home or relocating to acquire immobile sources of knowledge. There are a variety of 'in-between' options available to access location-specific resources, and these include cooperative agreements. Such agreements are also a useful organisational mode when firms seek technologies that are specific to other firms.

It should be apparent even to the most casual observer of business news that cooperative agreements are being signed continuously, and in ever-greater numbers with every passing year. This is a phenomenon that has sparked the attention of managers, national and supra-national regulators, policy-makers and academics alike. It is argued by some that this phenomenon is the death knell of the traditional firm, that firms will become increasingly 'virtual'. One of the main points that the literature highlights is that there are limits to the extent to which firms can use cooperative agreements as a substitute for in-house activity (see

e.g., Veugelers 1997, Nagarajan and Mitchell 1998, Nooteboom 1999, Brusoni *et al* (2001), Narula 2001). I believe that the death of the firm is greatly exaggerated and that there are a great many misconceptions about cooperative agreements, some of which I shall seek to address in this paper.

The growth of collaborative agreements is undoubtedly greatly influenced by the process of globalisation, which is taken here to mean the growing interdependence of locations and economic units across countries and regions (Narula 2003). As with globalisation, the effect varies across industries, and is particularly acute in sectors where consumption patterns are increasingly homogenous across countries, and which are capital-intensive as well as knowledge-intensive, in terms of (i) investment in innovation and technology, (ii) requiring large plant scales, and (iii) depend on new and fast-evolving technologies. These are sectors where firms have expanded internationally fastest, as they are thus able not just to compete in the various markets simultaneously, but also to exploit and acquire assets and technology that may be specific to particular locations.

It is axiomatic that firms in some sectors need to innovate in order to survive, which, in this day and age, implies being present in all the major international markets where competitors are present. This is not just to meet demand, but also to overcome supply constraints - companies wish to exploit the particular characteristics of given countries that represent inputs to the innovative process, required to generate new competitive advantages. Unfortunately, given the capital-intensity of these activities and the inherent risk of innovation, firms cannot afford to be omnipresent. Internalising and undertaking all (or even most) aspects of value-adding activity through wholly owned subsidiaries in every location is no longer possible, and in many instances not even desirable. Over the past two decades, firms have increasingly sought to undertake activities through collaborative efforts. Although collaborative activity is not a new practice, it is undeniable that there has clearly been a

process of evolution whereby there is an increasing use of alliances explicitly for strategic purposes. Its novelty is not as an organisational form – economic units have collaborated for millennia. Intricate linkages between economic entities that create informal and formal networks to undertake value added activity dates back to before the 17th century, where production of goods was undertaken by ‘putting out’. Rapid Japanese industrial growth over the last century has been partly attributed to the cooperation between interlinked firms with limited equity cross-holdings within industrial groups referred to in the post World war II era as *Keiretsu* (See e.g., Gerlach 1992, Nakamura 1981). Dunning (1995, 1997) and others suggest that this represents a new, ‘age of alliance capitalism’ whereby flexible economic arrangements find increasing favour, shifting away from the older paradigm of hierarchical capitalism where hierarchies represented the primary mode through which economic activity was undertaken. What is particularly unique about ‘the age of alliance capitalism’ is its widespread use by firms of all sizes and nationalities, and its use in a growing variety of activities which have hitherto been centralised and internalised, such as R&D. Furthermore, cooperative activity has a growing international element, and is not just limited to related firms but is often undertaken with international competitors. In addition, even within international strategic technology partnering (STP), there has been a gradual shift away from equity-based partnering to non-equity forms of agreements.

The rest of this paper focuses on evaluating some of these trends. First, I will clarify some definitional issues. There are a wide variety of cooperative agreements, all of which have fundamental differences in their structure and objectives, but are often referred to interchangeably as strategic alliances, collaborative agreements, or networks or outsourcing. I intend to clarify this issue. My primary objective is to focus on R&D alliances, but in the process I intend to also deal with more general aspects that apply to all kinds of cooperative agreements.

Second, cooperative agreements have different objectives, depending on what aspect of the value-added chain we are dealing with. This paper focuses on the narrow area of collaborative R&D activity. I intend to explain what role cooperative agreements play in technological competence development, in light of the growth of what is best described as the multi-technology corporation. I propose that these trends can be explained by combining a resource-based view of the firm, in addition to traditional economic rationale, and by acknowledging the special nature of innovative activity, which has certain unique characteristics that separates it from production activities, as well as the strategic nature of firm-decision making. I will illustrate my arguments with particular reference to some data on EU strategic technology partnering, explaining why alliances have become increasingly important to firms.

2 The characteristics of ownership advantages and technology

Although there are many motives for undertaking R&D alliances which Hagedoorn (1993) classifies into those relating to general characteristics of technological development; those relating to the innovation process; and those relating to market access and opportunities. One of the primary objectives of R&D collaborative ventures is to learn, for the basic reason that the ability of firms to compete effectively for market share is a function of their ability to maintain and renew its firm-specific assets. These assets are commonly referred to as ownership advantages. An important distinction needs to be made about the nature of ownership advantages of companies, which, in knowledge-intensive firms, comprise different forms of knowledge. There are two types of knowledge that comprise the ownership advantage of firms. First there is technical knowledge which is made up of what might traditionally be defined as technology, both embodied in plant and equipment (and to a large extent codifiable), as well as the employee-specific knowledge that is only to a limited degree

non-tacit. Second, there is organisational knowledge, which comprises knowledge of transactions, both *intra-firm* and *inter-firm*. In general, throughout the current paper, I focus on R&D alliances whose primary purpose is to acquire technical knowledge and to generate innovations. Although innovation can (and frequently do) occur through the acquisition of organisational improvements, and/or the ability to undertake inter-firm transactions more efficiently, we limit ourselves here to study only alliances to undertake *overt* R&D¹.

FIGURE 1 ABOUT HERE

There are different ways of classifying innovatory activities. In this paper innovation is viewed along a continuum between basic research to development, with the determining factors being (a) the generic nature of the innovation and (b) the distance from market. By generic nature, I refer to a distinction introduced originally by Kuznets (1962) and used in a modified way by Arora and Gambardella (1994) and Trajtenberg et al (1997). Figure 1 summarises the basic argument. Knowledge that is 'basic, or 'generic' represents knowledge that is not country or demand-specific, and is less appropriable than 'applied' or 'specific' ('applied D' in Figure 1). It is important to highlight that we are speaking of *research outcomes*, since laboratories are often engaged in several similar (and often related) projects simultaneously, and since technological development is an uncertain process, it is not always possible to say *ex ante* whether a certain project is applied or basic research. Nonetheless, a distinction can be made between the extremes. On the one hand, firms can explicitly engage in projects that are more 'blue sky', or pursue scientific research that has no clear market value in the short run, aim to change the technological paradigm, or have a major impact in defining

¹ For a discussion of organisational knowledge, see Inkpen (1996, 1998)

general laws rather than solving particular problems. On the other hand, demand-specific modifications or adaptations can be explicitly undertaken, which are more context-specific and are clearly 'applied D'. It is worth noting that regardless of the basic-ness or generic nature of the knowledge, there is always some extent of context specificity. Even codifiable technology is context-specific to at least some extent (Cantwell 1991). Because technology is the cumulative sum of innovations and proceeds incrementally based on 'localised search' patterns centred on the technology possessed by the firm in previous periods, the technology of any given firm is unique, such that no two firms can have exactly the same kind of technology.

3 Explaining Strategic Technology Partnering: Some Definitions

It is germane to begin this discussion with some fundamental definitions of terms as used throughout this paper. Before proceeding further, some distinction needs to be made of the difference between the following three terms which are often mistakenly used as synonyms: cooperative (or collaborative) agreements, networks and strategic alliances. Cooperative agreements include all inter-firm cooperative activity, while strategic alliances and networks represent two different (though related) subsets of inter-firm cooperation.

By strategic alliances I refer to inter-firm cooperative agreements which are intended to affect the long-term product-market positioning of at least one partner (Hagedoorn 1993). I am specifically interested in strategic technology alliances where innovative activity is at least part of the agreement. What differentiates a strategic alliance from a network is the underlying motive of the cooperation (Figure 2). This differentiation has its roots in an ongoing debate within the management literature of the relative merits of various underlying theories explaining the behaviour of firms to use markets and hierarchies (see Madhok 1997 for a more in-depth analysis of the various aspects of this debate). On the one hand, there is the

transaction costs/internalisation perspective, which derives its roots in the work of Williamson (e.g., 1975) and Coase (1937) which explains the behaviour and organisational mode and the mode of entry of firms based on their need to *minimise net transaction costs* faced by the firm. This body of literature has been expanded by others including Buckley and Casson (e.g., 1976), Hennart (e.g., 1993) and Rugman (e.g., 1980). On the other hand, there is also the organisational capability and technology based view of the firm developed in parallel by several schools, including behavioural theory (Cyert and March 1963) and the economics of technological change (e.g., Nelson and Winter 1982). Other work includes Kogut and Zander (1993) and Hill, Hwang and Kim (1990), and Cantwell (1991) who have highlighted the fact that firms undertake decisions based on the need to enhance their technological and organisational capabilities because they need to *enhance the value* of the firm. Underlying the difference between these two perspectives is a fundamentally different view of the way firms make decisions, since the transactions cost school assumes that firms are driven by opportunism while the technology/knowledge view assumes that firms are boundedly rational. I do not intend to debate the views here, but accept Madhok's (1997) perspective that the two schools may be regarded as complementary to each other, although an organisational learning and technology based view underlies our understanding of strategic technology partnering.

The approach favoured here is that both transaction cost minimising and value-enhancing reasons underlie most of the behaviour of firms. Firms would *prefer* to increase short term profits through cost-economising as well as long-term profit maximising through value enhancement, but this is not always possible. It is important to emphasise that very few agreements are distinctly driven by one motivation or the other. What I am trying to establish here is that agreements that are established with primarily short-term cost efficiencies in mind are generally customer-supplier networks, while agreements where a long-term value

enhancement is the primary objective are strategic alliances. Figure 2 illustrates my basic argument with a few examples.

*****FIGURE 2 ABOUT HERE*****

Decisions to conduct a vertical alliance may tend to be primarily cost-economising, but also have a strategic element to them, in that by collaborating with the supplier firm you may have pre-empted a similar move by a competitor. The behaviour of firms within Japanese Keiretsu, to a greater extent, tend to have cost-based benefits. Collaborations such as these are primarily cost-economising and may be defined as *networks*. On the other hand, cooperative agreements such as between Sony and Philips to develop DVD technology, or the Sematech partnership are clearly aimed at improving the future value of the various partnering firms and are thus more strategically motivated rather than cost-economising. As such they represent strategic alliances rather than networks. It should be noted that it is particularly difficult to clearly delineate strategic alliances from networks, given that firms have no incentive to reveal their true motives to the public, and more importantly, to their partner firm, especially where these might prove detrimental to the proposed relationship.

Collaborative agreements of all sorts have been undertaken for strategic, economic and diplomatic reasons since the beginning of history. However, what differentiates their current popularity is that until recently they represented a second-best option, utilised only where full internalisation was not possible. It was conventional wisdom that firms preferred, wherever possible, to establish wholly owned subsidiaries, and where this was not possible for whatever reason, to maintain a controlling (which generally implied majority-) stake in its affiliate. In general, firms preferred to maximise their equity stake in all their activities, particularly so when entering or expanding in foreign markets. Over the past two decades or so, alliances and

networks have come to represent a *first-best* option. Indeed, there are four primary characteristics that differentiate collaborative activity in the era of alliance capitalism from those in earlier periods (Narula and Dunning 1998). First, agreements are not primarily made to overcome market failure. Second, alliances are increasingly made not just to achieve vertical integration, but also horizontal integration. Third, alliance activity is no longer a phenomenon peculiar to certain countries such as Japan (see Gerlach 1992), but typical of most advanced industrialised economies (see Narula and Sadowski [2002] for a discussion on developing country alliances). Fourth, while agreements were primarily made to enhance or achieve market entry or presence (i.e., asset-exploitation), an increasing number of alliances are now made to protect or enhance the technological assets of firms (i.e., asset-creation or acquisition). It is worth noting that alliances involving marketing and sales are, more often than not, cost economising in nature, while R&D alliances are more strategic in character. Two independent surveys of alliances (Culpan and Kostelac, 1993, Gugler and Pasquier 1996) found that sales and marketing accounted for 41% and 38% of all alliances surveyed, while R&D alliances accounted for only 10.8% and 13% respectively. One of these studies noted, however, that R&D alliances had tripled in relative importance since the 1980s.

Organisational modes of alliances.

Figure 3 describes the range of inter-firm organisational modes generally utilised in collaborative agreement activity. There are a wide range of types of agreements, reflecting various degrees of inter-organisational interdependency and levels of internalisation. These range from wholly-owned subsidiaries, which represent complete interdependency between the firms and full internalisation. At the other extreme lie spot-market transactions, where totally independent firms engage in arms-length transactions in which either firm remains completely independent of the other. As Figure 3 illustrates, we include within the rubric of

collaborative agreements two broad groupings of agreements that can be regarded as representing different extents of internalisation, or what may succinctly be described as quasi-internalisation. Although it is difficult to be specific and concrete regarding the ordinal ranking, it is safe to say that equity-based agreements represent a higher level of internalisation and inter-organisational interdependence than non-equity agreements.

*****FIGURE 3 ABOUT HERE*****

Not all equity cooperative arrangements are alliances. For instance, joint ventures have always been a popular means for undertaking business activity in developing countries, but this was often because of government restrictions on the ownership of domestic companies by foreign investors. In other words, these joint ventures were only undertaken because of government restrictions prevented the establishment of majority or wholly owned subsidiaries. Very often, the partner would be a government corporation or ministry, who would act as a silent partner. As such, these so-called joint ventures actually represent a subsidiary of a multinational rather than a true joint venture, since the local partner is not sharing managerial control and providing a proportional input in a strategic sense. In addition traditional joint ventures were generally undertaken across several activities, often including marketing and production. Newer joint ventures are increasingly single activity: joint ventures that are formed primarily to conduct R&D are often referred to as research corporations.

4 The growth of alliance activity

There is little doubt that the growth of R&D alliances mirrors the globalisation process. Although there was some growth in R&D alliances in the 1960s and 1970s, inter-firm agreements began to grow exponentially since the 1980s (Hagedoorn 2002). Figure 4 illustrates this trend with data from 1980 onwards.

****FIGURE 4 ABOUT HERE****

The growth of partnerships is associated in part with economic imperatives. Nonetheless, simply by invoking globalisation one cannot explain the growth of this form of economic activity. I intend to shed some light on the determinants of this sustained interest in cooperative agreements in R&D.

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 case of the EU is particularly useful in illustrating the growth of alliances because the EU is not only at a rather advanced stage of economic integration achieved over the last 50 years, but EU firms are at the technological cutting edge, and some

EU locations are important agglomerative locations (see e.g., Cantwell and Iammarino 2003). From a transactions costs perspective, the harmonisation of regulations within the Single European Market (SEM) initiative, in such a view represents a more advanced version of this activity, and further lowers transaction costs for firms within the Union. As Narula and Hagedoorn (1999) have shown, there are no significant country-specific differences in the propensity to engage in alliances. As such, the benefits of integration have resulted in lower costs for all firms regardless of nationality. However, there continues to be a considerable bias of MNEs towards the home country in terms of the concentration of value adding activity: 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. As Figure 5 shows, intra-European cooperation did gain briefly in popularity relative to EU-Japanese and EU-US alliances, but this growth was not sustained for long, as predicted by Kay (1991).

****FIGURE 5 ABOUT HERE****

It is important to remember that the decline in transaction costs due to the SEM have also reduced costs for other organisational modes (Kay 1991, 1997). The costs associated with full internalisation will have also proportionally fallen, and all else were equal, alliances would still be a second best option. Certainly, reduced transaction costs might lead firms which otherwise might have considered full internalisation to undertake collaborative agreements. Firms that might not have had the resources to expand (whether domestically or

internationally) 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 European 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.

However, 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 completely 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. To understand the non-transaction cost based reasons for alliances, it is useful to return to the motives for alliances as discussed in figure 2, and reflect on the word 'strategic' in strategic alliances. What differentiates a strategic alliance from a customer-supplier network is the underlying motive of the cooperation. 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 have 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 an increasing range of competencies (Granstrand 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 1999). 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.

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 do 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 I have noted earlier, there is a 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, optimise 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 which I will discuss in the next section.

5 The special case of strategic alliances to conduct R&D

R&D 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, R&D tends to stay 'at home' (see e.g., Kumar 2001, Narula 2002a). 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 1996). Second, there has been a

growing use of external or quasi-external technological sources. Tidd and Trehwella (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 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 or 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 have lowered costs in general, the benefits of lowered communication costs (due inter alia to ICTs) have occurred on a global level.

Although 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, or, at least, will function inefficiently. It is no surprise, therefore, that technology partnering has grown fastest in high technology sectors where market options are less well-developed, while partnering activity in low and medium technology sectors has steadily declined as a percentage of all agreements (Hagedoorn 2002).

The choice of partner in R&D alliances can be international or domestic. There has been considerable variation in the international aspect of R&D alliances over time, although

broadly speaking this reflects the gradual internationalisation of firms and competition. Country size differences persist: Small countries tend to engage in more alliances than large countries – the US has the smallest level of international partnerships with less than 50% being international, while Switzerland has an international share greater than 90%. There are also considerable differences by industry (Hagedoorn 2002). 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 involves 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 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 an 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 (1999) 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 (see Inkpen and Beamish 1997).

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 (2002) have argued, while selecting partners that are well-established players in existing technologies may represent a 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 complementarity of resources. As Narula and Dunning (1998) 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.

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 1997). Much of the EU-subsidised R&D programmes were aimed at achieving this renewed competitiveness, and indeed, were 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. 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. Indeed, Hagedoorn and Schakenraad (1993) show that there was a concurrent rise in non-subsidised and subsidised R&D during the later half of the 1980s. Nonetheless, in a study of non-subsidised R&D collaboration by European firms, Narula (1999) shows that while intra-EU cooperation did in fact increase during the second half of the 1980s, this level was not sustained through the 1990s (as illustrated in Figure 5). The initial rise in intra-EU alliances reflected the fact 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 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). By the end of the 1980s this growth in intra-EU activity declined, but EU firms showed a continued propensity to undertake EU-US and EU-Japanese R&D collaboration, particularly in the information technology, biotechnology and new materials sectors. The subsequent decline of the number of new alliances in the 1990s is quite dramatic. Narula (1999) postulated that this reflected 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 by Siemens-GEC) as well as the re-positioning of firms' technological profiles (e.g., the exit of Philips from computers, its entry into 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 Figure 5 shows, 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 through 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 the 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.

It is important to note that the definition of strategic technology alliances includes both equity and non-equity agreements, as discussed in an earlier section. 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 1980-1994 (Narula and Hagedoorn 1999). A similar tendency has been noted for all alliance groupings by region. 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 form of technological innovation, they have gradually switched to more flexible, but inherently riskier agreements.

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.

6 Conclusions

This paper has focused attention primarily on a rather ‘macro’ scale the reasons why firms of a given nationality tend to engage in R&D alliances. Within this discussion I have dealt with some of the firm-level issues that determine why firm prefer alliances to full internalisation. Our admittedly simplistic analysis lends support to, and confirms, some of the trends and patterns observed by the technology partnering literature. First, that strategic technology partnering as a phenomenon is best explained using an organisational learning framework. Recent theoretical studies have suggested that firms’ decisions regarding what extent to internalise value adding activity is determined not just by a cost minimisation strategy driven by short term profit optimisation, but also by an interest to enhance the value of the firm in a more long term horizon. It does so by improving the nature and types of technological/knowledge-based assets it possesses. Given the firm’s bounded rationality, however, this decision is more of a strategic one. This is what determines the primary difference between networks and alliances.

There has clearly been an explosion in the use of alliances to undertake innovative activity, and this trend is closely related to the process of globalisation. Globalisation has affected the need of firms to collaborate, in that firms now *seek* opportunities to cooperate, rather than identify situations where they can achieve majority control. In addition, the increasing similarity of technologies across countries and cross-fertilisation of technology between sectors, coupled with the increasing costs and risks associated with innovation has led to firms utilising STP as a *first-best* option. STP, as with most forms of innovative activity, is primarily concentrated in the Triad countries. However, the propensity of firms of a given nationality to engage in STP varies according to the characteristics of the country. This is because small and technologically less advanced countries tend to be focused in fewer

sectors than large countries, due, *inter alia*, to the differences in economic structure and demand. We also see that strategic alliances are dominated by large firms, and there is indeed a positive relationship between firm size and STP levels by firm. We also observe a high percentage of STP utilised on a cross-border basis. That is, a considerable share of STP seems to be undertaken with partners of other nationalities. There seems to be some suggestion that while some firms undertake STP as a means to complement their existing R&D activity, other seek to use STP as a substitute.

There seems to be no clear relationship to the extent to which firms engage in international production and engage in technology partnering. This difference is not mediated, as might have been expected, by nationality of ownership or by R&D expenditures, but preliminary indications suggest that its differences exist on a sectoral basis, suggesting that it is an industry-specific phenomenon.

There is also a clear shift of alliance activity towards non-equity forms of agreements, and this has occurred more or less uniformly across countries, and we attribute this change partly to the improved enforceability of contracts and intellectual property protection, and partly to the increasing knowledge and familiarity firms now have in conducting international business activity. On a firm level basis, the propensity to use equity agreements is associated with industry-specific differences, rather than country-specific differences.

It would seem that countries are increasingly engaged in promoting the competitiveness of their domestic firms, in what can be loosely be described as ‘techno-nationalism’ (Ostry and Nelson 1995), with the intention of developing ‘national champions’. Most of the major industrial economies practice some sort of government intervention to boost the ownership advantages of their firms. While some governments do so through indirect means that improve the quality of location bound resources and capabilities to attract

mobile ownership advantages of domestic and foreign owned firms, others attempt more direct intervention by directly participating in ownership advantage-generating activities.

Much of this intervention was originally as a response to globalisation, with the desire of protecting weak domestic firms from international competition. Ironically, this has led to a greater use of alliance and network-forming activity. As such, techno-nationalism is doomed to failure, as the question of “who is us” and ‘who is them” makes such policies increasingly redundant (Reich 1990, Strange 1998). National champions are equally willing to act as free agents, and are in some instances receiving national treatment (and support) from several governments, both national and regional. The example of IBM being involved in several research consortia funded by both the EU and the US governments best illustrates this point.

Government intervention to promote R&D alliances does not –contrary to popular belief – lead to an increase in the overall level of R&D activity in a given location. It should be noted that R&D alliances are even more footloose than traditional majority-owned production or R&D activities, nor, it must be stressed, do R&D alliances provide significant levels of spillovers to the host economies where they might be located. Funds invested in joint research by governments are notoriously hard to track down, in terms of their application, both in a geographic and a technical (i.e., project-specific) sense. Furthermore, firms are more interested in establishing themselves near centres of agglomeration, regardless of where these might be located (Narula 2003). This indicates a very real danger of entering into an incentive war, with so many countries willing to subsidise R&D (Niosi 1995), and with so little obvious spillovers therefrom.

Nonetheless, it is clear that there are important welfare implications of R&D cooperation and how they affect industrial competitiveness of locations. Little is known on the effect of STP on industry dynamics, and on systems of innovation. Part of the problem has to do with the difficulties of monitoring and evaluating alliances, since it is difficult to

accurately estimate the importance of individual agreements, both ex ante and ex post. Even where firms can place a value on an agreement, they have no incentive to make such information available, either to each other, or to the public. We do not fully understand either how or why firms may (for instance) prefer partnering with a university rather than a private enterprise, and what intermediating factors control this decision (for a preliminary effort, see Tidd and Trehwalla 1997). The 'right' mix of internal and non-internal R&D activities can prevent firms not only from over- or under-investing in R&D, but also help maintain their long-term competitive position. Furthermore, these issues have considerable significance for industrial and technological policy, because economies and innovation systems are increasingly knowledge intensive, and the growth of STP can adversely affect the efficacy and optimal allocation of resources (Archibugi and Iammarino 1999, Narula 2003).

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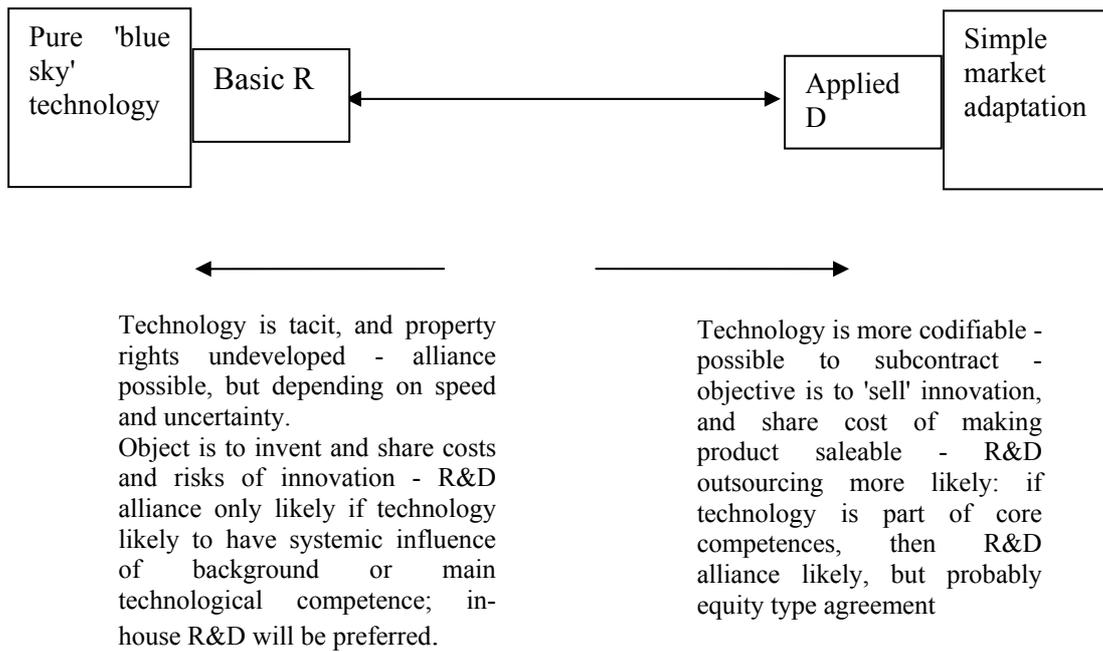


Figure 1 'Distance-to-market' issues in the innovation process

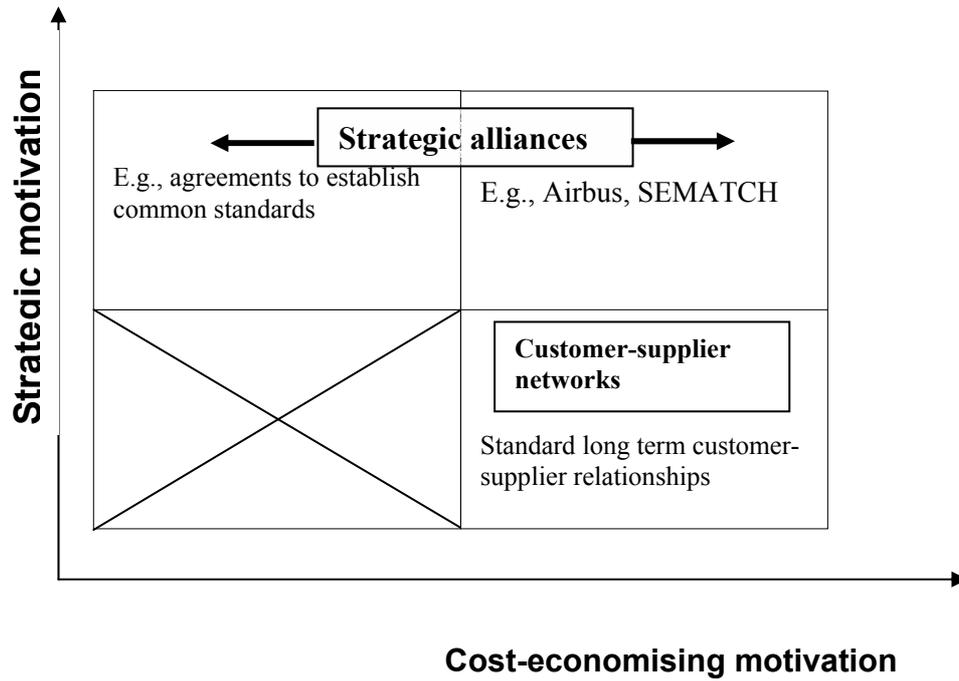


Figure 2 Explaining the underlying differences between strategic alliances and customer-supplier networks

Source: Narula and Hagedoorn (1999)

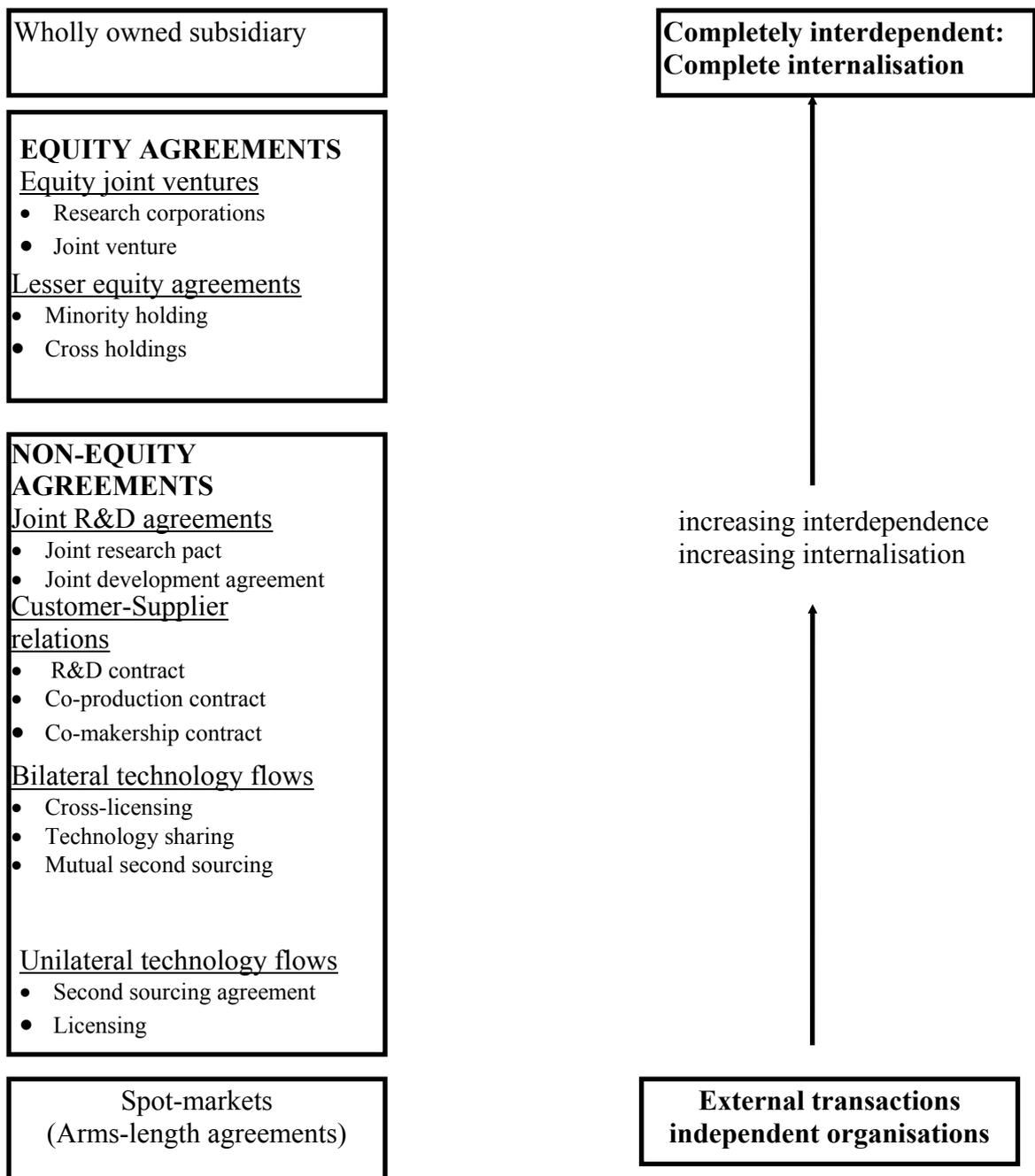
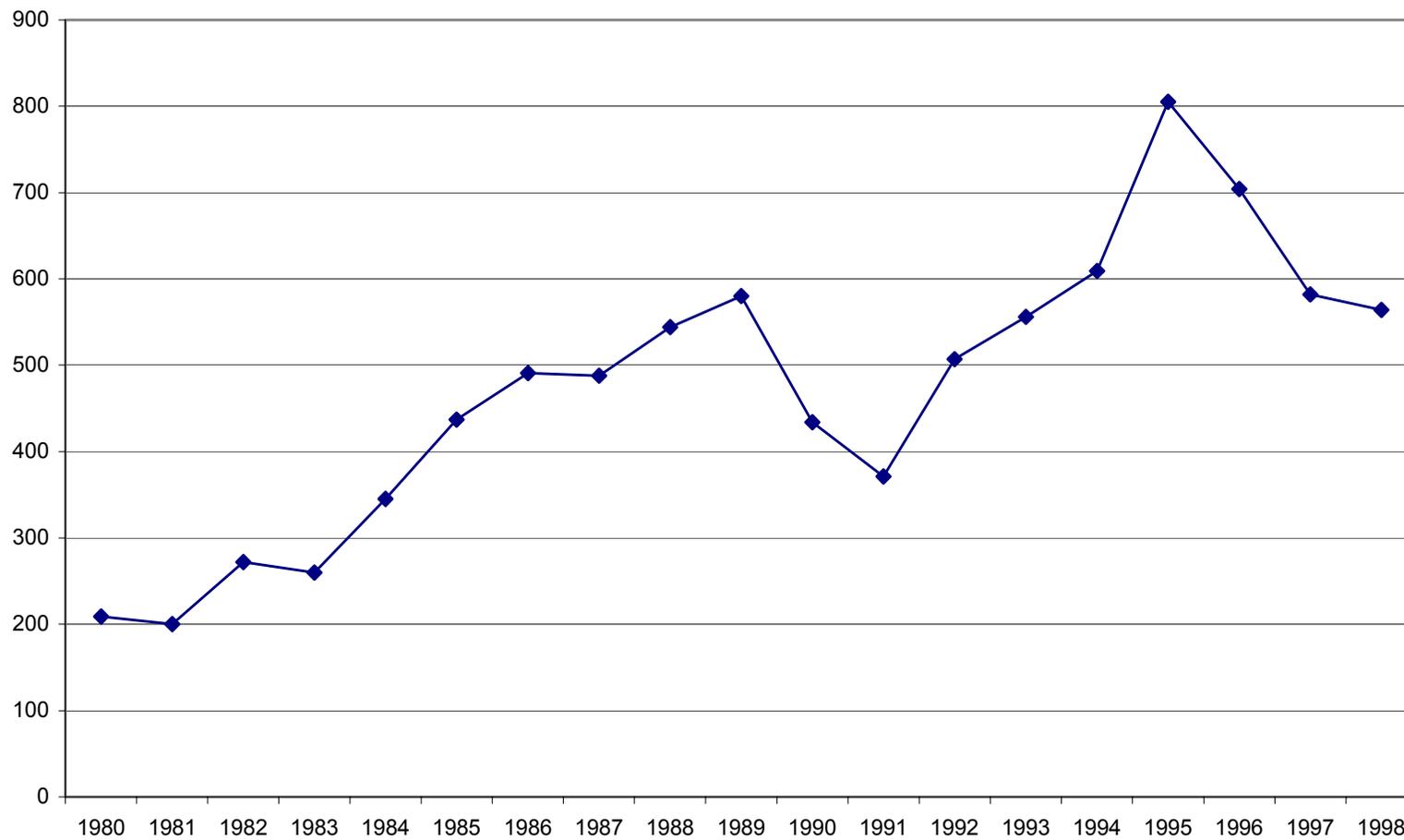


Figure 3 Organisational modes of inter-firm cooperation and extent of internalisation and interdependence

Source: Narula and Hagedoorn (1999)



Source: MERIT-CATI database

Figure 4. Growth of strategic technology partnering, 1980-1998

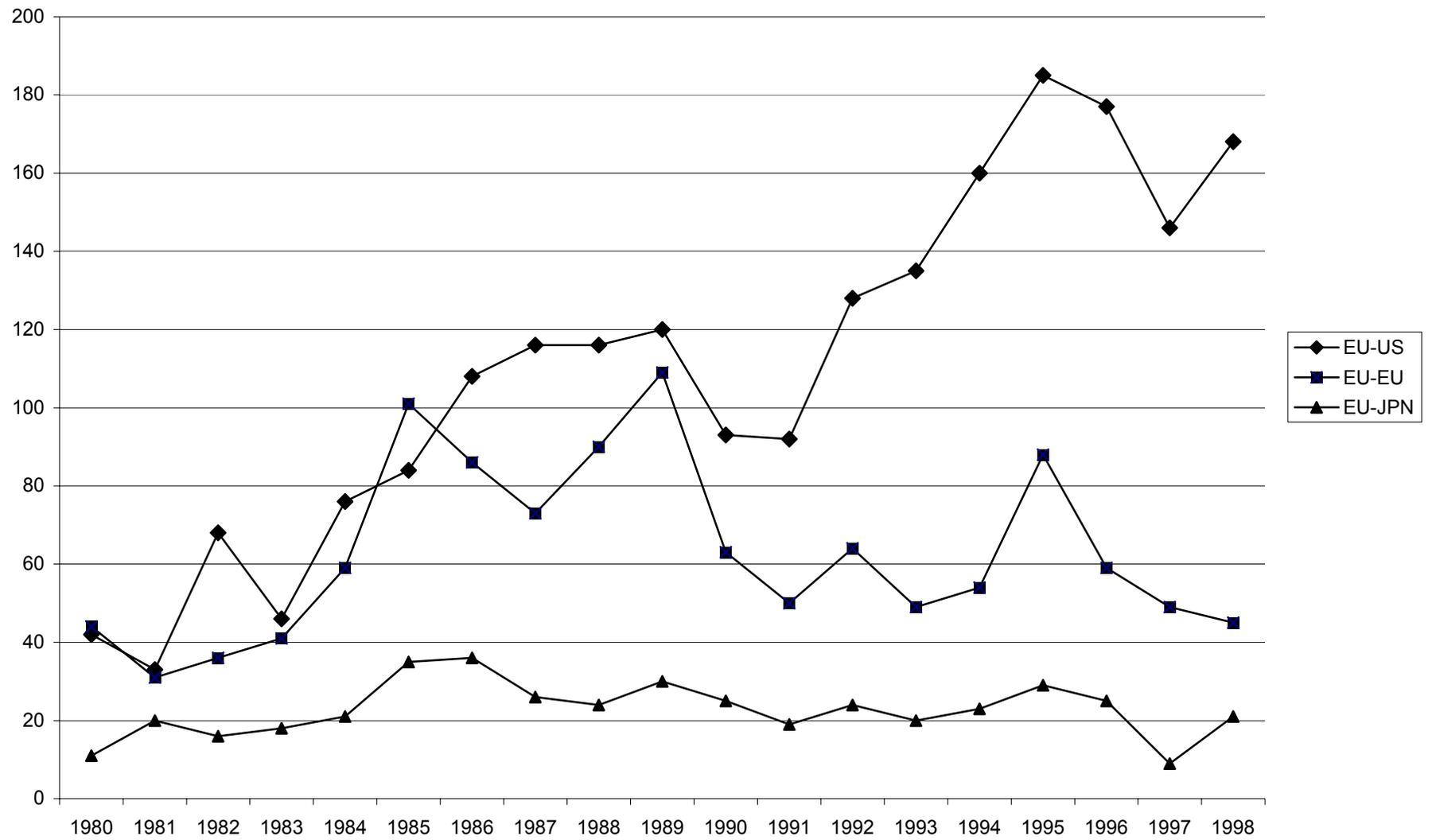


Figure 5: Number of new STP by year for EU firms, by nationality of partner.