Does being R&D intensive still discourage outsourcing? Evidence from Dutch manufacturing

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[1] The author would like to thank Statistics Netherlands (Centraal Bureau voor de Statistiek) for kindly allowing him to access the data employed in this study. He would also like to express his gratitude to Zella King for comments on an earlier version.

Abstract:

Being R&D intensive has traditionally been seen as an impediment to outsourcing. This study confirms that empirically this was the case for a set of manufacturing industries in the Netherlands in the early 1990s but also shows that R&D intensity was a positive predictor for changes in outsourcing levels over the 1990s, suggesting firms in R&D intensive industries have increasingly started to rely on (partnership) relations with outside suppliers. This confirms the need to move the analysis from traditional scale, opportunism and appropriation concerns to a relational perspective when studying outsourcing in R&D intensive industries.

Keywords:

Outsourcing, R&D intensity, supply chain strategy, manufacturing

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1. Introduction

Firms no longer are what they used to be, appears to have become the communis opinio among practitioners and academics alike when it comes to the newly emerging vertical structures of high-tech firms. More extensive outsourcing of activities, including activities in the manufacturing and product development realms, has led to more nimble and leaner firms, so the argument often starts (Domberger, 1998; Quinn, 1999). To compensate for the loss of internal technological capabilities, however, firms increasingly rely on partnering relations with outside suppliers that can act as an effective substitute to the internal generation of knowledge and innovation (Dyer and Nobeoka, 2000; Dyer and Singh, 1998; Hagedoorn, 1993; Kinder, 2003; Nooteboom, 1999; Quinn, 1999). Yet, through all the anecdotal evidence on leading manufacturing firms supporting these statements, it is unclear whether such changes in outsourcing policy have indeed taken on broader significance to the extent that R&D intensive industries have been engaged in large-scale outsourcing.

It has long been argued that a high R&D intensity should lead to lower levels of outsourcing (Harrigan, 1985; Stigler, 1951; Williamson, 1985). In R&D intensive industries scale advantages are usually sufficient to allow for more vertical integration (Harrigan, 1985; Stigler, 1951). Furthermore innovative activities may be harder to appropriate if not performed inside the firm (Teece, 1986; Pisano, 1990). And there can be an increased risk of opportunism under these conditions, especially where the

R&D concerned is of proprietary nature rather than a generic one (Williamson, 1985). Yet an alternative, relational view has arisen, which predict outsourcing levels should be on the rise in the context of R&D intensive firms, since there is increasing inter-sector technological specialization and buyer-supplier relations have become more effective vehicles for exchanging technological know-how (Dyer and Nobeoka, 2000; Dyer and Singh, 1998; Kinder, 2003; Quinn, 1999). It has been suggested that in the face of severe technological change (Afuah, 2001) or if heterogeneity among firms is a substantial driver of the competitive process (Barney, 1999) vertical integration can instill rigidity into technological trajectories. Furthermore the increasingly widening range of technologies needed to produce products like aircraft engines forces firms to look to outside suppliers for part of their innovative needs (Brusoni, Prencipe and Pavitt, 2001).

This paper attempts to tackle this controversy in the outsourcing literature by empirically unraveling the relationship between R&D intensity and outsourcing as it has been developing. By investigating outsourcing both as a state variable, in terms of how much a firm relies on external suppliers for producing its goods, and as a flow variable, in terms of changes in that external reliance, it captures static and dynamic effects. The two rival theoretical explanations are contrasted. An empirical test of 52 manufacturing industries in the Netherlands provides initial support for the traditional argument but also shows how the dynamic capabilities and technological change argument has gained impetus, implying R&D intensive industries were originally more vertically integrated but have since increasingly been outsourcing activities. This casts substantial doubt over the tenability of the traditional argument.

The second section of the paper discusses the current stock of knowledge on outsourcing in the management and applied economics literature, focusing in

particular on how R&D is believe to influence make-or-buy decisions. It also puts forward two hypotheses. Section three discusses developments in outsourcing in the Netherlands over the 1990s and presents the empirical data underlying this study. In the fourth section these data are used to test the hypotheses using OLS regression models. The conclusions, in section five, center on the theoretical implications, in terms of our understanding of when (not) to outsource and on the policy implications, in terms of how the changing nature and extent of outsourcing forces managers and policy makers to rethink existing practices.

2. Outsourcing and its predictors

The make-or-buy or outsourcing decision has been the topic of substantial analysis in economics and management. While there is no space to fully review this area, it may be useful to recapture some of the main arguments and findings. In particular various attempts have been made to construct contingency models that help explain under which conditions outsourcing is a beneficial solution. Transaction cost economics clearly is one such model that predicts (Williamson, 1981, 1985) outsourcing is related to low asset specificity, low uncertainty and a low frequency of transactions. Markets fail when transactions become highly asset specific due to pressures for opportunism, forcing firms to internalize transactions (Walker and Weber, 1984). Similarly if a certain asset is required quite frequently, the production cost advantages of the market will disappear and internalization will occur. Uncertainty, for instance in the form of volume fluctuations, will induce the same effect, since suppliers will want to receive a risk premium in their contracts, making external contracting less likely. This effect of uncertainty is strongest in the simultaneous presence of asset

specificity (Williamson, 1985). Williamson (1981) originally also argued that technological uncertainty, like volume uncertainty, would lead to vertical integration. Yet this has not been consistently confirmed in empirical research (Walker and Weber, 1984). More recently, Williamson's stance on this has changed somewhat in that technological uncertainty is no longer seen as a significant predictor (Williamson, 1996). But technological uncertainty is not quite the same as technological intensity, the focus of the current paper, as will be discussed shortly. There is of course also a literature linking different types of innovation to organizational forms (e.g. Henderson and Clark, 1990; Brusoni et al 2001) but that is likewise not within the scope of this paper.

Measurement and information approaches (Milgrom and Roberts, 1987) point at monitoring problems and information differentials between buyer and supplier as explanations of outsourcing. If a supplier's behavior cannot be appropriately monitored, this will stimulate vertical integration. Likewise the existence of substantial information differences, where the supplier knows things the buyer does not know, will induce vertical integration. Another type of explanation of outsourcing focuses more on what the firm itself is capable of doing. The knowledge-based (Grant, 1996; Kogut and Zander, 1992) and resource-based (Quinn, 1999) explanations of outsourcing suggest that a firm will outsource those activities in which it is not particularly specialized or that are 'non-core' because the firm is less capable of performing those activities. So rather than invoking a market failure explanation, this suggests firms may fail in certain respects. When there is such 'firm failure', outsourcing will come into play. Applying real options theory Leiblein and Miller (2003) argue that whether to outsource an activity or not can also be a consequence of the likelihood of that activity becoming a platform for future growth.

In addition some scholars have pointed at the influence of the institutional environment on outsourcing. Toulan (2001) related increases in outsourcing to liberalization of the economy in that liberalization provides more freely operating markets. This closely follows the institutional voids argument of Khanna and Palepu (2000), who argue that internalization of activities can be a consequence of the lack of properly functioning institutions in a country. Relational rent (Dyer and Singh, 1998) and trust (Zaheer, McEvily and Perrone, 1998) arguments suggest that establishing long-term, trusting, and idiosyncratic relations with certain suppliers can provide above average returns, which may also act as an incentive to outsource these activities. Very briefly these are some of the main arguments in the outsourcing area.

2.1 Innovation and R&D

For the purposes of this paper, however, it makes sense to discuss in some more detail the relation between R&D intensity and outsourcing. At this point it is necessary to briefly elaborate upon the difference between technological uncertainty, which is one of the variables originally included in transaction cost economics-based explanations of outsourcing, and R&D intensity. Empirically there is perhaps a positive correlation between R&D intensity and technological uncertainty, since disruptive technological change is more likely to substantially impact firms' business models in technologically intense industries. But this correlation is nowhere near perfect. Many industries that are not technologically intensive, in the sense of substantial R&D investments, have faced much disruptive technological change in the internet era. This holds for instance both for retailers like Barnes & Noble in its battle with Amazon and for many office environments, including teaching and research in universities.

Conceptually R&D intensity is a stock variable while technological uncertainty is a flow variable. Thus they operate at different levels of analysis.

2.2. The traditional argument on innovation and outsourcing

Traditional industrial organization (IO) accounts of vertical integration (Stigler, 1951) tend to stress how it is used as a means to enhance the scale of operations. Technologically intensive industries normally favor a large operating scale because R&D investments are mostly fixed costs that can be recuperated better when the firm increases its revenues. The marginal costs of production are relatively low in technologically intensive industries. Thus a technologically intensive industry can be expected to be dominated by one or a few firms that employ substantial degrees of (backward) vertical integration to maximize the scale of operations. More recent observers in the IO tradition (Harrigan, 1985; Porter, 1980) seem to concur that where R&D matters, vertical integration is preferred over outsourcing.

In transaction cost economics Williamson's (1985: 141-144) discussion on the role of innovation in vertical integration decisions brings to light several arguments favoring integration under conditions of substantial innovation but also includes some discussion concerning hybrid agreements. The key advantage of integration is that it promotes cooperation between stages. On the other hand it will compromise the high-powered incentives available in markets because costs and benefits will tend to be shared between the purchasing and supply stages in an integrated setting (Williamson, 1985). Additionally there may be instances of higher-level intrusion or accounting manipulation that can further distract from such incentives. The latter, however, will exist to a larger degree in markets where opportunistic behavior is more common. Williamson (1985) concludes that where innovation is of a proprietary rather than a

generic type it will lead to integration or at the very least partial ownership (hybrid forms), particularly when combined with a need for specific assets. He further suggests that non-specific assets will normally only lead to generic innovation. Thus there appears to be a positive correlation between proprietary innovations and specific assets. This further suggests that if R&D is undertaken in-house it must have some kind of proprietary value to the purchaser. Teece (1986) has added that when the R&D intensity of a sector is high, it will be more prone to integrate activities into the firm rather than to outsource them in order to protect intellectual property rights. Pisano (1990) similarly argued that appropriation problems around knowledge, like that obtained from R&D, lead to vertical integration.

Monteverde (1995) specifically discussed the application of transaction cost economics in the exchange of technical engineering knowledge. He investigated how unstructured technical dialog, one form of human asset specificity, affects outsourcing decisions. Because organizations can internally develop a specific dialect for exchanging unstructured and tacit knowledge, they are much more efficient at transferring this type of knowledge. Therefore the costs of transacting are substantially lower inside the organization and vertical integration is the preferred solution. Note that the latter observation, that organizations can be more efficient carriers of knowledge than markets, takes Monteverde's work closer to the knowledge-based explanation (Kogut and Zander, 1992), which also argues governance forms are less a result of market failure than one of organizational superiority in certain types of transactions.

These arguments suggest that innovation is created more efficiently inside firms than through markets. Outsourcing is not a means to innovation because outside suppliers lack incentives to innovate for the buying firm. Where they do innovate, it

will be hard for the buying firm to appropriate the rents of such innovation (Teece, 1986) as the supplier will seek to use it for a wide range of clients. Thus dedicated innovation is particularly hard to achieve under an outsourcing regime. All of this suggests that when R&D is an important part of an industry's value chain, firm in that industry will vertically integrate more activities (and outsource less).

> *Hypothesis 1*: The R&D intensity of an industry is a negative predictor of its extent of outsourcing.

2.3. A relational view of innovation and outsourcing

To provide an explanation for the recent changes in the supply chain strategies of firms discussed in the introduction, however, a different perspective is needed. For if R&D intensity and outsourcing are as incompatible as suggested above, how can we explain the rises in outsourcing in R&D intensive environments that have been reported (Quinn, 1999)? This other perspective, which is here coined relational view (Dyer and Singh, 1998), argues that much of a firm's innovation now occurs in conjunction with outside suppliers rather than inside the firm. Because developments in non-core technology areas have become very rapid, it is no longer feasible to keep up with all of these technologies in as much detail as needed (Brusoni et al, 2001; Quinn, 1999). Therefore outside technology sources are in many instances the only option for firms that wish to keep up-to-date (Hagedoorn, 1993). Barney (1999) has suggested that firms need not necessarily own all relevant capabilities, as long as they have sufficient access to them. Such access may well be obtained through relations with outside suppliers.

Brusoni et al (2001) have noted that among manufacturing firms knowledge is now becoming more extensive than needed for the activities performed inside the firm. In other words, firms must know more than they make in order to be able to integrate the inputs of various specialist outside suppliers. The more uneven rates of technological change in underlying components and the more often the interdependencies between components change, the more slack knowledge the buying firm needs to maintain (Brusoni et al, 2001). Nishiguchi (1994) has argued that the use of outside suppliers creates the option to access a much larger productive network and knowledge pool. This network provides much-needed flexibility to cope with changes in demand and helps to lower time-to-market substantially. Afuah (2001) further suggested that over the life cycle of a technology firms are best off by gradually increasing their extent of outsourcing. Only when a radical competence destroying technological change occurs does it make sense to revert to vertical integration into this new technology (Afuah, 2001).

In the context of innovation, Langlois and Robertson (1992) have developed the notion that it is feasible to develop initial innovation through outsourcing in a decentralized network, especially if substantial network externalities are present. If outsourcing is to make sense in the context of R&D intensive businesses though, relations with suppliers ought to replicate some of the characteristics of firms. For if relations are of a strict arm's length type, there is no incentive for external suppliers to undertake innovative activities on behalf of the buying firm. Dyer and Singh (1998) have developed a relational view of rent attainment, which argues that inter-organizational relations, including buyer-supplier relations, can provide benefits similar to hierarchies without the production cost disadvantages associated with hierarchies. Dyer and Nobeoka (2000) detail through their case study of Toyota how

new technology is developed through dedicated buyer-supplier relations. This new model of interorganizational relations as a means to innovation is superseding traditional in-house development so it is argued (Dyer and Singh, 1998; Kinder 2003; Quinn, 1999). This trend ought to be reflected in the outsourcing levels of R&D intensive industries.

> *Hypothesis 2*: The R&D intensity of an industry is a positive predictor of changes in its extent of outsourcing.

3. Outsourcing in Dutch manufacturing

Similar to elsewhere outsourcing and increasingly cooperative relations have in the 1990s been identified as a key trend in the Netherlands (De Wit, Mol & Van Drunen, 1998; Nooteboom, 1998). Firms in the Netherlands have increased their reliance on external suppliers dating back even to the late 1970s but from the early 1990s onwards a particularly large shift towards outsourcing started (De Wit et al, 1998). Where firms previously outsourced secondary and support activities, like catering, temporary labor, and other facilities management activities, they now increasingly outsourced core manufacturing activities. There was also increasing technological specialization between industries. The production of printed circuit boards (PCBs) for instance, which was formerly operated as a small-scale, made-to-order internal activity, was now subcontracted to specialized PCB suppliers. Rapid technological developments in electronics, mechatronics, and related fields made much of the existing internal knowledge on PCBs and other electronic components obsolete and

additionally raised the production costs because of rising equipment needs. Therefore in many cases non-specialized firms had little choice but to outsource.

The nature of the underlying supplier relations had to be altered because the newly outsourced activities required more intensive coordination given their sensitivity to overall product outcomes (Nooteboom, 1998). The implementation of these changes was sometimes problematic and buyers and suppliers both needed to adjust to the changed circumstances. Wynstra and Weggeman (2001) provide some evidence that manufacturing firms in the Netherlands have increasingly engaged in cooperation with suppliers to produce product innovation. Finally outsourcing also took on a more prominent role in the Dutch discourse on management and among policy makers. Management consultancy firms published on the topic, government institutions became interested in its consequences for local employment and growth, academics increasingly wrote about it and all kinds of employers' associations, training agencies, and conference organizers presented activities on outsourcing.

3.1. Empirical measures

The empirical tests, which will be discussed shortly, are based on 52 3-digit industry level census data of Statistics Netherlands (*Centraal Bureau voor de Statistiek*). The 3-digit level is specific enough to include a clearly defined product, like pharmaceuticals or machine tools, but no so specific as to render the number of companies in the industry too small for reliable analysis. The industry classification used is the European NACE system and all industries included are in manufacturing, ranging from complex assembly to simple processing industries. The industry level variables are formed by aggregating business unit level data gathered directly from manufacturing firms. The latter are collected on an annual basis and include questions

on total sales, external sourcing, profitability, R&D expenditures, total exports, and the number of firms, including an indication of the nationality of their parent firm. The dependent variable of OUTSOURCING is constructed by dividing total external sourcing in the industry in 1994 by total sales in the industry in 1994. Therefore it measures to what extent the industry relies on external suppliers for the creation of products across all its activities, including manufacturing, design and services. This OUTSOURCING measure therefore represents the vertical structure of the firm. The accompanying flow variable, of OUTSOURCING CHANGE is calculated as the difference between outsourcing in 1998 and outsourcing in 1994. R&D INTENSITY, the independent variable, is measured as the industry's 1993 total R&D expenditures over its 1993 total sales. In these data R&D levels are fairly constant across years (inter-year correlations range from 0.75 upwards).

Five control variables are employed in addition to the R&D intensity variable. The TOTAL SALES variable is the aggregated sales level of all firms in the industry in 1993. Thus it represents the size of the industry. Larger industries may have developed more inter-firm specialization and could therefore have outsourced more. The extent of presence of FOREIGN FIRMS is measured by dividing the number of foreign subsidiaries over the total number of firms. It is conceivable foreign firms have developed a different outsourcing pattern because they are less familiar with local suppliers. PRODUCTIVITY is calculated as 1993 total sales divided by the 1993 total number of employees. In order to become more productive firms in an industry probably need to focus on a smaller set of tasks, which they can do by outsourcing more. Productivity is therefore one of the drivers of outsourcing decisions and a positive association may be expected. EXPORT INTENSITY is the 1993 total amount of exports over 1993 total sales. Since the ability to export products is an

indicator of company strength, more export intensive industry possibly possess more internal capabilities and will therefore outsource less. UNCERTAINTY in the industry is measured by the variance in the industry's annual return on sales measures over the 1993-1998 period. The uncertainty-outsourcing relationship was discussed at length above. Ordinary least squares (OLS) regression is used to test the hypothesized relationships.

4. Empirical results and discussion

Table 1 below briefly captures the means, standard deviations, and correlations of the key variables. It is worth noting that the average outsourcing level stands at 52.3% of sales in 1994 and increases by another 3.5% between 1994 and 1998, which is a fairly substantial increase. Also note that while the average R&D intensity is not particularly high among these industries, about 0.5% of sales there is substantial variance in R&D levels in the sample. Finally note that there is a negative correlation between the outsourcing and outsourcing change variables, implying a catching-up effect. Industries that initially outsourced less have now seen the most substantial increases.

Insert table 1 around here

Recent research in the transaction costs strand (Gilley and Rasheed, 2000; Leiblein, Reuer and Dalsace, 2003) has continued its focus on how a set of predictors at a given

time influences outsourcing choices at that time. Yet time differences will often exist between the presence of R&D intensity and the implementation of outsourcing and a one-year time lag was introduced to reflect this. In addition any claim to causality is much strengthened if the independent variable occurs prior to the dependent variable. Table 2 investigates the effect of 1993 R&D intensity and a set of control variables on the industry average level of outsourcing in 1994. It confirms hypothesis 1: R&D intensive industries initially displayed a lower level of outsourcing. Thus the traditional perspective, which holds that under conditions of high innovation there are scale, appropriation, and opportunism concerns that make outsourcing a less preferred option, did hold true initially.

Insert table 2 around here

Table 2 also provides some interesting findings on the control variables employed. The presence of foreign firms is a slightly negative predictor for outsourcing levels. This confirms what is known as the 'liability of foreignness' in international management research (Kostova and Zaheer, 1998). Because foreign firms are less familiar with their host environments they will have more difficulties than local firms in partnering with local suppliers. Given the higher search and evaluation costs attached to outsourcing for foreign firms, outsourcing is normally a less viable option for them. In addition foreign firms have often established themselves in their host environment on the basis of some superior set of internal capabilities that may help them offset the liability of foreignness (Dunning, 1993). Having such a superior set of

internal capabilities, for instance human resources, also makes it less likely that foreign firms will outsource activities since they will want to fully exploit these internal strengths. The productivity of firms, measured as per-employee turnover, is positively related to outsourcing. This is a strongly intuitive and perhaps even mathematically determined relation, since firms that produce large volumes with a limited number of employees will typically also need to outsource many activities to achieve such productivity. The size of the sector is not a significant predictor of outsourcing. The positive impact of the export intensity variable points to the role that having to compete more ferociously, in international markets, can play in forcing firms to outsource. In general, competition between firms is thought to stimulate outsourcing (Cachon and Harker, 2001). More export intensive industries will be faced with a more competitive environment and will therefore seek to outsource more. And similar to foreignness, a high export intensity reflects the competitive strength of an industry. The more internal strengths firms in an industry possess, the less likely they are to outsource. Uncertainty is shown to be a strongly negative predictor of outsourcing levels, confirming the TCE logic. In the presence of substantial uncertainty it is harder to write complete contracts.

In table 3 the results of the regression on changes in the outsourcing level between 1994 and 1998 are displayed. There is a strongly positive relation between R&D intensity in 1993 and subsequent changes in the level of outsourcing. Thus the second hypothesis is confirmed in that R&D intensity acted as a positive predictor for changes in outsourcing[1]. This confirms what many studies have suggested about the changing nature of outsourcing, though the evidence presented here is not based on perception data or anecdotal or small-scale evidence. Especially in technologically

[1] In fact, a rerun of the analysis presented in table 2 for 1997 R&D intensity and 1998 outsourcing revealed that the initially significantly negative relationship between R&D intensity and outsourcing turned into a positive one in 1998, albeit not a significantly positive one.

volatile environments where R&D is a key priority, firms have increased their reliance on external suppliers. They could do this because of the changed nature of underlying technologies and relations with suppliers. The need to understand and utilize multiple technologies that cannot all be maintained in-house forces firms to outsource more activities than before. Changes in communication technologies and the increasing openness of economies increase the rent potential of relations with external suppliers, many of them foreign, and permit firms to set up closer relations with suppliers than hitherto possible.

Insert table 3 around here

There are two other significant findings in table 3. Foreign firms have not increased their extent of outsourcing as much as have local firms, consistent with the logic outlined above. Foreign firms will have a lower degree of penetration among local suppliers and will use their internal capabilities as much as possible. Uncertainty is a positive predictor of changes in outsourcing levels here. This could be construed to imply that the predictive power of TCE has been decreasing over time, since more uncertainty is no longer associated with more vertical integration. As stated before though uncertainty is seen to explain integration particularly effectively in the joint presence of asset specificity. Since no asset specificity test was included, it is not possible to reach any final conclusion on this point.

4.1 Research limitations

In terms of limitations, the number of sampled industries (52) is fairly low which is potentially troublesome in the context of running regressions, where some 40 observations are often seen as a bare minimum and 5 to 10 observations are needed per variable to create models with sufficient statistical power. Yet there are several reasons to believe the number of observations is not problematic here. First, the industry data themselves are aggregates of firm level data, involving thousands of firms. Thus any aberrations at the firm level are wielded out through the aggregation process and the resulting industry level data are more reliable. Second, the model statistics of both models are solid. The F-tests are fairly high and adjusted R^2 figures are also quite satisfactory. Third, more industries become available when omitting the focal R&D variable from the regressions, i.e. there are quite a few missing values for R&D expenditure in the database. Missing values appear mostly in industries with particularly small numbers of firms where industry level R&D data could be traced back to individual firms. Re-running the models for a wider set of some 84 industries, the other variables in the model maintain their signs and mostly become more significant. Therefore it appears fair to conclude the results are fairly robust despite the small number of observations.

One variable missing from the equations was asset specificity, for which no valid empirical measures were available in the present study. Including asset specificity might have provided additional explanatory power. On the other hand, asset specificity is likely positively correlated with R&D intensity as argued before. Furthermore it is hard to say what would constitute a proper measure of asset specificity at the business unit level. Another limitation is that the R&D intensity of industries is only one indicator of an industry's innovative output. And it is not a perfect measure for innovative output either. Thus it could be informative to test how

other innovation measures, like the number of patents granted, are related to the outsourcing behavior of firms. Similarly the empirical context used here, the Dutch manufacturing sector, may produce results specific to that sector's development. Although there are no obvious indications that outsourcing in the Netherlands is very different from outsourcing in other OECD countries, there could certainly be differences in timing or degree. A replication elsewhere would be useful. Where available firm level data could shed a different and more detailed light on the outsourcing-innovation relation than these industry level data, for instance by investigating possible interactions with asset specificity, capabilities or firm size. Such a trade-off of breadth for depth could generate additional insights. Similarly there is merit in applying other outsourcing measures, for instance by linking the probability that a specific component will be outsourced given its R&D intensity.

5. Conclusions

A major controversy in the area of outsourcing and innovation is whether R&D intensity discourages outsourcing or is compatible with it. This paper demonstrated, in the empirical context of the Dutch manufacturing sector, that while R&D may historically have been a negative predictor of outsourcing there was a clear reversal over the 1990s. The relational view of outsourcing and innovation, which maintains that buyer-supplier relations can be an effective substitute for internal development, thus appears to have gained impetus in practice. Alternatively the more humble, and perhaps more correct, perspective is that the relational view appears to be an appropriate portrait of empirical reality as it has been developing. Product life cycles are becoming shorter and there has been a shift in priorities away from appropriating

in-house innovations towards developing the ability to rapidly launch new products. This kind of ability is often better developed in a buyer-supplier network setting where a more flexible and larger joint capacity can be obtained than inside a single firm.

Brusoni et al (2001: 599) stated that: “firms invest in broadening their knowledge bases while narrowing down their manufacturing bases”. The evidence presented here seems to suggest that the latter aspect, of narrowing down the manufacturing base, is moving at a much faster pace than the former, the broadening of the knowledge base. Therefore rather than suggesting firms know more than they make, it seems more appropriate to say that most firms are starting to make less than they know. To test this further it could be fruitful to find out whether R&D investments are generally maintained over longer time periods, even when firms have disengaged from the underlying activities. This also points to one of the problems associated with outsourcing, which is how to maintain sufficient knowledge inside the firm to be able to jointly develop new knowledge with a supplier and at the same time to assess the supplier’s performance. Since many instances of outsourcing involve moving people to suppliers much knowledge can be lost with the transition. Outsourcing can become a source of serious bargaining and learning problems in the long run.

Firms increasingly outsource activities that are crucial to the competitive advantage of the firm. In itself this type of outsourcing can be beneficial, if rents can be obtained from the relation (Dyer and Singh, 1998). Where such rents are deeply ingrained in the relation itself, there are few problems of spillovers. But there is a big question mark over how to appropriate such rents in the case of new technology. Technology that is developed in conjunction with a supplier may have multiple

alternative uses for the supplier but none for the buying firm. Technological knowledge is often replicated fairly easily within the same supplier firm. Under such circumstances there are serious dangers of knowledge leaks to competitors and appropriate governance responses must be found (Nooteboom, 1999). This may involve the creation of different contracting solutions where buyers and suppliers are both provided with incentives to innovate and can obtain joint ownership. From a public policy perspective this creates pressures for legal protection of joint intellectual property.

From a public policy perspective a key implication of increased outsourcing is its effect on underlying technology activities and employment. If R&D intensive industries can outsource many more manufacturing and design activities, as now appears to be the case, this implies these activities become increasingly footloose. The recent rise of global sourcing structures need therefore not be limited to activities where cost of labor is the key consideration but might also begin to include more innovative activities. For practicing managers global sourcing poses different challenges, for instance in terms of how to deal with suppliers in institutional and cultural environments differing from that of the buyer.

There are few longitudinal accounts of how outsourcing and technology intensity are related in current literature. Yet, quite a bit is known about technological collaboration between buyer and supplier and what influences outsourcing levels at a given point in time. What is needed then, is a more intricate understanding of how the technology-outsourcing relation evolves over time. Some specific research questions can be suggested. Under what conditions is a high R&D intensity compatible with much outsourcing? Will outsourcing levels be maintained in the face of technological

change (Afuah, 2001)? Answers to these questions would be very valuable outcomes of future research.

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Tables

	Mean	S.D.	1	2	3	4	5	6	7	8
1. R&D intensity	.4538	.7530	1	-.239	.543**	.279*	-.036	.205	.222	-.123
2. Outsourcing	52.29	14.00		1	-.375**	-.106	.463**	.199	.296**	-.306**
3. Outsourcing change	3.460	6.487			1	-.069	-.165	-.151	-.047	-.054
4. Foreign firms	32.82	23.60				1	.304**	.281*	.167	.062
5. Productivity	334.3	315.6					1	.200	.567**	-.165
6. Export intensity	35.64	17.27						1	.074	.105
7. Total sales	2.85M	4.14M							1	-.207
8. Uncertainty	2.868	3.676								1

*Table 1: means, standard deviations and correlations among variables. ** Significant at the 1% level; * significant at the 5% level. N = 84, except for row 1 where N = 52.*

Variable	**Unstand. β**	**Standard error**	**t-value**	**significance**
Constant	0.495	0.032	15.386	0.000
Foreign firms	-0.133	0.072	-1.841	0.072
R&D intensity	-0.0496	0.020	-2.468	0.017
Productivity	0.0002	0.000	3.015	0.004
Export intensity	.002142	0.001	2.620	0.012
Total sales	-3.64 E-10	0.000	-0.084	0.933
Uncertainty	-0.0174	0.004	-4.563	0.000
F-value: 10.173 (.000)		R^2: .576	Adjusted R^2: .519	

Table 2: OLS regression on 1994 industry level of outsourcing. N = 52.

Variable	**Unstand. β**	**Standard error**	**t-value**	**significance**
Constant	0.04805	0.017	2.772	0.008
Foreign firms	-0.0685	0.039	-1.764	0.084
R&D intensity	0.06001	0.011	5.537	0.000
Productivity	-4.11 E-06	0.000	-0.113	0.910
Export intensity	-0.00020	0.000	-0.453	0.653
Total sales	-2.63 E-09	0.000	-1.131	0.264
Uncertainty	0.004489	0.002	2.181	0.034
F-value: 6.798 (.000)		R^2: .475	Adjusted R^2: .405	

Table 3: OLS Regression on industry level outsourcing change between 1994 and 1998. N = 52.