Offshoring of R&D activities and new organisational concepts at home

Abstract

There is a vivid discussion on the impact of offshoring R&D activities to other parts of the world, namely Eastern Europe and Asia. Empirical results on the home base effects of R&D offshoring are, however, sparse. This paper analyses the relationship between companies' R&D offshoring activities and the use of new organisational concepts at the home base as well as the short-term impact on different innovation indicators. We employ a matched pair analysis, using German data from the European Manufacturing Survey 2006, covering 1,663 firms of all manufacturing industries. We find that firms that have offshored R&D activities mainly for cost reasons do not exploit all existing organizational potentials to improve the efficiency of their product development processes at home. There is also evidence that core competences, which are necessary for the development of products new for the market, seem to be concentrated in one local centre of excellence.

Key Words

R&D, offshoring, organisational innovation, innovation indicators, matched pair method

1 Introduction

In Western Europe and the US there is a vivid discussion on the impact of increasing relocations of R&D activities to other parts of the world, namely Eastern Europe and Asia. Public opinion and policy are concerned that foreign R&D might substitute value

added and therefore employment at home, as it was the case in Western Europe when production offshoring was a rising phenomenon in the early 2000s when the upcoming enlargement of the European Union (EU) with ten new Central and East European member states provided an intense stimulus (Kinkel et al. 2007; Lewin and Peeters 2006). Most of these discussions are concerned with the labour market effects of R&D offshoring. Some empirical results conclude that offshoring of p high skilled functions does not necessarily replace jobs onshore (e.g. Barba Navaretti and Falzoni 2004; Barba Navaretti and Venables 2004; Couto et al. 2006, Lewin and Peeters 2006; Farell 2004). Other studies point out present and future R&D offshoring activities will go along with further reduction of domestic R&D (e.g. Salmi 2006).

This paper, in contrary, focuses on the relations between companies offshoring R&D activities and the use and introduction of new innovative organisational concepts at their home base. Our aim is to investigate whether companies that have offshored R&D activities within a defined two years time frame (mid 2004 to mid 2006) make use of organisational concepts like Simultaneous Engineering or Continuous Improvement Processes etc., which aim at improving the innovativeness and competitiveness of the firm, more or less intensely at their home base than non-offshoring firms do. Or in other words: Does R&D offshoring lead to a reduced or improved activity and capability to make use of innovative organisational forms in product development and value adding at home? Furthermore, it is analysed what short run impact R&D offshoring has on innovation and performance indicators like sales with new products, productivity or profit margins of manufacturing firms comparing R&D offshoring and non-offshoring companies. The relationship between R&D offshoring and organisational innovations at the home base will be tested with German data from the European Manufacturing Survey (EMS), a survey on the introduction of advanced production technologies and or-

ganisational concepts in European manufacturing industry. The German data set includes 1,663 answering firms of all manufacturing industries. Methodically we apply an economic matching procedure to construct a sample of enterprises that relocated R&D and a control group that did not but shares the same size, industry, personnel intensity etc. with the first group. We will then compare the two groups. To do so we need to employ a probit analysis to identify the significant determinants of offshoring R&D activities to explain the offshoring dummy.

The paper is organised as follows. Section 1 gives a brief overview on the relevant literature regarding relevance, driving sectors and organisational and performance effects of R&D offshoring. Section 2 presents our data and the methodology used for applying the economic matching procedure. Section 3 provides a short overview on the relevance and the motives of R&D offshoring in the German manufacturing industry. Section 4 presents our results of the economic matching procedure on the relationship between R&D offshoring and use of organisational innovations at the home base and discusses the findings. In section 5 we draw conclusions for enterprise strategies and future research.

2 R&D offshoring in the literature

Public interest in the extent and the development of the home country effects of foreign investment goes back to the 1930s (Lipsey 2002), but has freshed up in recent years in the course of a “new” globalisation debate. During the last few years, offshoring of in the first step production and assembly activities, but with rising importance also of R&D and other knowledge intensive activities, particularly to so called low wage countries in Eastern Europe and Asia, has turned again into the focus of economic policy discussion (e.g. Egger and Egger 2006; Ferdows 1997; Hansson 2005). It has been shown

that technology related direct foreign investment, which is arguably the major key towards an increase in foreign R&D expenditures, has increased considerably in the past years (UNCTAD 2005, OECD 2005, 2006; Patel and Pavitt 2000, Edler 2004; Belitz et al. 2006 (for Germany), Thursby and Thursby 2006). This trend towards more internationalised R&D will further continue as a couple of surveys, most recently the UNCDAT survey 2005 and the study on offshoring of R&D (Salmi 2006) have shown. For example, 96 percent of all companies responding to the UNCDAT survey indicate to increase their R&D activities in locations abroad (UNCDAT 2005, p. 152).

Another important indicator for measuring the internationalisation of companies' R&D is the percentage of R&D expenditures of foreign affiliates at the total R&D expenditures of a company. Between 1995 and 2003 the R&D activities of foreign affiliates have grown much faster than those of indigenous companies in almost all OECD countries (OECD 2006, p. 125). The share of foreign industrial R&D ranges from 5 percent in the example of Greece to more than 45 percent in the UK and around 80 percent in Ireland and Hungary. The data indicates that the different sizes of countries make a big difference. Companies of small, open economies such as the Netherlands, Switzerland or Sweden are much more internationalised regarding their R&D activities than those of large countries (Criscuolo and Patel 2003; OECD 2006, p.128). This indicates that the extent and consequences of present and future R&D offshoríng activities are therefore considerably different between countries.

The need for a country specific view is not only relevant for the home country view of R&D internationalisation, but also for the host country view. For example, it seems that R&D activities of foreign companies in Europe are less contributing to innovation output (measured through patents) than those of foreign companies in the US. Foreign companies in Europe account only for around 8 percent of all domestic patents, whereas

they are responsible for 18 percent within the US (OECD 2006, p. 129). There are also signs that in the course of the 1990s the attractiveness of Europe as a location of foreign companies' R&D has declined. Of all R&D expenditures under foreign control in the manufacturing industry within the OECD countries, the share that has been spent in the US has grown from 54 percent to 56 percent (from 1991 to 1998), whereas the share of Germany, France and the UK has declined (from between 11 to 18 percent to between 9 and 15 percent). More current data, limited to US based companies (Morris 2005) confirms this message, but also shows that the negative trend in Europe seems to have stopped. The R&D expenditures of US parent companies in Western European countries has declined from 70 percent in 1995 to 61 percent in 1999, but remained at this level until 2003 (OECD 2001). At the same time, R&D expenditures in the Asia Pacific region have increased from 15 to 18 percent and in China from 0.1 to 0.5 percent of all foreign expenditures of US parent companies.

The rising relevance of China is also confirmed in more recent surveys. In the UNCTAD survey conducted in 2004, 62 percent of the responding multinational enterprises (MNEs) rated China as the most attractive location for R&D activities (UNCTAD 2005), followed by USA (around 40 percent) and India (around 30 percent). UK, France, and Germany were placed at ranks 5, 7, and 8 in this survey with percentages between 7 and 14 percent. The shift indicated from these expectations is not hypothetical, it has already materialised in real R&D investments. In the last years, the number of foreign laboratories in China has risen from 4 in 1993 to 705 in 2005 (von Zedwitz 2006). The 2006 Duke Booz/Allen/Hamilton offshoring survey in 537 US and European companies shows that India with 41 percent is mostly chosen as location for product development offshoring, with China following on rank 2 with 19 percent of all offshoring locations. This survey gives a sound impression of R&D offshoring target countries and

motives but does not allow for an estimation of the share of companies using R&D offshoring or not as it is predominantly targeted at asking offshoring companies.

As regards client and technology related foreign direct investments there are some more indicators for the internationalisation of the generation of innovation and technology. For example, the volume of cross-border technology transfer not only via technology intensive trade but also through international licensing and patenting, has considerably increased. The annual growth of high-tech exports between 1994 and 2003 is higher in all major European countries as well as in the US than the exports in total manufacturing. The annual high tech export growth rate ranges from 5 percent up to more than 25 percent in these countries. In addition, the joint generation of knowledge across borders has also grown. Patents with foreign co-inventors have risen for all major OECD countries (Edler et al. 2007). All of these mentioned indicators point out that the internationalisation of R&D and technology development is an increasing phenomenon, but concrete and reliable data on the extent and relevance of R&D offshoring strategies of manufacturing companies is very sparse.

Regarding the motives of R&D offshoring and possible changes in motivation patterns, the dichotomy of differentiating motivations in knowledge exploiting (adaption) versus knowledge augmenting (generation) can be predominantly found in literature (e.g. Ramah 2007, Patel and Pavitt 2000; Farrell 2006). *Knowledge exploiting* means that a company needs to perform some R&D in foreign markets in order to adapt to local tastes and requirements, often following already existing foreign production sites. Another recent pattern related to knowledge exploitation strategies is that companies relocate R&D outposts or centres in lead markets, where new practices from the most innovative users are emerging (Beise 2004; Gerybadze and Reger 1999). *Knowledge augmenting* means that companies are driven by the search for excellent research

conditions and the availability of highly skilled people at the foreign location. Most studies based on various methodologies in principle conform this finding. However, most of them also indicate that the knowledge augmenting pattern is gaining relative importance versus the market adaptation motive. Particularly the access to talent is a major and rising reason for companies to offshore parts of their R&D to foreign countries (Couto et al. 2006; ADL 2005, Amboss 2005, DIHK 2005; Edler et al. 2003; EIU 2004, Ramah 2007, Thursby and Thursby 2006). For German multinationals a survey clearly shows that the number of capability augmenting foreign R&D units has sharply increased in the 1990s (Amboss 2005). In parallel to the move towards the augmenting mode there has been another major shift in the recent past. The cost factor has increasingly become relevant for offshoring decisions, not only regarding production activities any more but also regarding R&D activities. The 2006 Duke Booz/Allen/Hamilton offshoring survey has shown that besides access to qualified personnel also cost reduction is of rising importance for R&D offshoring activities (Couto et al. 2006). Sachwald (2007) has shown that cost driven R&D is becoming more important and he concludes that in addition to the already established business models based on knowledge exploiting or augmenting, a third business mode thriving for more efficiency is on the rise. This "new" motivation pattern leads to a rising attractiveness of low cost locations and emerging countries for the location of R&D, especially in Asia and Eastern Europe. Sometimes the knowledge augmenting motivation is deeply intertwined with cost efficiency reasons. Although company executives usually emphasise the availability of skilled technicians and researchers, it seems difficult to disentangle this argument from the potentials of the access to low cost R&D personnel. India, in particular attracts foreign firms because it offers more intellectual power per dollar than industrialised countries do in some R&D activities (Warton 2005).

The main motivations and the related arguments for locating R&D activities onshore or offshore are depicted in figure 1. Thus, the future location of R&D personnel and investments depends on where the lead markets for the specific technology are, where the largest markets which can realistically be served by the products of the company are, where centres or clusters of excellence in research and development are located, where qualified personnel and "talent" is available and which costs can be realised at a specific location for good quality R&D work. The latter does not only include the hourly costs per R&D but also the total cost to performance relation including coordination costs in the global R&D network and the possibility to realise economies of scale in concentrated R&D centres, e.g. in the home country.

Insert Figure 1 around here

Regarding the effects of R&D offshoring activities on innovation ability, organisational innovation, business performance, and employment, very few results and data are available. Regarding the question whether R&D performed in foreign location substitutes or complements the R&D work of these companies at the home base, evidence is mixed (Couto 2006; Salmi 2006; Andersen 2005, Patel and Vega 1999). Some surveys find support for complementary effects where R&D offshoring does not replace jobs in the home base country (Couto 2006; Patel and Vega 1999). Some other surveys find support for the thesis that offshoring of R&D leads to a further reduction of domestic R&D in the midterm future (Salmi 2006).

Regarding the innovation impacts of international R&D strategies most studies point out that companies using internationally dispersed R&D concepts show in many cases superior innovation outputs, e.g. measured in patents or share of turnover with new products. But there is no large scale firm level data or results on this question available,

particularly focussing on the offshoring pattern as internationalisation strategy for R&D. Ramah (2007) points out that there is insufficient empirical support to ascertain whether R&D abroad is more efficient than researching in the home country. One problem in this context is the lack of firm level data on this question and on the long term effects of internationalisation of R&D, which are difficult to foresee (Edler 2004). The lack of reliable data also holds true for questions regarding the relationship between R&D offshoring activities and the internal organisational forms of companies at their home base. There is evidence that internal organisational constraints are becoming more and more important as obstacles to successful offshoring activities of companies. Particularly operational efficiency, loss of managerial control and lack of acceptance among internal clients has risen significantly in the years 2004 to 2006 as impediments for offshoring (Couto et al. 2006, p. 8). The study does conclude that companies must arrange organisational boundaries and adopt new management processes in organisational structures on the way to more successful offshoring practices. An interesting question in this area might be, if offshoring companies are already making a more intense use of innovative organisational concepts as non-offshoring companies do or whether they are lagging behind in organisational innovations.

Taking into account these different and sometimes very sparse predictions and findings the paper focuses on the following research questions:

- What is the extent and what are the main motives for R&D offshoring in the German manufacturing industry? Which are the main motives for repatriating R&D activities as an indicator for the quality of the home base and the onshore motivation of R&D locations?
- What is the relationship between R&D offshoring activities and the intensity of use of innovative organisational concepts at the home base of the company? Or in other

words: Is R&D offshoring connected to an improved or reduced activity and capability to make use of innovative organisational forms in product development and value adding at home?

- What are the short run effects of R&D offshoring on innovation and performance indicators like sales with new products, productivity or profit margins of German manufacturing firms? What effects does R&D offshoring have on the employment development at the home country?

To be able to answer these questions, we have chosen an explorative approach applying an econometric matching procedure. This procedure allows controlling for the selection bias arising from differences in the characteristics of the R&D offshoring and non-offshoring companies, but does not require strong assumptions on the underlying research questions like multivariate regression models would need. The created “pair matching” also allows for investigating the short run effects of R&D offshoring on company performance and innovation indicators. The findings on these topics may provide additional insights into the rationales behind RT&D offshoring and the possibly changing organisation patterns at the companies’ home base.

3 Data and methodology

Our analysis will use the German dataset from the European Manufacturing Survey (EMS), a survey on the diffusion of advanced production technologies and organisational concepts in European manufacturing industry. The data set has been compiled by Fraunhofer ISI for Germany and by partner institutes in 12 European countries. It covers the period mid 2004 to mid 2006. The German dataset includes 1663 observations of German firms of all manufacturing industries. Figure 2 illustrates the distribution of the observations on the covered industrial sectors.

Insert Figure 2 around here

Econometric approach

The econometric analysis proceeds in two steps, each step addressing one of the research questions. The first step identifies determinants of R&D offshoring activities. We employ a probit analysis to explain the offshoring dummy. The second step analyzes the effects R&D offshoring has on companies' current organisational principles and their short run innovation behaviour and economic performance. The aim here is to compare two groups of companies; the first group has relocated R&D activities; while the second has not. As the first step establishes the differences in exogeneous characteristics of both groups, simple comparison of means will yield biased results. The selection bias can be seen from differences of the offshoring companies and the non-offshoring companies as illustrated by Figure 3. The average offshoring company differs significantly from the average non-offshoring company (column I and column II).

Insert Figure 3 around here

There are several ways to control for this bias. We could estimate a regression model which explains the propensity to innovative organisational concepts by various firm-specific factors, including size, sectoral affiliation, and, among others, an indicator for the enterprises which have relocated R&D. This approach, however, would require a functional form for the use of new organisational principles and strong assumptions on how – additively or multiplicatively – offshoring affects the organisational behaviour and company performance.

A different approach is to apply an econometric matching procedure. The matching approach was originally developed in the evaluation of labour market programs to iden-

tify treatment effects when the available observations on individuals are subject to a selection bias (Blundell and Costa Dias 2000). Such a bias typically occurs when participants in the programs differ from non-participants in observable and/or unobservable characteristics that influence the outcome to be evaluated. Participants of a labour market program, for example, may differ from non-participants with respect to their attitude towards taking up a new job. A comparison which does not account for this difference may come up with a wrong estimation of the effects of the measure. We use the methodology to be able to assess difference between firms which have offshored R&D activities and firms which have not.

The basic idea of the matching approach is to avoid the influence of a selection bias by comparing only entities with are similar except in one characteristic. Matching procedures identify a counterfactual entity for each entity from a given group which has similar propensities except the one to be observed. In our case, the matching estimator individually balances the sample for offshoring firms with respect to the variables included in the analysis for each observation. Czarnitzki (2005) argues that the advantage of a matching approach compared to a parametric regression analysis is the fact that the matching approach avoids any assumption on the functional form of the relationship. Another advantage over a parametric regression analysis is that it directly addresses the question “What could be expected from a firm with given characteristics if it had not relocated production activities?” The dissimilarity of offshoring and non-offshoring companies will potentially not be captured by a fully specific regression model. It may lack flexibility to take account of the different characteristics of offshoring and non-offshoring companies.

Technically, for each offshoring company the matching procedure selects – with replacement - a company from the non-offshoring companies which is most similar in a

given set of characteristics and adds it to the data set for analysis. With a growing number of characteristics it gets increasingly difficult to find appropriate matches. Following the suggestion of Rosenbaum and Rubin (1983) we use the propensity score of the first step probit anylysis as a matching criterion. As a result the set of offshoring and non-offshoring companies will be balanced in all exogeneous variables which enter the probit regression. The effect of R&D offshoring on the organisational behaviour and economic performance can be analyzed by comparing the groupwise mean values of the variables. As the selection of the non-offshoring companies is carried out with replacement certain non-offshoring companies can have multiple occurances. This underestimates the standard error within the group of non-offshoring companies and over estimates the significance of the effect. We account for the multiple occurances by employing the correction of standard errors suggested by Lechner (1999).

4 Results

4.1 Relevance and motives of R&D offshoring

According to our data of 1.663 German firms covering all manufacturing industries, 3.5 percent of the answering companies have offshored R&D activities in the two year time frame from mid 2004 to mid 2006 (Figure 4). Compared to production offshoring, where in the same time frame more than 20 percent of the firms were active, this ratio is still relatively low. As it was to be expected, especially larger firms with more than 1000 employees have offshored parts of their R&D (16.3 percent), whereas this ratio is significantly lower in medium sized firms (50 to 249 employees: 2.4 percent) and small firms (20 to 49 employees: 1.4 percent).

Insert Figure 4 around here

It is worth mentioning that in the indicated time frame not only R&D offshoring but also repatriating and backsourcing of R&D activities occurred. With 0.6 percent the ratio of firms repatriating parts of their foreign R&D is momentarily still very low, but it is not completely irrelevant, since every sixth firm making use of R&D offshoring is countered by one firm repatriating R&D activities in the same time frame.

The ratio of firms having offshored R&D activities also depends strongly on the specific manufacturing sector. Manufacturers of vehicles and vehicle components are most active in R&D offshoring with a ratio of almost 13 percent of these companies, followed by the chemical industry with more than 7 percent. The machinery and equipment producing companies represent the mean with around 3.5 percent firms performing R&D offshoring, whereas in the food industry no offshoring activities (0 percent) can be observed.

Insert Figure 5 around here

Regarding the motives triggering off R&D offshoring activities the reduction of personnel costs is most frequently named with 56 percent of the offshoring firms (figure 5). Capacity bottlenecks take the second place as they are relevant for the R&D offshoring activities of 46 percent of the companies, followed by the motive of knowledge augmentation in excellence clusters named by 30 percent. Also relevant for R&D offshoring activities is the possibility to adapt products to foreign markets to pursue a market acquisition strategy (28 percent) and being closer with R&D activities to important customers (22 percent). Regarding the three major motive bundles for R&D offshoring, namely knowledge exploitation, knowledge augmentation and reduction of costs (Sachwald 2007) it seems that nowadays cost motives are most important for R&D offshoring activities, followed by knowledge augmenting motives (capacity bottlenecks

and knowledge augmentation in clusters) and knowledge exploiting motives (market acquisition and vicinity to customers).

If these results are compared to the main motives triggering off R&D backsourcing activities (figure 5), a similar picture emerges. High coordination costs are the most relevant motive for the repatriation of R&D activities, named by 83 percent of the backsourcing companies, followed by a better availability of qualified personnel at the home base with 67 percent. Quality and flexibility problems as major reasons for R&D backsourcing activities are each named by 33 percent of the firms, whereas better infrastructural conditions at the home base are only relevant for 17 percent of the R&D repatriating activities. Therefore it can be concluded that surprisingly also for R&D backsourcing activities, cost motives played the most important role followed by knowledge augmentation motives like for instance availability of qualified personnel.

4.3 Determinants of R&D offshoring

Before we are able to construct the matching procedure in the next step, we need to calculate a probit estimation to identify the relevant determinants that influence the probability of a firm to offshore R&D activities. We employ a probit regression using robust standard errors. We assume that the offshoring decision may be first influenced by firm size, as larger companies are significantly more often multinational companies and have the necessary critical mass in financial and personnel resources as well as more often already gathered experiences with cross border production activities (e.g. Johanssen and Vahlne 1997; Dunning 1980, 1988; Buckley and Casson 1976; Rugman and Hodgetts 2000). Additionally, we include a number of variables describing the concrete manufacturing branch of the firm, the extent of R&D inputs (R&D expenditures and R&D personnel), the main strategic competition factor of the firms as well as vari-

ables describing the nature of their product development processes. As these variables affect the R&D intensity and efficiency of a firm, it is very likely that they will influence the propensity of a company to offshore R&D activities to foreign countries.

Figure 6 displays the results of the probit regression where we report the coefficient and significance estimations. The results show as was to be expected that one of the most important and significant influence factors on the probability to offshore R&D activities is the size of the company. This finding is in line with other studies investigating the frequency of R&D activities differentiated by firm size (e.g. DIHK 2005; Edler 2007; Belitz et al. 2006). We also find that firms with a higher R&D in terms of share of R&D expenditures at turnover are offshoring R&D activities significantly more often than companies with a lower R&D intensity do. These findings are also well in line with previous studies showing that R&D intensive manufacturing sectors are much more active in the internationalisation of their R&D activities than manufacturing sectors with lower R&D intensity (e.g. Belitz et al. 2006; Edler 2007).

Insert Figure 6 around here

A further look at the way companies are doing product development shows that companies which are developing new products for standard product programmes they are offering to their customers are significantly more active in R&D offshoring, whereas companies which do not have an own product development are obviously not. Finally, differences in the propensity of a firm to offshore R&D activities according to its main strategic competition factor can be observed. Companies relying mainly on a leadership strategy in terms of quality show a significantly lower probability to offshore R&D activities. In addition to the results on the major motives for R&D offshoring these findings might be interpreted that especially for companies focussing on product quality as

main competitive advantage, the cost performance relationship of their R&D and production processes is much more important than other factors, which in many cases leads to a concentration of R&D activities at the well-known home base.

4.3 Effects of R&D offshoring on organisational forms

After matching the sample using the probit analysis shown before, the samples of R&D offshoring and non-offshoring companies are comparable. On the average the differences between these two groups and the variables used in the probit analysis have vanished. A comparison of column 1 and column 3 in figure 3 does not show significant differences between the samples anymore.

We now test for differences in the intensity to use innovative organisational concepts at the home base, using a procedure suggested by Lechner (1999) to compute the standard errors in matched samples. The results show some interesting differences between R&D offshoring and non-offshoring companies in the use of advanced organisational forms (figure 7). Some concepts like decentralisation of planning, operating and controlling functions or R&D co-operations with external research institutions are significantly more often used in offshoring firms than in non-offshoring firms. The more frequent use of R&D co-operations with external research institutions can be interpreted as an indicator that R&D offshoring firms are more focused on organising their R&D activities in networks, not only with their foreign subsidiaries but also with external partners. This result is again a clear indication for the relevance of knowledge augmenting motives to organise R&D activities, internally and externally, to be able to pursue an innovation and technology leadership strategy. The more frequent use of centralisation concepts of R&D offshoring firms show that offshoring companies seem to use more frequently networks of decentralised units as a preferred organisational form

of their value adding processes. R&D offshoring activities might fit better into more decentralised network structures than into an organisational company structure focussing more on concentrating resources and capabilities at specific locations.

Insert Figure 7 around here

No the differences between R&D offshoring and non-offshoring firms can be discerned regarding the use of Continuous Improvement Processes (CIP), quality management systems according to the EFQM model and R&D cooperations with other companies. In all of these organizational principles there are no market differences in the share of firms using these principles between R&D offshoring and non-offshoring firms. All of them do not seem to be a prerequisite to be able to deal with the organizational challenges arising from R&D offshoring activities and the resulting needs for transnational coordination. On the other hand there is also no evidence that companies tend to use R&D offshoring as an alternative solution instead of implementing these organisational principles.

A different picture emerges when we compare the use of simultaneous engineering practices and time banks for flexible labour capacity between R&D offshoring and non-offshoring companies. The share of companies using flexible time banks for working hours is significantly higher in non-offshoring firms (96 %) compared to firms which have offshored R&D capacities (82 %). A similar pattern appears for the intensity of use of simultaneous engineering principles, ranging from 1 (low) to 2 (medium) to 3 (high). The mean extend of the exploited internal potential of simultaneous engineering is thus significantly lower in R&D offshoring firms (2.05) than in their non-offshoring counterparts (2.55). Referring to the high frequency of the motive of reduction of personal costs for R&D offshoring activities these results can be interpreted as a hint that

not always all organizational potentials for reducing costs are exploited at the home base before R&D offshoring activities as a measure for cost reduction are planned and implemented. Time banks for working hours with their potentials to reduce costs for overtime and additional personnel as well as simultaneous engineering practices as an appropriate principle to reduce product development times and duplication of work are both adequate alternative concepts to reduce personnel costs in product development. Thus the question occurs if some R&D offshoring activities mainly targeting on personnel cost reductions might sometimes have been decided rashly without taking into account all organizational potentials for reducing product development costs at the home base of the company. These findings are in line with previous research results on production offshoring, showing that many companies tend to underestimate the improvement potentials at their established locations and do not calculate them adequately when location decisions in favour of a new foreign plant are evaluated (Kinkel 2004, Dachs et al. 2006).

4.4 Effects of R&D offshoring on innovation and performance indicators

Besides the analysis of different organizational paths, the matched samples of R&D offshoring firms and non-offshoring pendants were also used for analysing the effects on selected innovation and performance indicators (figure 8). Offshoring firms do not significantly differ from their non-offshoring counterparts in the share of firms with product innovations as well as the share of firms with products new to the market. This observation holds also true for the share of turnover with product innovations, but surprisingly not for the share of turnover with products that are new for the market. Here non-offshoring firms show a significantly higher share (11.2 %) as R&D offshoring compa-

nies do (4.3 %). This might be interpreted as a first hint that development processes for more radical product innovations, which are not only new to the firm but for the world market, can be organized more effectively and efficiently when R&D activities and capacities are concentrated in one R&D location. This is an line with previous findings stating that the core competences of a firm in R&D, which are the crucial preconditions to be able to realise advanced product innovations with a clear degree of novelty for the world markets, should be preferably organized and concentrated in a specific centre of excellence of the company (e. g. Gerybadze and Reger 1999, Porter 1990, 1998). At least these results clearly show that R&D offshoring activities are not an appropriate strategic approach to improve a company's capability of realising product and particularly market innovations in the short-run[1].

Insert Figure 8 around here

The product development time to market and the share of turnover for investments are unaffected by R&D offshoring activities, at least in the short-run. Offshoring companies do not show significantly shorter nor longer product development times than their non-offshoring counterparts do. The potentials of speeding up development processes by working globally around the clock seem in the short run not to be able to outweigh the higher coordination and transaction affords for transnational organized R&D. The investment intensity at a home base shows no sign that offshoring companies provide their remaining R&D capacities at the home base with more modern equipment than non-offshoring companies do. On the contrary, the lower (but not statistically significant) investment rates of offshoring companies show that these activities might rather lead to sub-par investments in the R&D home base in favour of the foreign R&D sub-

[1] The time period between having realised R&D offshoring and measuring the innovation effects is a maximum of 2 years in our survey

sidiaries. This can not really be interpreted as a dangerous sign for the future of the domestic R&D base, as in the long run the whole global R&D network of the company might benefit from strategic R&D offshoring activities if they are able to contribute to the strengthening of strategic innovation and competition factors of the company (e.g. Farrell 2006, Couto et al. 2006).

Not surprisingly, however, R&D offshoring firms show a higher export quota than their non-offshoring counterparts do. This can be explained in two directions. Firstly, companies which have offshored R&D capacities particularly for knowledge augmenting reasons might be able to adapt their products more successfully to the specific market conditions in the respective foreign countries. Thus offshoring companies are able to sell more market "adapted products" in these countries, resulting in a higher share of exports at their total turnover. Secondly, the higher export might not be the outcome, but rather the cause of R&D offshoring activities. In this sense companies being more successful in foreign markets, e. g. by having established foreign production facilities, show a higher tendency to offshore R&D activities. This indicates that a further motivation for R&D offshoring can be that firms try to support their successful export mode or to follow their already existing foreign production facilities with corresponding development activities, particularly in application development (e. g. DIHK 2005; Farrell 2004; Kinkel 2007).

Finally, the profit margin and the development of the employment at the home base do not differ between offshoring and non-offshoring companies. The first result conclusively shows that expectations of some companies that offshoring of R&D activities would immediately lead to an improvement of the financial performance of their parent plant must be rejected. This is a strong indication that hopes to improve the profitability of the home base through R&D offshoring already within a short time period seem be

too optimistic, as it was also the case regards production offshoring (van Eenemaam and Brouthers 1996; Dachs et al. 2006). On the other hand, the results on the development of the employment level show that fears that R&D offshoring activities lead to a significant loss of high qualified jobs at the home base are in most cases too pessimistic. But a comparison of the annual employment growth ratio between R&D offshoring (1.4 %) and non-offshoring companies (5.9 %) shows also that R&D offshoring activities do, at least in the short run, not lead to a higher employment growth ratio at a home base as a result of a better competitive position of the companies. Overall the results on the employment effects of R&D offshoring show no large negative effects in the short run which could not be compensated by positive effects form additional competitive advantages in the long run. Therefore, innovation and industry policy must not regard R&D offshoring strategies of manufacturing firms as major threat for the employment markets of the home country and should not advance in measures targeted on avoiding R&D offshoring activities.

5 Conclusions

This paper analysed the relationship between a firm's decision to offshore R&D activities and its use of innovative organizational principles at home. We employed German data from the European manufacturing survey (EMS), a study on the introduction of advanced production technologies and innovative organizational concepts in European manufacturing. Our sample included 1 663 companies from all German manufacturing industries. To account for self-selection we employed an econometric matching approach to construct a similar sample of enterprises that offshored R&D activities and a control group that did not.

We found a mixed picture of differences in the use of innovative organisational concepts between R&D offshoring and non-offshoring firms. Decentralised concepts for the a organisation of planning, operating and controlling functions as well as R&D cooperations with research institutes are significantly more often used by firms that have offshored R&D capacities than by their non-offshoring counterparts. These findings can be interpreted as an indicator that R&D offshoring firms are more focused on organising their R&D activities in networks, using decentralised units, foreign subsidiaries and also external research partners, to be able to pursue an innovation and technology leadership strategy. On the other hand, time banks for flexible labour capacities are significantly less frequently used in R&D offshoring firms and the intensity of use of simultaneous engineering practices in product development is also at a significantly lower level in offshoring companies. These findings can be interpreted as an indication that firms that are offshoring R&D activities mainly for reasons of cost reductions, do not always exploit all existing organisational potentials to improve the efficiency of their productive development processes and thus to reduce development costs at their home base.

With respect to our findings on the effects of R&D offshoring on certain innovation and performance indicators, some recommendations for company planning can be drawn. The results have conclusively shown that there is no positive correlation between R&D offshoring activities of a firm and its economic performance. There is no measurable difference in the profit margin, the share of turnover with new products and the mean-time for product development (time to market) of R&D offshoring and non offshoring companies. Quite contrary, the share of turnover with products that are new not only for the firm, but for the world market, is significantly lower in firms that have offshored R&D activities. The latter can be interpreted as a clear indication that core competences,

which are necessary for the development of new products for the world market, are reasonably concentrated in one local centre of excellence, usually at the home base. The other results on the performance effects indicate that expectations of companies, that offshoring of R&D activities would be a promising option to improve the profitability of the home base within a short time period of one or two years, seem quite often to be too optimistic. May be there is a positive effect of R&D offshoring on the profitability and the innovativeness of the firm in a longer time perspective, but not as by many companies expected in a quite short time frame of just a few months.

With respect to policy, our results indicate no significant negative effect of R&D offshoring on labour demand at the parent location. However, our data only allows studying short-term effects and we cannot conclude on the effects in the long run. Company and employment growth in the long run does mainly depend on the innovative capabilities of the company and its ability to create new products and competitive advantage. These capabilities do not seem to be affected negatively by a company's decision to offshore R&D activities. Therefore, fears of some politicians that R&D offshoring might lead to a reduced demand for high skill personnel at the home base might be too pessimistic. On the other hand it is obvious that knowledge augmenting motives, e. g. the access to innovative knowledge in foreign clusters or capacity bottlenecks in high skilled work force at the home base, are important motives for R&D offshoring. Thus it is of major importance for the innovativeness and competitiveness of a country or region to secure that high skilled researches and developers, particularly in natural sciences and engineering, do not become a bigger bottleneck than they already are in many industrialized countries (e.g. Kinkel 2007).

Our findings paved the way for some interesting aspects for further research. Firstly, it would be important to analyse the effects of R&D offshoring on the innovativeness and

competitiveness of a firm in a longer perspective. Additionally, it would be interesting which time lag has to be expected between the implementation of R&D offshoring activities and potentially positive effects on the innovative capabilities and the economic performance of the company. This touches one of the most important limitations of our research, the limitation of our data on the measurement of short time effect of R&D offshoring strategies. In this context it is also important to gain substantive data on the differences in the time lag between implementation and economic effects of cost driven R&D offshoring strategies on the one hand and the implementation of suitable organizational principles to improve the efficiency of product development processes at the home base. Studies on production offshoring strategies have conclusively shown that many firms assume that a measurable positive impact on the economic performance of a firm could be realised earlier with offshored processes than with the implementation of innovative organizational concepts at the home base (Kinkel 2004, Dachs et al. 2006), which is in most cases not realistic. For organizational studies it would be interesting to get a deeper look into the interrelation of R&D offshoring activities and the implementation of new organizational principles. One of the crucial questions in this context is whether companies evaluate the strategic and economic value of different organizational principles and settings with an adequate intensity within location decisionn processes or whether they are already at an early stage of the decision process predominantly focused on R&D offshoring as their implicitly favoured option.

6 References

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Figures

Figure 1: Main motivation patterns for locating R&D capacities

	Onshore	Offshore
Knowledge Exploitation	• Largest market at/ close to home • Lead market at home	• Adapt products to foreign market requirements • Lead market abroad
Knowledge Augmentation	• Centres/ clusters of excellence at home • Strong R&D capabilities/ knowledge base in the home country	• Centres/ clusters of excellence abroad • Availability and access of "talent" abroad
Costs	• Economies of scale in R&D at home • Superior performance/ cost relation • High co-ordination costs	• Low cost (and good quality) R&D-personnel • Superior performance/ cost relation

Figure 2: Sectoral distribution of the sample

Manufacture of food products, beverages and tobacco	83	5,0%
Manufacture of textiles, textile products, leather and leather products	34	2,0%
Manufacture of wood and wood products	28	1,7%
Manufacture of pulp, paper and paper products; publishing and printing	73	4,4%
Manufacture of chemicals, chemical products and man-made fibres	95	5,7%
Manufacture of rubber and plastic products	174	10,5%
Manufacture of other non-metallic mineral products	62	3,7%
Manufacture of basic metals and fabricated metal products	324	19,5%
Manufacture of machinery and equipment n.e.c.	364	21,9%
Manufacture of electrical machinery and apparatus n.e.c.	116	7,0%
Manufacture of office machinery, computers and communication equipment	63	3,7%
Manufacture of medical, precision and optical instruments etc.	134	8,1%
Manufacture of transport equipment	75	4,5%
Manufacture of furniture; manufacturing n.e.c.; Recycling	38	2,3%
Total	**1663**	**100,0%**

Figure 3: Company characteristics and their group affiliation

	R&D Offs-horing	Non-Offshoring		
		Before Matching		After Matching
Number of employees (logarithmic)	5,76	4,05	***	5,62
Number of employees 2005	2456,54	413,514	**	1668,78
NACE 15;17; 18; 20; 37	2,0%	8,4%	***	10,0%
NACE 21; 22; 24	20,0%	14,1%		16,0%
NACE 25; 27; 28	14,0%	30,5%	***	14,0%
NACE 29	22,0%	21,1%		18,0%
NACE 30; 31; 32; 33; 36	26,0%	22,0%		30,0%
NACE 34; 35	16,0%	3,8%	**	12,0%
Eastern Germany	10,0%	14,7%		12,0%
Share of R&D staff (logarithmic)	1,69	1,156	***	1,673
Personnel of R&D (%)	7,81%	5,50%	**	9,06%
Share of R&D expenditures (logarithmic)	1,673	1,194	***	1,685
Share of R&D expenditures 2005	7,76%	4,98%	**	12,50%
Strategy: Price	24,0%	26,1%		26,0%
Strategy: Quality	10,0%	28,8%	***	10,0%
Strategy: Innovation/Technology	36,0%	16,9%	***	40,0%
Strategy: Customised products/service	22,0%	19,6%		16,0%
Strategy: delivery on time/ short delivery times	8,0%	8,6%		8,0%
According to customer´s individual specification	42,0%	45,1%		46,0%
Standard basic programme with variations	36,0%	36,6%		24,0%
Standard programme	20,0%	12,3%	*	30,0%
No product development	2,0%	6,0%	**	0,0%

Levels of significance: *** 1%, ** 5%, * 10%

Figure 4: Share of companies with R&D offshoring activities (mid 2004 to mid 2006)

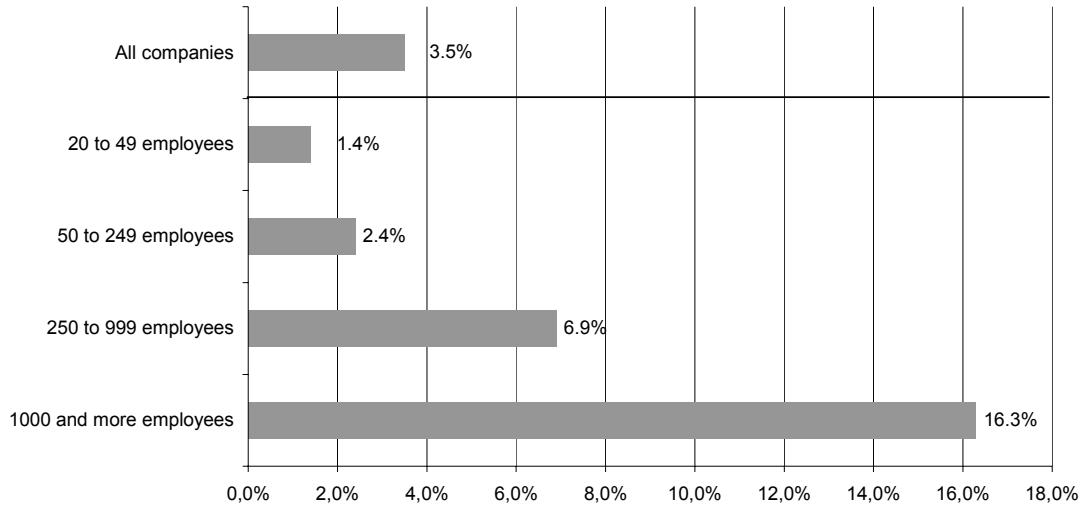

Figure 5: Motives for offshoring and backsourcing R&D capacities

	Onshore	**Offshore**
Knowledge Exploitation	• Quality (33%) • Flexibility (33%) • Infrastructure (17%)	• Opening up of new markets (28%) • Proximity to important customers (22%)
Knowledge Augmentation	• Availability of qualified staff (67%)	• Capacity bottleneck (46%) • Access to innovative knowledge/ clusters (30%)
Costs	• Co-ordination costs (83%)	• Personnel costs (56%)

Figure 6: Probit regression of the propensitiy to offshore R&D activities

	Coefficient	**P>|z|**	
Metall and plastic products	-0,28	0,202	
Mechnical equipment	-0,204	0,338	
Electrical Equipment, electronics and instruments	-0,16	0,444	
Vehicles and vehicles part	0,409	0,143	
Number of employees (logarithmic)	0,198	0	***
Region (Western/Eastern Germany)	-0,073	0,739	
Strategy: Quality	-0,505	0,035	**
Strategy: Innovation/Technology	0,175	0,385	
Strategy: delivery on time/ short delivery times	0,078	0,774	
Strategy: Adaption of products	0,117	0,569	
Product development on customer demands	0,106	0,501	
Product development for standard programme	0,388	0,055	*
Share of R&D staff (logarithmic)	0,057	0,522	
Share of R&D expenditures (logarithmic)	0,214	0,059	*
_cons	-3,132	0	

Number of obs	1366	
LR-chi^2	62,48	***
Log-LR	-183.216	
Pseudo-R^2	0.146	

Levels of significance: *** 1%, ** 5%, * 10%

Figure 7: Effects of R&D offshoring on the use of innovative organisational concepts

	Non Offshoring	R&D Offshoring	Signi-ficance
Decentralisation of planning, operating and controlling functions	48,9%	**67,3%**	**0,094** *
Decentralisation of planning, operating and controlling functions: Extent of used potential	2,2	2,0	0,635
R&D co-operation with research institutes	69,4%	**87,8%**	**0,044** **
R&D co-operation with other companies	44,0%	42,0%	0,854
CIP Continuous Improvement Process	88,0%	88,0%	1,000
CIP Continuous Improvement Process: Extent of used potential	2,1	2,3	0,483
Quality Management (EFQM Model)	40,0%	51,1%	0,339
Quality Management (EFQM Model): Extent of used potential	1,7	2,3	0,101
Time bank for flexible labour capacity	**96,0%**	82,0%	**0,028** **
Time bank for flexible labour capacity: Extent of used potential	2,5	2,4	0,690
Simultaneous Engeneering	61,4%	47,9%	0,240
Simultaneous Engeneering: Extent of used potential	**2,5**	2,0	**0,075** *

Figure 8: Effects of R&D offshoring on innovation and performance indicators

	Non Offshoring	R&D Offshoring	Signi-ficance
Share of firms with product innovations	75,5%	83,7%	0,360
Share of firms with products new for the market	61,2%	46,9%	0,188
Share of turnover of product innovations	20,0%	13,4%	0,178
Share of turnover of products new for the market	**11,2%**	4,3%	**0,062** *
Time to market (in month)	19,7	21,3	0,696
Share of turnover of investment	8,2%	4,5%	0,227
Graduate degree (ratio of employees, %)	17,0%	19,6%	0,418
Export ratio (logarithmic)	2,9	**3,7**	**0,081** *
Return on sales before tax	3,3%	3,7%	0,227
Development of employees from 2003 to 2005 (% p.a.)	5,9%	1,4%	0,281