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Changing patterns of R&D relocation activities in the course of the global economic crisis

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Abstract

Offshoring of R&D activities to low-wage countries in Asia and Eastern Europe has become more and more important. Recently, the global search for highly-qualified workers and lower-cost personnel in developing countries emerged as the major drivers for the relocation of knowledge-intensive activities. Our paper focuses on the change of patterns of R&D relocation activities in the course of the global economic crisis, comparing evidence of firms which have been active before 2007 with companies being active in the period from 2007 to mid 2009, using data of 1,484 German manufacturing companies.

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Abstract

Offshoring of R&D activities to low-wage countries in Asia and Eastern Europe has become more and more important. Recently, the global search for highly-qualified workers and lower-cost personnel in developing countries emerged as the major drivers for the relocation of knowledge-intensive activities. Our paper focuses on the change of patterns of R&D relocation activities in the course of the global economic crisis, comparing evidence of firms which have been active before 2007 with companies being active in the period from 2007 to mid 2009, using data of 1,484 German manufacturing companies.

Keywords: R&D offshoring, relocation, global economic crisis

Literature review and hypotheses on trends and drivers of R&D relocation

The globalization of companies' R&D activities has increased considerably over the past few years (e.g. OECD, 2005; UNCTAD, 2005). Particularly the so-called offshoring of R&D activities to low-wage countries in Asia and Eastern Europe has become more and more important (e.g. Lewin et al., 2009; UNCTAD, 2005). Whereas in the past companies relocated R&D activities to foreign countries mainly to adapt its products or services to local tastes and requirements, but the basic knowledge was still generated in the parent site of the company, today the global search for highly-qualified workers and lower-cost personnel in developing countries is one of the major drivers (e.g. Ambos, 2005; Couto et al., 2006; Lewin and Peeters, 2006; Lewin et al., 2009). Against the background of the recent economic crisis, the question comes up if these patterns and trends are going to continue or if the extent and drivers for R&D relocation activities has been significantly affected.

According to co-evolutionary approaches (e.g. Hutzschenreuter et al. 2007; Manning et al., 2008), institutional and environmental factors and particularly external shocks like the recent worldwide economic crisis, caused by a major credit crunch in almost all economically important nations, are affecting companies' FDI and offshoring strategies significantly. The 2009 World Investment Report has conclusively shown that the recent economic crisis led to a severe reduction in global FDI flows (UNCTAD, 2009). However, the fall of FDI inflows hit most emerging economies later and not that hard than most developed countries. Thus, it is not clear whether the economic crisis affected offshoring activities to emerging economies negatively or not. One argument for a reduction of R&D offshoring activities in the course of the economic crisis goes back to transaction cost theory, predicting that the degree of vertical and spatial integration

tends to rise with higher uncertainty of economic activity (Williamson, 1985). On the other hand, evidence on manufacturing offshoring has shown that in times of economically challenging environmental conditions, firms tend to use relocation activities more frequently to make use of labour cost advantages in low-wage countries (Kinkel et al., 2007; Kinkel and Maloca, 2009). As evidence is not clear and mixed, we propose two opposing hypotheses regarding the development of the extent of R&D relocation activities in course of the economic crisis:

H 1a: The share of R&D relocating companies has been (still) rising in the course of the global economic crisis [no trend reversal].

H 1b: The share of R&D relocating companies has declined in the course of the global economic crisis [trend reversal].

Regarding the *motives* of R&D offshoring and possible changes in motivation patterns, the dichotomy of differentiating motivations in home base exploiting or *knowledge exploiting* (KE) versus home base augmenting or *knowledge augmenting* (KA) can be predominantly found in literature (e.g. Kuemmerle 1997, 1999; Le Bas and Sierra, 2002; Niosi, 1999). Studies 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 (Ambos, 2005; Couto et al., 2006; Edler 2004; EIU, 2004). In parallel to the move towards the augmenting mode, the *cost factor* has increasingly become relevant for R&D offshoring decisions (e.g. Couto et al., 2006; Sachwald 2008). This "new" motivation pattern of *efficiency seeking* leads to a rising attractiveness of low-cost locations and emerging countries for the location of R&D, particularly in Asia, but for developed Western European countries also in Eastern Europe (e.g. Kinkel, 2008).

Taking into account the effects of the economic crisis on local labour markets, we have to consider the fact that the availability of qualified personnel with science and engineering (SE) skills, which are particularly important for R&D activities, is heavily influenced. According to approximations of the Association of German Engineers (VDI), the shortage of engineers in German industry, calculated as the difference of demand and offer of skilled employees, dropped from a historical high of 70,000 at the end of 2007 to 25,500 in November 2009. Therefore, we propose the following hypotheses regarding the development of the motives for R&D relocation activities in course of the economic crisis:

H 2: In the course of the global economic crisis, the access to qualified personnel is losing significance and labour cost reduction motives are gaining importance for R&D relocation activities.

H 3: As labour cost savings are gaining significance in the course of the economic crisis, companies focusing on a price leadership strategy will be particularly active in R&D relocation activities.

According to transaction cost theory, growing distance between integrated or outsourced activities and the focal enterprise is also a factor of rising uncertainty (Williamson, 1985). Following this rationale and the theoretical expectations of learning-based explanation models of internationalisation processes, it is assumed that companies in-

ternationalise like "rings in water" (Johanson and Vahlne, 1990). Particularly in times of economic crisis with a high uncertainty of future economic activity, firms tend to concentrate their activities in culturally and physically "close" countries whose traditions and history appear known. Additionally, most low-wage Eastern European countries (EEC) are suffering much harder and longer from the consequences of the economic crisis than the emerging economies in Asia, particularly China, leading to stable or even declining wages in EEC compared to (again) rising labour costs in Asia's developing countries. Considering the (probably) rising importance of labour cost reduction for R&D relocation strategies, we propose:

H 4: In the course of the global economic crisis, Near-Shoring (NS) R&D relocation activities are gaining importance compared to Far-Shoring (FS) activities.

Besides the motives of R&D relocation decisions intended by the companies' responsible managers, path dependency is also a recognized factor for R&D offshoring practises (e.g. Hutzschenreuter et al., 2007). As most companies "manage" the process of internationalisation by experimental learning or imitation (Henisz and Delios, 2001; Johanson and Vahlne, 1977), location decisions are influenced by existing interpersonal links and organisational routines rather than by systematically collected research (Nelson and Winter, 1982; Zollo and Winter, 2002). Offshoring decisions are thus significantly shaped by past experiences on how to initiate and manage such processes. Some authors describe the relocation of innovation activities as an adoption process of offshoring projects, starting with rather simple or standardised activities and progressively leading – by learning and doing – to offshoring of increasingly advanced activities (Lewin and Peeters, 2006; Maskell et al., 2007). Therefore, it can be argued that firms with past experiences in R&D relocation activities are more likely to take up such activities again than firms with no past experience in this specific arena:

H 5: Previous experiences with R&D relocation activities will have a significant impact on current R&D relocation activities.

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 current German dataset of 2009 includes 1,484 observations of German firms of all manufacturing industries. On the whole, the database can be regarded as a representative cross-section of the German manufacturing industries. Small companies are slightly underrepresented in the sample whereas large companies tend to be slightly overrepresented. These little discrepancies between the sample and the population have been compensated by weighting factors.

To analyse the determinants of R&D relocation activities before and in the course of the global economic crisis, we employed a structured econometric probit analysis of three different models. Model 1 describes the determinants of R&D relocation activities in a timeframe of 1999 to 2006, which was all before the emergence of the recent economic crisis. Model 2a describes the determinants of R&D relocation activities from 2007 to mid 2009, which was at least on one half influenced by the recent economic crisis and hit large parts of the German industry heavily in 2008 and 2009. In Model 2b we in-

clude, again for the recent timeframe from 2007 to mid 2009, additionally two dummy variables of past experiences (1999-2006) with manufacturing and R&D relocation activities to control for path dependency effects.

Relevance, motives and target countries of R&D relocation activities

According to our data, 2.1 percent of companies with R&D activities have relocated parts of their R&D activities to foreign countries in the recent two-year time frame from 2007 to mid 2009 (table 1). Compared to the 3.5 percent of companies which have been active in the last surveyed two-year timeframe before the emergence of the economic crisis (mid 2004 to mid 2006), there has been a significant decline of relative 40 per cent in the share of R&D relocating companies, providing support for hypothesis H 1b (and rejecting H 1a). The analysis also shows that the decline of R&D relocation activities in the course of the economic crisis is significantly higher in small firms than in large firms, which show an almost stable picture. As large firms are responsible for up to 90 per cent of the industrial R&D expenditures in the German economy, it can be assumed that the total amount of relocated R&D capacities has not dropped as sharply as the relative 40 per cent suggest.

Table 1 – Share of companies with R&D relocation activities

R&D offshoring companies	R&D offshoring 2007 to mid 2009	R&D offshoring mid 2004 to mid 2006
20-99 employees	0.8 %	2.9 %
100-499 employees	2.8 %	3.5 %
500 and more employees	13.9 %	13.8 %
Manufacture of consumer goods	2.1 %	2.9 %
Manufacture of input goods	1.7 %	3.3 %
Manufacture of investment goods	2.8 %	4.7 %
All companies	2.1 %	3.6 %

Regarding the main motives triggering off R&D relocation activities (table 2), the reduction of labour costs is in the recent timeframe (2007 to mid 2009) most frequently named with 65 percent of the R&D relocating firms, followed by the access to innovative knowledge, technology or clusters (33 percent), favourable taxes and subsidies at the foreign location (17 percent), access to new markets (17 percent), capacity bottlenecks and lack of qualified staff (13 percent), and being closer with R&D activities to important customers (10 percent). Compared with the relevance of these motives in the last surveyed two-year timeframe before the emergence of the economic crisis (mid 2004 to mid 2006), it is obvious that efficiency seeking motives as labour cost and tax savings have gained relative importance in the course of the global economic crisis, whereas particularly the access to qualified personnel lost dramatically in relevance as a driver for R&D relocation strategies. These results provide support for Hypothesis H 2.

Table 2 – Main motives for R&D relocation activities

Main motives for R&D offshoring decisions	R&D offshoring 2007 to mid 2009	R&D offshoring mid 2004 to mid 2006	Mode*
Lower labour costs	65 %	53 %	ES
Access to innovative knowledge/ technologies/clusters	33 %	23 %	KA
Taxes, subsidies	17 %	2 %	ES
Access to new markets	17 %	20 %	KE
Capacity bottlenecks/ lack of qualified staff	13 %	58 %	KA
Vicinity to important customers	10 %	29 %	KE

* KE = Knowledge Exploitation; KA = Knowledge Augmentation; ES = Efficiency Seeking

The descriptive analysis of the target regions for R&D relocation activities (table 3) shows that near-shoring locations in Eastern or Central Europe were recently (2007 to mid 2009) the most attractive destinations for R&D relocation activities, summarizing almost 80 percent of all offshore target regions. Asia, including China, does only account for one third of all recent R&D relocation targets. The comparison with the two-year timeframe before (mid 2004 to mid 2006) shows also clearly that the near-shoring European regions have since then gained in importance or at least could sustain their pre-crisis level, whereas all far-shoring regions in Asia (including China), the Americas and the rest of the world have significantly lost relevance as offshoring targets, providing support for hypothesis H 4.

Table 3 – Target regions for R&D relocation activities

Target countries for R&D offshoring activities	R&D offshoring 2007 to mid 2009	R&D offshoring mid 2004 to mid 2006	Mode*
Other (than EU 12) Eastern European countries	31 %	21 %	NS
“Old” European Union member states (EU 15)	26 %	15 %	NS
Asia (besides China)	23 %	32 %	FS
New Eastern European Union member states (EU 12)	21 %	22 %	NS
China	9 %	14 %	FS
Americas	0 %	8 %	FS
Rest of the world	2 %	10 %	FS

* NS = Near-Shoring; FS = Far-Shoring

Determinants of R&D relocation activities

To identify the relevant determinants that influence the probability of a firm to relocate R&D activities and the changing patterns due to the economic crisis, we calculated three probit estimations using robust standard errors. Table 5 displays the results of the probit regressions where we report the coefficient and significance levels. The models are all statistically significant ($\chi^2 = 0.0000$) and show a Pseudo R^2 of between 0.2149 and 0.4047, which is quite good.

Table 4 – Probit regressions of firm-level determinants to relocate R&D activities

Probit regression	Model 1 (1999 - 2006)			Model 2a (2007 - mid 2009)			Model 2b (2007 - mid 2009)		
	Number of obs = 1052			Number of obs = 1073			Number of obs = 1044		
	LR chi2 = 49.20			LR chi2 = 65.13			LR chi2 = 86.93		
Dependent Variable: R&D relocation	Prob > chi2 = 0.0000			Prob > chi2 = 0.0000			Prob > chi2 = 0.0000		
	Pseudo R2 = 0.2149			Pseudo R2 = 0.3035			Pseudo R2 = 0.4074		
	Coef.	P> z	Sig.	Coef.	P> z	Sig.	Coef.	P> z	Sig.
log number of employees	.234416	0.001	***	.3363009	0.000	***	.3021511	0.001	***
man. input goods	-.2499103	0.321		-.5256019	0.068	*	-.5005202	0.114	
man. investment goods	-.6078674	0.036	**	-.35623	0.196		-.1387372	0.642	
German Region (Western part)	.3513017	0.317		.0557115	0.876		.094451	0.824	
customer specific product development	-.5179786	0.023	**	-.4828533	0.055	*	-.4489481	0.111	
man. complex products	.4233958	0.060	*	.1772443	0.465		-.0463732	0.867	
strategy: price leadership	.5701506	0.032	**	.5846581	0.085	*	.2510396	0.542	
strategy: quality leadership	-.1724495	0.464		.400496	0.134		.4224726	0.137	
R&D intensity (% R&D expend. at turnover)	.02702	0.033	**	.0178084	0.298		.0052427	0.840	
use of supply chain management tech.	.1391503	0.518		.4797554	0.048	**	.5367848	0.047	**
product development collaborations	.4246369	0.080	*	.3170699	0.228		.1832698	0.514	
R&D relocation (1999 - 2006)							1.563.522	0.000	***
Manufacturing relocation (1999 - 2006)							.0812144	0.781	
constant	-3.713.921	0.000	***	-4.298.428	0.000	***	-4.205.892	0.000	***

Significance level: *** = p < 0.01; ** = p < 0.05; * = p < 0.1

The results show that in all three models the size of the company is significantly and positively related to the probability to relocate R&D activities. In model 1 and 2a, companies which are engaged in customer-specific product development are – as expected – less active in R&D relocation. R&D intensity and the use of product development collaborations with other firms and institutions are significantly and positively related to the probability to relocate R&D activities only before the occurrence of the economic crisis (model 1). Conversely, the use of supply chain management technologies as a proxy for the firms' experience with IT and organisational processes to coordinate separated actors and units shows a significant correlation only after the emergence of the economic crisis (models 2a and 2b). As assumed, companies focusing on a price leadership strategy are significantly more active in R&D relocation activities than companies focusing on a differentiation strategy (model 1 and 2a), providing support to hypothesis H 3. If we add in model 2b, for the recent timeframe from 2007 to mid 2009, two dummy variables to control for past experiences (1999-2006) with manufacturing and R&D relocation activities, we also find expected results. Previous experiences with R&D relocation activities have a significant and positive impact on recent R&D relocation activities, whereas past experiences with manufacturing relocation activities show no significant correlation, providing support to hypothesis H 5.

Discussion and conclusions

Consistent with the recent cutback of global FDI flows (UNCTAD, 2009), we found a significant decline of R&D relocation activities of German manufacturing companies in the course of the global crisis, compared to a (relatively) 40 percent higher level before the crisis. These findings are in line with arguments of transaction cost theory, predicting that with a higher uncertainty of the economic environment the degree of organisational and spatial separation tends to decrease (Williamson, 1985). Interestingly, particularly small firms reduce their R&D relocation activities, reacting very sensible to the growing uncertainty in foreign locations. They seem to be very reluctant to engage in such activities in times when they are not able to develop a sound awareness of the associated risks (Kenney et al., 2009) and when they could not afford a possible setback

because of their already slim capital backing (van Eenemaam and Brouthers, 1996). Larger firms seem to make further use of R&D relocation activities even in economically challenging times, focusing stronger on their labour cost saving potentials than in times of a prosperous economy.

Regarding the main *motives* triggering off R&D relocation activities, our results indicate that nowadays, in the course of the global economic crisis, cost reduction or efficiency seeking (ES) motives are most important for R&D relocation activities, followed by knowledge augmenting (KA) motives and knowledge exploiting (KE) motives. The further decline of the relevance of KE motives supports previous findings that the access to new markets in foreign countries seems to be no primary strategic driver for R&D offshoring activities any more (Lewin and Peeters, 2006; Lewin et al., 2009). It can also be concluded that for the relocation of R&D activities to foreign low-wage countries, cost reduction and the search for efficiency as the "third business mode" (Sachwald 2008) are still on the rise and even further promoted by the emergence of the global economic crisis. However, the recent dramatic drop of the access to qualified personnel has a new quality. This result points quite in the opposite direction than the "emerging trend" towards talent seeking which has been described in some recent studies (e.g. Lewin et al., 2009; Manning et al., 2008; Maskell et al., 2007). As the economic crisis reduced – at least temporarily – the beforehand rapidly growing shortage of SE talent in many developed economies, it gave a break to the rising importance of the global search for qualified workers as major driver for R&D relocation decisions.

As we have assumed in H 4, along with the growing importance of labour cost rationales in the course of the economic crisis comes the (re)emergence of near-shoring locations in Eastern or Central Europe, which are primary target regions for almost 80 percent of all R&D relocation activities of German manufacturing companies. This can be explained with transaction cost theory and learning-based rationales, as companies tend in times of high economic uncertainty towards lower physical and cultural distance to their offshore locations (e.g. Johanson and Vahlne, 1977, 1990; Williamson, 1985). The decline of low-wage countries in Asia might also be explained by the fact that these countries did not suffer as hard and long as many EEC countries from the consequences of the economic crisis, leading to a relative rise of their wage levels compared to EEC and thus a lower attractiveness for the now predominantly labour cost driven R&D relocation decisions. On the other hand, evidence from recent FDI statistics of the German Central Bank shows that particularly Asian countries, with China in the forefront, are currently gaining attractiveness for market-driven direct investments of German MNEs. This suggests that the relocation mode of (R&D) offshoring decisions follows clearly different motivation and localisation patterns than that of foreign expansion investments, particularly in times of a challenging economic environment.

The results of our structured probit analyses uncover further insights into the changing patterns of R&D relocation strategies by comparing firm-level determinants before and in the course of the crisis. As labour costs savings play an important role for R&D relocation activities before 2007 as well as 2007 and after (cf. table 3), it could have been expected that companies focusing on a price leadership strategy have been particularly

active in R&D relocation activities in both observed periods (model 1 and 2a). A different pattern can be found when we check for the firms' R&D intensity as an indicator for their innovativeness. Our results show that before 2007 companies with a higher R&D intensity and experiences in the use of product development collaborations with external partners engaged significantly more often in R&D relocation, whereas these correlations vanished for R&D relocation activities 2007 and after (model 1 and 2a). This may serve as evidence that before the emergence of the economic crisis R&D relocation activities were characterized by a more open approach followed also by firms pursuing an innovation leadership strategy. These companies were globally searching for excellent research conditions and personnel and thereto made use of their experiences with the initiation and management of knowledge augmentation (KA) through external networks and "open innovation" practices.

When we include the past experience (1999-2006) with R&D and manufacturing relocation activities in our model 2b to explain the R&D relocation behaviour after 2007, it improves significantly the overall quality of the model, increasing the Pseudo R^2 from 0.3035 (model 2a) to 0.4047 (model 2b). A deeper analysis shows that this additional explanation power is almost completely triggered by past experiences with R&D relocation, whereas the insertion of experiences with manufacturing relocation does not improve the model significantly. This leads to two conclusions: Firstly, past experience with R&D relocation really matters for recent activities in this area. This suggests that particularly in economically uncertain times, companies seem to be more reluctant to new approaches with subjectively higher associated risks and to experimental learning of more advanced offshoring activities and modes. Secondly, the insertion of past experience with R&D relocation has also a methodical surplus, as it significantly sharpens the differences between the models of firm-level determinants before and after 2007.

Overall, these results support evidence for a clear shift in companies' R&D relocation strategies in the course of the economic crisis. Before the emergence of the economic downturn, firms pursuing price and innovation leadership strategies were both above-average engaging in R&D relocation activities, particularly to improve their cost saving potentials or to get a superior access to highly qualified human capital. The latter has been stressed in some recent studies as an "emerging trend" towards knowledge and talent seeking in R&D offshoring operations (e.g. Lewin et al., 2009; Manning et al., 2008; Maskell et al., 2007). The global downturn then seems to have changed firms' R&D relocation behaviour again. Small and innovation-focused firms became more reluctant to R&D relocation activities, as they assess the associated risks higher than the potential benefits in today's uncertain times, particularly if they do not have any past experience with R&D relocation. In contrast, large companies pursuing a price leadership strategy are still above-average engaging in R&D relocation, putting a strong focus on the labour cost saving potentials of these activities and efficiency-securing coordination technologies and processes. It can be assumed that these changing patterns are of temporary nature, depending on the timeframe until the global economy has recovered on pre-crisis level, which is likely to last at least 3 to 4 years. Thereafter, if the global economy does not recover much slower than expected, the shortage of qualified staff will relatively soon be back on the strategic agenda for offshoring decisions again, par-

ticularly because of the demographic developments in many developed countries. However, some predictions on future developments in global FDI and offshoring avenues could, at least temporarily, be brought to a hold.

These findings clearly illustrate the high impact of environmental factors such as global or local economic developments, but also developments of wages, education or (political) risks, on companies' offshoring decisions (e.g. Doh et al., 2009; Manning et al., 2008). Therefore, it would be helpful to systemically integrate possible scenarios on the future development of influencing environmental factors and their potential impact on IB strategies and offshoring decisions in future research frameworks. Nobody has estimated or seriously "guessed" the impact of a severe global economic downturn, or of suddenly very high dynamics of rising wage levels of yearly up to 30 percent in some Eastern European emerging regions, on the feasibility and sustainability of specific internationalization strategies. Also, the deduction of future "trends" and new paradigms in IB and offshoring research should always be mirrored in the light of possibly changing (or even trend reversing) environmental and economic conditions. This would help academics and practitioners to develop a sound understanding and "feeling" of the described phenomenon and its interrelation with and sensitivity to significant changes of the relevant environment.

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