

# **Production Offshoring and Technological Competencies at Home**

**Abstract:** There is a vivid discussion in Western Europe about the consequences of the ongoing relocation of production activities to other parts of the world, namely Eastern Europe and Asia. This paper analyzes the relationship between a firm's decision to offshore production activities and its investment in advanced production technology at home. Moreover, we will also investigate what (short run) effects offshoring has on company indicators such as growth, profit margin, research and development intensity and service sales of manufacturing firms.

We employ data from the European Manufacturing Survey (EMS), a study on the introduction of advanced production technologies and organisational concepts in European manufacturing. We find only few significant differences between firms that relocated production and firms that did not with respect to their investment behaviour in advanced production technologies at their home base. There is neither a concentration on advanced production technologies at home, nor do we identify significant substitution effects between lower factor costs abroad and investment in labour-saving production equipment at home. Relocating firms, however, exhibit a changing specialisation pattern with a higher growth in services sales and in R&D expenditures.

JEL-Codes: F230, O320, O330

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# 1 Introduction

There is a vivid discussion in Western Europe about the consequences of the relocation of production activities to other parts of the world, namely Eastern Europe and Asia. People are concerned that investment abroad may lead to job losses in the home countries of offshoring enterprises, while others argue that production abroad increases total productivity of the companies and therefore also promotes competitiveness in the home country. While most of these discussions are concerned with the labour market effects of relocation, this paper examines the relation between overseas activities and the use of advanced production technologies at home. Moreover, we will also investigate what (short run) effects production offshoring has on company indicators such as growth, profit margin, research and development (R&D) intensity and service sales of manufacturing firms.

The association between foreign production and home investment will be tested with data from the European Manufacturing Survey (EMS), a dataset compiled by Fraunhofer ISI and partner institutes. EMS provides detailed information on the introduction of new production technologies and organisational concepts. We apply an econometric matching estimator to construct a sample of enterprises that relocated production and a control group that did not, but share the same size, industry, personnel intensity etc, with the first group. We will then compare the two groups.

The paper is organized as follows; section one discusses the relevant literature and come up with two hypotheses about the connection between production offshoring and technological capabilities at home. Section two presents our data; section three explains our econometric approach. The empirical results are discussed in section four. Section five draws conclusions.

## **2 Theoretical background and research questions**

Public interest in the home country effects of foreign investment goes back to the 1930s (Lipsey 2002, p. 7), but has freshed up in recent years in the course of a "new" globalisation debate. Some empirical results indicate on one hand that foreign investment may substitute production, exports and therefore employment at home (Mucchielle and Saucier 1997; OECD 1995). On the other hand empirical evidence also shows that these fears may be only partly justified (see Barba Navaretti and Falzoni 2004 for a recent survey) or find no general tendency that domestic jobs are substituted by foreign employment (Brainard and Riker 1997; Braconier and Ekholm 2000; Bruno and Falzoni 2003; Deutsche Bundesbank 2004). In the long run, most authors find no association or a complementary relationship between production activities at home and abroad.

The reason for these ambiguous results lies in the dynamic characteristics of the process (Markusen and Maskus 2001; Lipsey 2002; Markusen 2002; Barba Navaretti and Venables 2004). The internationalisation of production as well as research and development activities is not just a simple 'reducing at home and building up elsewhere', but involves rather complex substitution and complementary effects, determined by different factor costs, factor endowments, (lead) market expectations and technological competencies (e.g. Ayal and Zif 1979; Caves 1982; Gerybadze and Reger 1997). Moreover, one has also to distinguish between 'vertical' investment that relocates stages of production previously carried out at home, and 'horizontal' foreign investment which duplicates home activities. There is a tendency that vertical activities substitute while horizontal activities complement home production, but evidence varies considerably between sectors and countries (Barba Navaretti and Venables 2004), as well as the underlying motives of production offshoring (Kinkel, Lay, Maloca 2007).

Foreign operations therefore do not necessarily reduce domestic activity. They may even strengthen domestic production, if the company can achieve higher overall sales and a higher overall productivity via foreign activities, which, in turn, generates a higher demand for the output of the stages of production located at home. Theory predicts that units in the home country will specialize on more skill-intensive and capital-intensive activities like highly automated production or flexible, 'customized' manufacturing, while foreign affiliates exploit factor price advantages of their host countries in labour-intensive production activities. However, a specialisation of the parent company on supervising, co-ordinating and value adding auxiliary activities, resulting in the creation of firm-level assets that can be employed in all affiliates of the multinational enterprise, may also arise from horizontal, market-exploiting foreign direct investment (Buckley and Casson 1976; Dunning 1988; Bartlett and Ghosal 1989; Ferdows 1997). Recent empirical evidence shows that offshore outsourcing indeed shifts relative employment in the home country significantly in favour of high-skilled labour (Egger and Egger 2003; Hansson 2005; Egger and Egger 2006). This may also indicate a higher propensity to invest in advanced production technology.

The link between relocation and investment decisions at home may also be influenced by self-selection. Theoretical as well as empirical research has argued that firm heterogeneity leads to a selection-bias in the internationalisation strategies of firms (Head and Ries 2003; Helpman *et al.* 2004). Only the most productive firms expand their operations via FDI, while less productive firms choose to export or serve only domestic markets. Foreign production and growth at home go hand in hand, as Pfaffermayr (2004) shows. If relocation is part of a wider growth and diversification strategy to serve foreign markets by local production, we may see a similar or even higher level of technological competence of these firms, and foreign activity may preserve and even reinforce a firm's growth potential at its domestic loca-

tion (Porter 1990, 1998). This may lead to a situation where capital- and skill-intensive stages are concentrated at home, while labour-intensive stages of production are located in low-wage countries (Mucchielle and Saucier 1997; Ferdows 1997). We will account for this bias by employing an econometric matching estimator described in the next chapter.

Based on these findings, we assume that an increasing division of labour within the relocating enterprise leads to a concentration and augmentation of the most advanced production steps at home, while labour-intensive activities are performed abroad. Therefore, we expect to find a higher or at least an equal propensity to employ modern production technology in enterprises that relocated production than in enterprises that did not. If we find a lower propensity in enterprises engaged in foreign production, we may conclude that reductions in overall production costs by offshoring or outcontracting to locations abroad also reduce incentives to invest in new technologies at home.

### **3 Data**

Our analysis will use a dataset from the European Manufacturing Survey (EMS), a survey on the diffusion of advanced production technologies and organisational concepts in European industry<sup>1</sup>. The data set has been compiled by Fraunhofer ISI for Germany and by partner institutes in Austria, Switzerland, France, the UK, Slovenia, Croatia, and Turkey. It covers the period 2000-2002. We will only use the German, Swiss and Austrian results from this survey due to representativeness and comparability of the three countries. The dataset includes 1,875 observations of German, Swiss and Austrian firms. 1,601 observations provide sufficient information for the analysis. Our sample consists mainly of German enterprises.

<sup>1</sup> [http://www.isi.fhg.de/i/projekte/survey\\_pi.htm](http://www.isi.fhg.de/i/projekte/survey_pi.htm)

Producers of finished metal products and machinery are most frequent in the dataset. Table 1 illustrates the distribution of the observations on the countries and the industrial sectors.

**Table 1: Geographical and sectoral distribution of the sample**

Country	Freq.	Percent	Cum.
Germany	1,243	77.64	77.64
Switzerland	219	13.68	91.32
Austria	139	8.68	100.00
<b>Total</b>	<b>1,601</b>	<b>100.00</b>	

  

Industrial sector	Freq.	Percent	Cum.
Chemicals industry	135	8.43	8.43
Rubber and plastic products	153	9.56	17.99
Finished metal products	398	24.86	42.85
Machinery	451	28.17	71.02
Electrical engineering	165	10.31	81.32
Precision instruments	150	9.37	90.69
Other	149	9.31	100.00
<b>Total</b>	<b>1,601</b>	<b>100.00</b>	

The EMS questionnaire inquires in detail about the implementation of 30 production technologies (like industrial robots, teleservice, automated handling services, CAD, CIM) including the year of first use and plans to reduce or increase the use of these technologies. Based on a factor analysis we have grouped these technologies in five classes. The technology groups are numeric control technologies (NC), automation technologies (AUT), information technologies (ICT), electronic network technologies (NET), and technologies for the treatment of various materials (MAT). A complete list of the technologies is given in Table 6 in the annex. The other exogenous variables entering the analysis are given in Table 2. Table 3 contains a summary of the endogenous variables of the analysis.

**Table 2: Exogeneous variables used in the analysis**

Variable	Description	Mean	Std.Dev.	Min	Max
OUTSOURCE (dummy)	Offshoring production activities in 2002-2003	0.297	0.457	0	1
SIZE	Logarithm of number of employees	4.536	1.258	0	10.33
EXP_NC	Years of experience in NC technologies	5.938	8.572	0	52
EXP_AUT	Years of experience in automation techn.	2.465	5.281	0	42
EXP_ICT	Years of experience in ICT technologies	3.913	5.558	0	44
EXP_NET	Years of experience in NET technologies	1.075	1.916	0	19
EXP_MAT	Years of experience in material technologies	2.871	7.969	0	52
INNOV (dummy)	Commercialized product innovations within the last 3 years	0.653	0.475	0	1
OLDPROD (dummy)	Has products on market which are older than 10 years	0.819	0.384	0	1
PROD1 (dummy)	Production according to customers' order	0.708	0.454	0	1
PROD2 (dummy)	prefabrication & final assembly after customers' order	0.207	0.400	0	1
PROD3 (dummy)	Production in stock	0.096	0.294	0	1
LOT_SML (dummy)	Small lot size (up to 20 pieces per month)	0.439	0.496	0	1
LOT_MDL (dummy)	Middle lot size (20-1.000 pieces per month)	0.278	0.448	0	1
LOT_LRG (dummy)	Large lot size (more than 1.000 pieces per month)	0.255	0.436	0	1
PCOMP1 (dummy)	Mainly one-piece products (e.g. cogwheels)	0.194	0.396	0	1
PCOMP2 (dummy)	Mainly multi-part products with simple structure	0.312	0.463	0	1
PCOMP3 (dummy)	Mainly multi-part products with complex structure	0.225	0.418	0	1
PCOMP4 (dummy)	Mainly complex systems (e.g. manufacturing systems)	0.158	0.364	0	1
SECT1 (dummy)	Chemicals	0.084	0.277	0	1
SECT2 (dummy)	Rubber and plastics	0.095	0.294	0	1
SECT3 (dummy)	Finished metal products	0.248	0.432	0	1
SECT4 (dummy)	Machinery	0.281	0.449	0	1
SECT5 (dummy)	Electrical engineering	0.103	0.304	0	1
SECT6 (dummy)	Precision instruments	0.093	0.291	0	1
SECT7 (dummy)	Others	0.093	0.291	0	1
CTRY_DE (dummy)	Country: Germany	0.776	0.416	0	1
CTRY_CH (dummy)	Country: Switzerland	0.136	0.343	0	1
CTRY_AT (dummy)	Country: Austria	0.086	0.281	0	1

**Table 3: Endogenous variables used in the analysis**

Variable	Description	Mean	Std.Dev.	Min	Max
IMPL_NC (dummy)	Implementation of NC technologies in 2002-2003	0.024	0.152	0	1
IMPL_AUT (dummy)	Implementation of AUT technologies in 2002-2003	0.038	0.192	0	1
IMPL_ICT (dummy)	Implementation of ICT technologies in 2002-2003	0.062	0.241	0	1
IMPL_NET (dummy)	Implementation of NET technologies in 2002-2003	0.125	0.331	0	1
IMPL_MAT (dummy)	Implementation of MAT technologies in 2002-2003	0.011	0.103	0	1
POT_NC	Realized potential of NC technologies	0.694	0.294	0.000	1.000
POT_AUT	Realized potential of AUT technologies	0.508	0.315	0.000	1.000
POT_IKT	Realized potential of ICT technologies	0.673	0.295	0.000	1.000
POT_NET	Realized potential of NET technologies	0.260	0.236	0.000	1.000
POT_MAT	Realized potential of MAT technologies	0.494	0.341	0.000	1.000
INT_NC (dummy)	Planned intensification of NC technologies	0.418	0.493	0	1
INT_AUT (dummy)	Planned intensification of AUT technologies	0.281	0.450	0	1
INT_ICT (dummy)	Planned intensification of ICT technologies	0.535	0.499	0	1
INT_NET (dummy)	Planned intensification of NC technologies	0.496	0.500	0	1
INT_MAT (dummy)	Planned intensification of NC technologies	0.107	0.310	0	1
RED_NC (dummy)	Planned reduction of NC technologies	0.061	0.240	0	1
RED_AUT (dummy)	Planned reduction of AUT technologies	0.019	0.136	0	1
RED_ICT (dummy)	Planned reduction of ICT technologies	0.021	0.142	0	1
RED_NET (dummy)	Planned reduction of NET technologies	0.012	0.111	0	1
RED_MAT (dummy)	Planned reduction of MAT technologies	0.007	0.083	0	1
PERINT	Personnel intensity, payroll as share of sales	0.342	0.109	0.000	0.830
PERGRW	Personnel intensity growth	1.023	0.128	0.542	3.273
SALESGRW	Sales growth	1.054	0.258	0.354	8.660
PMRG	Profit margin	3.284	5.880	-0.300	0.774
PMRGGRW (dummy)	Profit margin growth	0.193	0.395	0	1
SERV	Services as share of sales	0.040	0.100	0.000	1.000
SERVGRW (dummy)	Service growth	0.170	0.376	0	1
R&D	R&D as share of sales	0.037	0.065	0.000	0.800
RDGRW (dummy)	R&D growth	0.236	0.425	0	1

## 4 Econometric approach

The econometric analysis proceeds in two steps, each step addressing one of the research questions. The first step identifies determinants of offshoring production activities. We employ a probit analysis to explain the offshoring dummy. The second step analyzes the effects offshoring has on companies' current investment decisions and their short run economic be-

havior and performance. The aim here is to compare two groups of companies; the first group has relocated production 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 Table 8 in the appendix. The average offshoring company differs significantly from the average non-offshoring company (column I and column II).

There are several ways to control for this bias. We could estimate a regression model which explains the propensity to invest in a certain technology or the economic performance by various firm-specific factors, including size, sectoral affiliation, and, among others, an indicator for the enterprises which have relocated production. This approach, however, would require a functional form for the investment decision and strong assumptions on how – additively or multiplicatively – offshoring affects the investment behaviour and company performance.

A different approach is to apply an econometric matching procedure. The matching approach was originally developed in the evaluation of labor market programs to identify treatment effects when the available observations on individuals are subject to a selection bias (for a summary see 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. Although the matching algorithm is

predominantly used in impact analysis to estimate the effect of some sort of treatment, having offshored production activities *is not intended* to be interpreted as a treatment. We rather use the methodology to be able to assess difference between firms which have offshored some of their production 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 which 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 relocating firms with respect to the variables included in the analysis for each observation. One example of such an approach is Czaritzki (2005) who uses an econometric matching procedure to study the productivity gap between Western and Eastern Germany at the firm level. Czaritzki 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?” Using a regression model and capturing the offshoring companies by a dummy variable may pose rather limiting constraints on the relationship between offshoring and non-offshoring companies. 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 analysis as a matching criterion. As a result the set of offshoring and non-offshoring companies will be balanced in all exogenous variables which enter the probit regression. To increase the quality of the matching procedure we select three non-offshoring companies for each offshoring one. The effect of offshoring on the investment, behaviour and performance variables 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 occurrences. 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 occurrences by employing the correction of standard errors suggested by Lechner (1999).

## **5 Empirical results**

### **5.1 Determinants of offshoring**

In the first step of the analysis we identify companies which have offshored production activities in 2002 or 2003. We employ a probit regression using heteroskedasticity robust standard errors. We assume that the offshoring decision may be first influenced by firm size, as larger companies have more easily the necessary critical mass for international production. Large firms have more financial and personnel resources than SMEs for preparing and carrying out foreign location decisions (Truijens 1992) and they have more often already gathered competencies and experiences with cross border activities (Johanson and Vahlne 1977). Moreover, we include a number of variables describing the nature of the main product and production process of the firm, like product complexity, lot size, and customized or stock

production. As these attributes affect the capital cost to labour cost relation of a manufacturing company, it is very likely that they will influence the propensity of a firm to relocate production capacities to foreign countries (Kinkel, Lay, Maloca 2006). The effect of offshoring of production activities on the investment in production technologies does also hinge on the experience of the company with advanced production technologies. As the opportunities which come along with the implementation of certain technologies deplete with the level of investment in these technologies and therefore new opportunities have to be searched for, we include the first-time investment in advanced production technologies in the regression determining the offshoring. We proxy the investment into such technologies by the years of experience the companies have with them (variables EXP\_NC, EXP\_AUT, EXP\_ICT, EXP\_NET, EXP\_MAT).

Table 4 displays the results of the probit regression where we report the marginal effects rather than the coefficient estimates. The results show as expected that one of the most important and significant influence on the likelihood to offshore production activities is the size of the company. These findings are in line with other studies investigating the propensity of companies to relocate production according to firm size (e.g. Mucchielli and Saucier 1997; Pennings and Sleuwaegen 1997; Eenemaam and Brouthers 1996; Meyer 1996). We find an inverted U-shaped influence of the complexity of the manufactured product on the likelihood of offshoring. Manufacturers of multi-part products such as gear boxes or pumps (PCOMP2) have a higher propensity to offshore than manufacturers of one-piece products such as gear wheels (PCOMP1) whereas manufacturers of multi-part products with a more complex structure such as machine tools (PCOMP3) or manufacturers of complex installations such as whole production systems (PCOMP4) have not. These findings indicate that production in high wage countries like Germany, Austria or Switzerland can be competitive

either when it focuses on highly automated and capital intensive production of very simple parts or when it sufficiently exploits the innovation and flexibility potentials of the available qualified staff for the manufacturing of very complex products and systems.

**Table 4: Probit regression of the propensity to relocate production activities to locations abroad**

Variable	dy/dx	Std.Err.	
SIZE	0.105	0.010	***
EXP_NC	-0.003	0.002	
EXP_AUT	0.004	0.002	*
EXP ICT	0.004	0.002	*
EXP_NET	-0.000	0.006	
EXP_MAT	-0.000	0.002	
INNOV	0.025	0.025	
OLDPROD	0.098	0.029	***
PROD2	0.039	0.031	
PROD3	0.086	0.043	**
LOT_SML	-0.036	0.031	
LOT_LRG	-0.013	0.032	
PCOMP2	0.068	0.035	*
PCOMP3	0.033	0.041	
PCOMP4	0.018	0.047	
CTRY_CH	0.053	0.038	
CTRY_AT	0.182	0.046	***
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Number of obs	1601		
LR-chi <sup>2</sup>	263.19	***	
Log-LR	-841.866		
Pseudo-R <sup>2</sup>	0.136		

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

The typical lot size (LOT\_SML, LOT\_LRG) produced within the company has no significant influence on offshoring activities, as mature large batches as well as labour-intensive small batches may be appropriate for relocation to foreign plants (Kinkel, Lay, Maloca 2006). Companies that typically produce into stocks (PROD3) have an almost 9 percentage point higher probability to off shore production activities than companies have which pro-

duce only to customer order (PROD1 and PROD2). The former can rely on their already existing buffer capacities and do not have to react very sensitive on problems with production quality and the ability to supply, which sometimes occur especially in vertical foreign production plants in low wage countries (Kinkel, Lay, Maloca 2007). Austrian companies (CTRY\_AT) in the sample are more likely to offshore their production than German companies, whereas Swiss companies (CTRY\_CH) are not. This reflects the investments of Austrian enterprises in Middle and Eastern Europe in advance of their accession to the EU as well as a specific "backlog" of Austrian firms regarding foreign direct investments (Dell'mour 2005). Another important result from the probit regression is that firms having products on the market which are at least ten years old show an increased probability to offshore production activities by almost 10 percentage points (OLDPROD). It seems that offshoring is attractive to firms that want to extend the life cycle of their 'cash cows', if all adequate automation potentials have been exploited and further investments in new production technologies do not seem to be reasonable any more.

Prior investment decisions in production technologies also exert a significant influence on the companies' offshoring propensity. Companies with a longer experience in employing ICT technologies for planning and control of their production processes have a higher likelihood to offshore their production activities (EXP\_ICT). The propensity to offshore also increases with the companies' experience in automation technologies such as industrial robots etc. (EXP\_AUT). This is also a strong indication that firms tend to relocate production activities to foreign countries if their potentials at the home base to increase productivity by technologically upgrading their production processes via automation and ICT are already limited.

## 5.2 Effects of offshoring

After matching the samples of offshoring and non-offshoring companies are comparable. On the average the differences between these two groups of companies have vanished. A comparison of column I and column III in Table 8 shows no significant differences between the samples.

We now test for differences in the propensity to take up various technologies. The results show no significant difference between offshoring and non-offshoring companies in the propensities to implement various production technologies (Table 5). The only exception is that offshoring companies tend to start implementing electronic network technologies (NET) more often than non-offshoring companies. Moreover, significantly more companies which have offshored some of their production activities intend to increase their investment in ICT technologies and NET technologies than non-offshoring companies do, although having already accomplished a similar level of implementation (realized potential). The need for technical solutions allowing a smooth communication and coordination of home-based production with the foreign manufacturing plant seems to trigger initial or follow-up investment in electronic network technologies (NET) via internet or intranet or in ICT technologies like enterprise resource planning (ERP) or supply chain management (SCM) systems. On the other hand, significantly more offshoring companies intend to reduce their engagement in material-related technologies (MAT) than non-offshoring companies do. The former seem to tend to substitute expensive and high risk technical solutions for the processing of new materials through more labour-intensive manufacturing processes in countries with lower wages. This result indicates that the possibility of offshoring production might serve as a barrier for an intensive use of technologies for the treatment of advanced materials (MAT) at the home base of the offshoring company, which should be carefully monitored in future research.

**Table 5: Effects of production offshoring on the implementation of new technologies**

Variable			NC	AUT	ICT	NET	MAT
Implementation 2002-2003 (dummy)	IMPL_	Non-Offshoring	0.024	0.066	0.115	0.189	0.006
		Offshoring	0.052	0.041	0.167	0.282 **	0.013
Realized potential (0 – 1)	POT_	Non-Offshoring	0.741	0.540	0.718	0.274	0.522
		Offshoring	0.713	0.553	0.713	0.284	0.564
Planned intensification (dummy)	INT_	Non-Offshoring	0.463	0.370	0.615	0.537	0.116
		Offshoring	0.481	0.346	0.687 **	0.618 **	0.118
Planned reduction (dummy)	RED_	Non-Offshoring	0.072	0.018	0.030	0.016	0.002
		Offshoring	0.088	0.027	0.031	0.006	0.012 *

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

Table 6 summarizes the effects of offshoring on firm behaviour and performance. Offshoring firms do not differ from their non-offshoring counterparts in the level of personnel intensity. One explanation for this fact may be that offshoring companies showed a higher share of personnel costs of turnover before relocating parts of their production abroad and lowered this above-average level via offshoring. Another assumption is in line with our previous findings to the offshoring probability of different batch sizes which showed that not only small and especially labour-intensive batches but also large and usually more capital-intensive batches are transferred to foreign manufacturing plants.

Not surprisingly, however, offshoring firms show a slower personnel growth than non-offshoring companies. As we can only measure short-term effects, this result is in line with other studies showing that especially labour-cost-driven relocations to low-cost countries seem to be job exporting (Kinkel, Lay, Maloca 2007; Mucchielle and Saucier 1997), while market oriented offshoring activities show no negative effects on the employment situation at the home base. The sales growth rate, the profit margin and the profit margin growth are unaffected by offshoring of production activities. Expectations of some companies, that offshoring of production activities would immediately lead to an improvement of the financial

performance of their parent plant must therefore be rejected. Also the fraction of sales generated by services does not differ for the offshoring and the non-offshoring companies. But during the period where companies relocated production activities to locations abroad the fraction of sales generated by services grew significantly stronger in offshoring firms as compared to non-offshoring firms. Some manufacturing companies seem to combine the strategic option of production offshoring with an intensification of their offers of product-accompanying services at their home base, which allows them to generate additional market and differentiation potentials while partly using their experienced workforce formerly engaged in production activities.

**Table 6: Effects of offshoring production activities on performance of companies**

			all companies	emp < 500
Personnel intensity (in 2002)	PERINT	Non-Offshoring	0.338	0.342
		Offshoring	0.319	0.321
Personnel growth rate (2000-2002)	PERGRW	Non-Offshoring	0.027	0.028
		Offshoring	0.011 **	0.012 **
Sales growth rate (2000-2002)	SALESGRW	Non-Offshoring	0.057	0.059
		Offshoring	0.048	0.051
Profit margin	PMRG	Non-Offshoring	0.032	0.035
		Offshoring	0.032	0.034
Profit margin growth (2000-2002)	PMRGGRW	Non-Offshoring	0.205	0.211
		Offshoring	0.234	0.252
Services (share of sales in 2002)	SERV	Non-Offshoring	0.037	0.034
		Offshoring	0.039	0.035
Services growth (2000-2002)	SERVGRW	Non-Offshoring	0.168	0.174
		Offshoring	0.219 *	0.210
R&D (share of sales in 2002)	RD	Non-Offshoring	0.041	0.040
		Offshoring	0.036	0.038
R&D growth (2000-2002)	RDGRW	Non-Offshoring	0.249	0.238
		Offshoring	0.300 (10.5%)	0.298 *

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

The R&D intensity of offshoring firms and non-offshoring firms does not differ significantly. However, offshoring firms have experienced a growth in their R&D intensity more

often than non-offshoring companies. The difference is statistically significant only for the SMEs but not at the 10%-level for all companies. As some studies show that offshoring activities are especially performed by companies with a below-average R&D quota (e.g. Kinkel, Lay, Maloca 2007), our findings may partly be interpreted as catching-up processes of offshoring companies regarding R&D intensity. On the other hand, the higher growth of R&D, together with the higher growth of service activities in offshoring companies, is an indication for an ongoing specialisation of the parent company on supervising, co-ordinating and value adding auxiliary activities.

## **6 Conclusions**

This paper analyzed the relationship between a firm's decision to offshore production activities and its investment in advanced production technology at home. We employed data from the European Manufacturing Survey, a study on the introduction of advanced production technologies and organisational concepts in European manufacturing. Our sample included about 1,600 firms from Germany, Austria and Switzerland. To account for self-selection predicted by the literature, we employed a matching approach to construct a sample of enterprises that relocated production and a control group that did not.

We found only few significant differences between firms that relocated production and firms that did not with respect to their investment behaviour in advanced production technologies at their home base. There is neither a concentration on advanced production technologies at home, nor did we recognize substitution effects between lower factor cost abroad and investment in advanced, labour-saving equipment at home. We are in good company with our results: "What is noticeable in a review of past studies [of home country effects], ... is the frequency of results indicating no association in either direction" (Lipsey 2002, p. 12). How-

ever, there are clear signs of a changing specialisation of relocating enterprises at their home base as predicted by the literature. Offshoring firms exhibit a higher growth in services sales and in research and development expenditures.

With respect to policy, the results indicate a negative effect of production offshoring on labour demand at the parent location. However, our data only allows to study short-term effects and we cannot conclude on the effects in the long run. Firm and employment growth in the long run is mainly affected by the technological capabilities of the firm and its ability to create competitive advantage and new products. These capabilities, however, seem to be unaffected by the firm's decision to relocate production and tend towards growing even slightly stronger in offshoring firms than in non-offshoring firms.

## 7 Appendix

**Table 7: Technologies and their group affiliation**

Technology	Technology group
Industrial robots and automated handling systems for tools or parts	AUT
Automated material flow systems (manufacturing and/or assembly)	AUT
Automated assembly stations	AUT
Visual data processing in production (e.g. quality control, process management)	AUT
Utilisation of tele service (tele diagnosis/tele maintenance via modem)	ICT
Simulation for product design FEM-computation, digital prototype)	ICT
Simulation of single processing steps (e.g. FEM-forming or weld seam simulation)	ICT
Process simulation (e.g. material flow, collision prevention)	ICT
PPS/ERP-module of a commercial operational control software (e.g. PP-module by SAP)	ICT
Product Lifecycle Management System (PLM)	ICT
Exchange of disposition data with other companies (supply chain management)	ICT
Rapid Prototyping, Rapid Tooling, Rapid Manufacturing (e.g. stereolithography)	ICT
Composite materials (e.g. carbon fibre and glass fibre)	MAT
Renewable primary products	MAT
Integration of CAD/CAM (geometric data transfer)	NC
CNC processing centres	NC
Machine tools with linear drives	NC
Dry processing/minimal lubrication with traditionally "wet" processed parts	NC
High-speed cutting (HSC; cutting speed >300 m/min)	NC
Sale of own products via the internet (electronic commerce)	NET
Purchase at suppliers via the internet (electronic procurement)	NET
Intranet for knowledge management	NET

**Table 8: Technologies and their group affiliation**

Variable	I. Offshoring	II. Non-Offshoring (before matching)	III. Non-Offshoring (after matching)
SIZE	5.185	4.262 ***	5.098
EXP_NC	6.701	5.616 **	6.703
EXP_AUT	3.756	1.921 ***	3.276
EXP_ICT	5.315	3.321 ***	4.865
EXP_NET	1.223	1.013 **	1.308
EXP_MAT	3.432	2.636 *	3.007
INNOV	0.711	0.630 ***	0.734
OLDPROD	0.863	0.801 ***	0.873
PROD2	0.257	0.187 ***	0.259
PROD3	0.120	0.085 **	0.127
LOT_SML	0.387	0.461 ***	0.386
LOT_LRG	0.299	0.237 **	0.281
PCOMP2	0.364	0.290 ***	0.347
PCOMP3	0.255	0.213 *	0.252
PCOMP4	0.152	0.161	0.160
CTRY_CH	0.137	0.137	0.137
CTRY_AT	0.143	0.063 ***	0.143

Levels of significance: \*\*\* 1%, \*\* 5%, \* 10% Note: for the matched sample the standard errors are computed by the procedure suggested in Lechner (1999).

## 8 References

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