The Influence of International Dispersed vs. Home based R&D on Corporate Growth

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Motivation and Background

- Internationalisation of corporate R&D is a growing phenomenon in both large MNEs and international SMEs
  - About 3% of innovative German firms without foreign R&D activity in 2005 planned to start it in 2006/07 (Rammer and Schmiele 2008)

- Motives (Edler et al., Zedtwitz and Gassmann, 1998, Belderbos et al. 2008): Benefit from
  - a better adoption of own existing technology to foreign demand and/or
  - a better access to foreign science and technology resources

➔ Foreign R&D should have a positive impact on innovation performance and profits

Motivation and Background

- However, decision to set up a foreign R&D center is associated with high costs
  - set-up costs for the R&D department
  - foregone economies of scale in the R&D production process
  - intra-firm coordination costs
  - risk of intra-firm knowledge losses
  - outgoing knowledge spillovers
  - liability of foreignness (Zaheer, 1995)

➔ Foreign R&D activities may also have a negative impact on innovation performance and profits

Motivation and Background

- Existing literature
  - R&D internationalisation decision and its firm and country specific determinants

    Kuemmerle 1997, 1999; Florida 1997; Belderbos, 2001; 2003; von Zedtwitz and Gassman, 2002; Odagiri and Yasuda, 1999;

    Norback, 2001; Sanna-Randaccio and Veugelers, 2002, Belderbos et al. 2008

  - Determinants of multinational firms' choices of locations for production and R&D simultaneously (Gersbach and Schmutzler 2006)

  - Many studies on the impact of (the degree of) internationalisation on firm performance.

    Quian et al. (2008): 'regional diversification (number of nations in which a firm has subsidiaries) has a positive and linear effect on firm performance up to a medium level. Above that the positive effect begins to diminish'.

Motivation and Background

- Existing literature
  - Scarce evidence on effect of foreign R&D on innovative performance:

    Penner-Hahn and Shaver (2005): find a positive effect of international R&D of Japanese pharmaceutical firms on patents

    Singh (2008) uses patent data to observe the outcome of international innovative activities by the location of the investors and relates it to the quality of the patent referring to the number of citations. He finds a negative effect for its innovation activities abroad.

  - Studies on impact of foreign R&D on firm performance?

Contribution and Research Questions

- Contribution:
  - This paper contributes to the literature by analysing the effect of R&D *location* and *organizational structure* of foreign R&D on innovation performance and firm performance.

- 3 Research Questions:
  - Do firms benefit from R&D abroad in terms of a higher innovation success?
  - Does the degree of decentralisation of R&D activities abroad play a role for the innovation performance?
  - Do firms benefit from R&D abroad in terms of a higher profits?

Data

- Mannheim Innovation Panel
- Official innovation survey in the German manufacturing and services sector
- 2006: main topic internationalisation of innovation activities
- Merged with data from following surveys in 2007 and 2008 (performance measures)
  - ➔ sensible time structure which mitigates potential endogeneity problems
- Target population: legally independent firms with at least 5 employees with headquarter in Germany
- Stratified random sample (size classes, region, industry)
- Sample: 1264 innovative firms

Variables Measuring R&D Abroad

R&D Engagement:

Continuous R&D	1 if the firm is engaged continuously in intramural R&D activities

R&D Location:

Home-based R&D only	1 if the firm has R&D labs in Germany only
R&D abroad	1 if the firm has R&D labs in Germany and at least one R&D lab abroad (outside Germany)

R&D Organization Abroad:

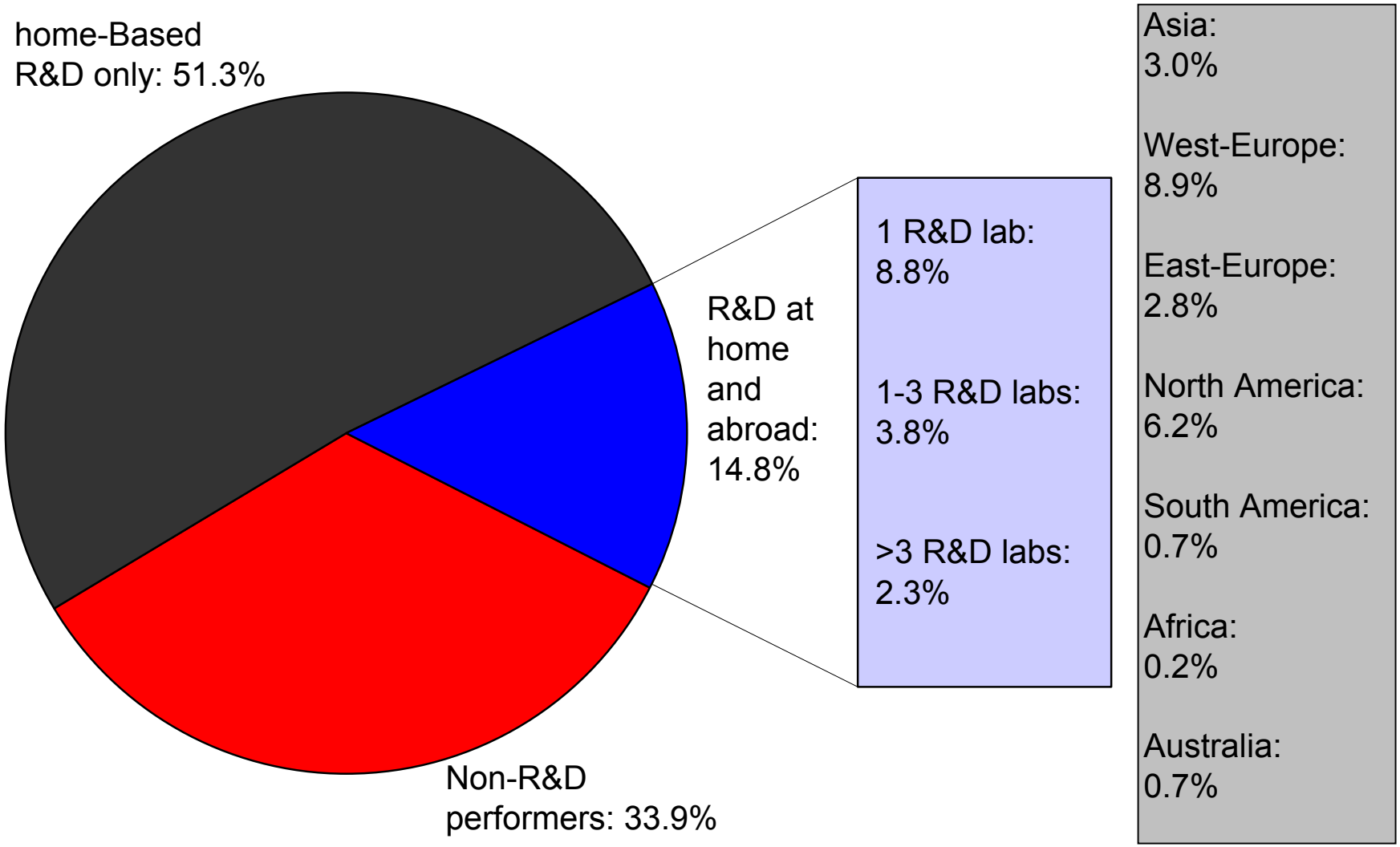
Centralized R&D	1 if the firm has only 1 R&D lab abroad
Medium-centralized R&D	1 if the firm has between 1 and 3 R&D labs abroad
Decentralized R&D	1 if the firm has 4 or more R&D labs abroad

R&D Organization Abroad Based on Regions

Centralized R&D	1 if the firm has one or more R&D labs abroad in only one region. Regions: West Germany, East Germany, North America, South America, Australia, Asia and others).
Medium-centralized R&D	1 if the firm has one or more R&D labs abroad in two regions.
Decentralized R&D	1 if the firm has one or more R&D labs abroad in two or more regions.

All variables are related to the year 2005 (except continuous R&D which is related to 2003-2005).

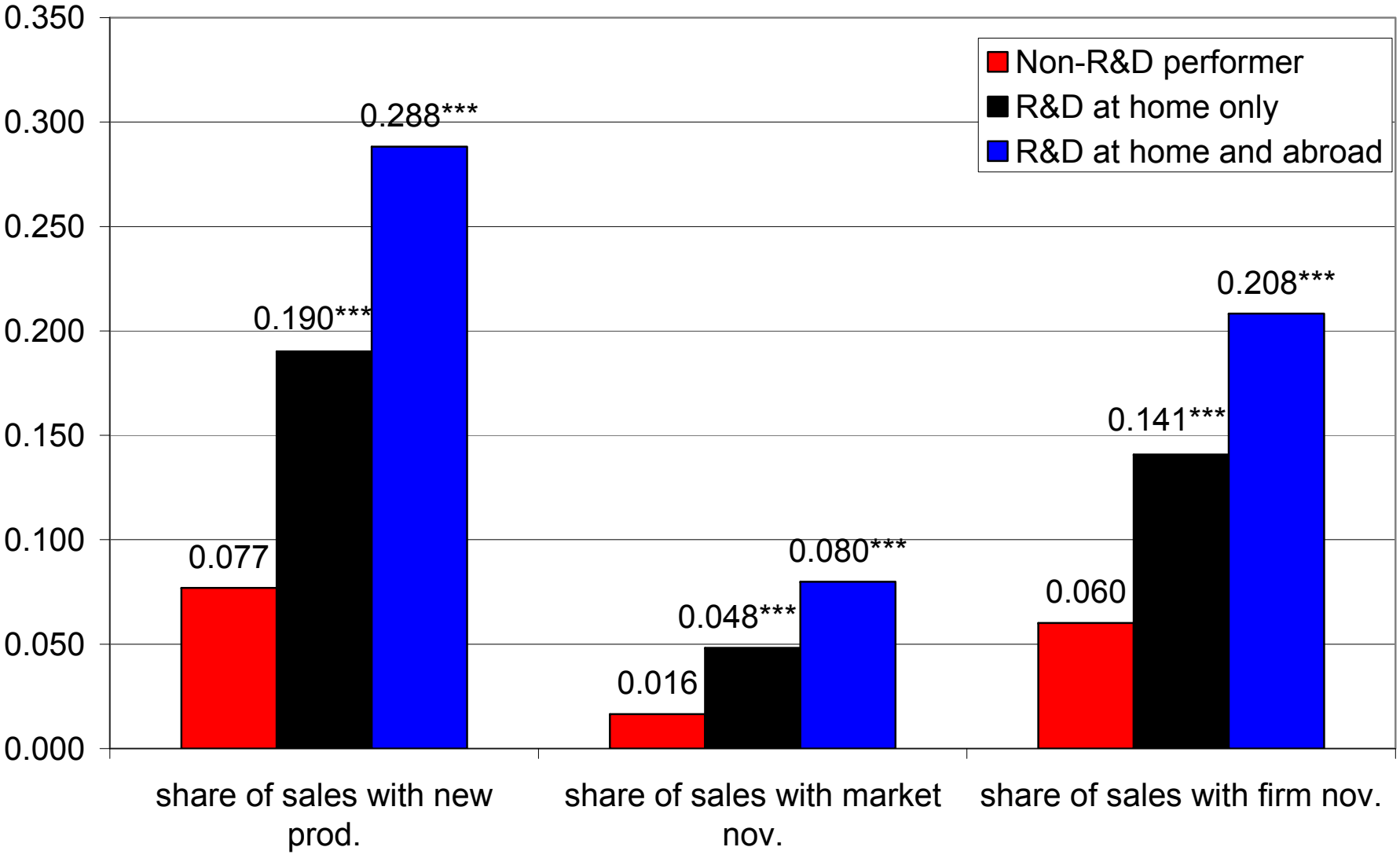
R&D Activities at Home and Abroad



Performance Indicators (Dependent Variables)

INNOVATION PERFORMANCE:	
Share of sales …:	
due to new products	Share of sales in 2007 due to new products introduced during 2005-2007
due to market novelties	Share of sales in 2005 due to market novelties introduced during 2005-2007
due to firm novelties	Share of sales in 2005 due to firm novelties introduced during 2005-2007
FIRM PERFORMANCE:	
Profits:	
Profits	Measured as the ratio of profits before taxes to turnover in 2006.

Innovation Performance Indicators by R&D Activity



Profits by R&D Activity

Profit	Non-R&D performer	R&D at home only	R&D at home and abroad
<0%	12.27	9.68	8.98
0%-<2%	20.47	14.86	11.72
2%-<4%	16.9	17.7	12.89
4%-<7%	18.2	21.54	25
7%-<10%	10.97	14.02	17.19
10%-<15%	10.32	11.02	13.67
>=15%	10.89	11.19	10.55
Total	100	100	100

Innovation Performance: Control Variables

Firm Size	Number of employees in 2005 (in log.)
Human capital	Share of employees with a university or college degree in 2005
Export intensity	Share of export per sales in 2005
R&D intensity	R&D expenditure per sales in 2005
Market-related innovation intensity	Innovation expenditure (except R&D) per sales in 2005
Group	Dummy being 1 for firms belonging to a group in 2007
Price Competition	Importance of price competition in the main product market (averaged across firms at the NACE 3-digit level)
Technology Leadership	Importance of technology leadership for competition in the main product market (averaged across firms at the NACE 3-digit level)
National Cooperation	Dummy being 1 if the firm has any co-operation arrangements on innovation activities with national partners during 2003-2005
International Cooperation	Dummy being 1 if the firm has any co-operation arrangements on innovation activities with international partners during 2003-2005
Industry dummies	6 industries dummies

Research Question 1

Do firms benefit from R&D abroad in terms of a higher innovation success?

Effect of R&D Location on Innovation Performance (I)

Dependent Variable: Share of sales due to …

	New Products		Market novelties		Firm novelties	
	1	2	3	4	5	6
Continous inhouse R&D	0.053 ***	-	0.026 ***	-	0.041 ***	-
R&D Location: Home-based R&D only	-	0.054 ***	-	0.023 ***	-	0.043 ***
R&D Location: R&D at home and abroad	-	0.067 ***	-	0.032 ***	-	0.056 ***
Firm size	0.009 ***	0.010 ***	0.005 ***	0.005 ***	0.007 ***	0.008 ***
Export intensity	0.027	0.029	0.003	0.004	0.024	0.025 *
National Group	0.013	0.012	0.007	0.006	0.005	0.004
International group, HQ: Germany	0.023	0.027	0.002	0.000	0.022 *	0.022 *
International group, HQ: abroad	-0.002	-0.001	0.007	0.007	-0.017	-0.016
R&D intensity	0.076 **	0.079 ***	0.042 ***	0.045 ***	0.029	0.030
Market-related innovation intensity	0.066 *	0.069 *	0.030	0.030	0.038	0.042
Human capital	0.051 ***	0.056 ***	0.034 ***	0.037 ***	0.030 *	0.033 **
Diversification	0.000	0.000	0.000	0.000	0.000	0.001
East Germany	0.023 **	0.024 ***	-0.003	-0.003	0.021 ***	0.021 ***
Competition: Price	-0.045 ***	-0.045 ***	-0.012 **	-0.012 *	-0.034 ***	-0.034 ***
Competition: Technological lead	0.018 **	0.020 **	0.002	0.003	0.013 *	0.014 **
F-Test: Home >=Abroad	-	0.275	-	0.168	-	0.267
Pseudo R2	0.256	0.257	0.289	0.284	0.232	0.237
No. of observations	1264	1264	1264	1264	1264	1264
LR/Wald chi2	342.7	343.7	257.4	252.3	261.3	266.0
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Marginal effects (change in conditional expected value) of tobit regressions. Industry dummies are included but not reported.

Effect of R&D Location - Sensitivity Analysis: Alternative Innovation Performance Measure

ALTERNATIVE INNOVATION PERFORMANCE:

Sales growth …:

due to new products	Growth rate of turnover between 2005 and 2007 due to product innovations introduced in that period. Computed as: share of sales with new products in 2007 * (sales in 2007/ sales in 2005)
due to market novelties	Growth rate of turnover between 2005 and 2007 due to product innovations which were new to the market.
due to firm novelties	Growth rate of turnover between 2005 and 2007 due to product innovations which were new to the firm only.

Effect of R&D Location - Sensitivity Analysis: Alternative Innovation Performance Measure

Dependent Variable: Sales growth due to …

	New Products		Market novelties		Firm novelties	
	1	2	3	4	5	6
Continous inhouse R&D	0.064 ***	-	0.040 ***	-	0.056 ***	-
R&D Location: Home-based R&D only	-	0.083 ***	-	0.027 **	-	0.079 ***
R&D Location: R&D at home and abroad	-	0.099 ***	-	0.036 **	-	0.107 ***
Firm size	0.011 **	0.012 **	0.007 ***	0.008 ***	0.012 ***	0.011 ***
Export intensity	0.055	0.054	0.021	0.025	0.032	0.029 *
National Group	0.045 *	0.043 *	0.015	0.015	0.024	0.022
International group, HQ: Germany	0.031	0.032	0.001	0.001	0.027	0.027
International group, HQ: abroad	-0.013	-0.001	0.000	0.000	-0.030	-0.028
R&D intensity	0.076	0.073	0.067 **	0.077 ***	0.002	-0.008
Market-related innovation intensity	0.071	0.082	0.056	0.054	0.033	0.043
Human capital	0.093 **	0.092 **	0.043 **	0.049 **	0.076 ***	0.074 **
Diversification	0.002	0.003	0.000	0.001	0.002	0.001
East Germany	0.048 ***	0.049 ***	-0.011	-0.010	0.048 ***	0.049 ***
Competition: Price	-0.084 ***	-0.083 ***	-0.029 **	-0.028 **	-0.062 ***	-0.061 ***
Competition: Technological lead	0.022	0.024	0.004	0.006	0.012	0.012
F-Test: Home >=Abroad	-	0.367	-	0.291	-	0.194
Pseudo R2	0.101	0.105	0.181	0.172	0.089	0.098
No. of observations	1117	1117	1117	1117	1117	1117
LR/Wald chi2	197.9	206.0	208.0	198.5	153.9	168.4
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Marginal effects (change in expected conditional value) of tobit regressions. Industry dummies are included but not reported.

Effect of R&D Location - Sensitivity Analysis: Excluding German Subsidiaries of Foreign MNE

Dependent Variable: Share of sales due to …

	New Products		Market novelties		Firm novelties	
	1	2	3	4	5	6
Continous inhouse R&D	0.053 ***	-	0.027 ***	-	0.040 ***	-
R&D Location: Home-based R&D only	-	0.052 ***	-	0.021 ***	-	0.044 ***
R&D Location: R&D at home and abroad	-	0.077 *	-	0.035 ***	-	0.063 ***
Firm size	0.009 ***	0.010 ***	0.004 ***	0.005 ***	0.008 ***	0.008 ***
Export intensity	0.036 *	0.037 *	0.005	0.006	0.031 *	0.031 *
National Group	0.012	0.010	0.006	0.005	0.004	0.003
International group, HQ: Germany	0.021	0.021	0.002	-0.004	0.020	0.019
R&D intensity	0.055 *	0.055 *	0.032 **	0.035 **	0.020	0.017
Market-related innovation intensity	0.078 *	0.082 *	0.035 *	0.035 *	0.043	0.048
Human capital	0.049 **	0.053 ***	0.031 ***	0.035 ***	0.029 *	0.031 *
Diversification	0.000	0.000	0.000	0.002	0.000	0.001
East Germany	0.022 **	0.022 **	-0.005	-0.004	0.021 ***	0.022 ***
Competition: Price	-0.045 ***	-0.044 ***	-0.009	-0.009	-0.037 ***	-0.037 ***
Competition: Technological lead	0.021 **	0.023 ***	0.002	0.003	0.017 **	0.018 **
F-Test: Home >=Abroad	-	0.107	-	0.060	-	0.134
Pseudo R2	0.255	0.256	0.297	0.287	0.238	0.244
No. of observations	1149	1149	1149	1149	1149	1149
LR/Wald chi2	311.6	312.5	229.4	221.5	248.5	255.1
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Marginal effects (change in expected conditional value) of tobit regressions. Industry dummies are included but not reported.

Research Question 2

Does the degree of decentralisation of R&D activities abroad play a role for innovation performance?

Effect of Organizational Structure of foreign R&D on Innovation Performance (I)

Dependent Variable: Share of sales due to …

	New Products	Market novelties	Firm novelties
	1	2	3
Home-based R&D only	0.054 ***	0.023 ***	0.044 ***
R&D Organization Abroad: Centralized	0.061 ***	0.028 ***	0.053 ***
R&D Organization Abroad: Medium cent.	0.080 ***	0.049 ***	0.055 ***
R&D Organization Abroad: Dezentralized	0.093 **	0.034 *	0.082 ***
Firm size	0.009 ***	0.005 ***	0.008 ***
Export intensity	0.029	0.005	0.025 *
National Group	0.012	0.006	0.005
International group, HQ: Germany	0.023	0.000	0.021 *
International group, HQ: abroad	0.000	0.007	-0.015
R&D intensity	0.078 ***	0.045 ***	0.029
Market-related innovation intensity	0.068 *	0.029	0.042
Human capital	0.056 ***	0.037 ***	0.033 **
Diversification	0.001	0.000	0.001
East Germany	0.024 ***	-0.003	0.021 ***
Competition: Price	-0.045 ***	-0.012 *	-0.034 ***
Competition: Technological lead	0.020 **	0.003	0.014 **
F-Test: Home>=Centralized	0.491	0.405	0.391
F-Test: Home>=Medium Cent.	0.234	0.047	0.408
F-Test: Home>=Decentralized	0.167	0.319	0.123
F-Test: Centralized>=Medium Cent.	0.258	0.086	0.484
F-Test: Centralized>=Decentralized	0.184	0.376	0.171
F-Test: Medium Cent.>=Decentralized.	0.374	0.220	0.201
Pseudo R2	0.258	0.286	0.237
No. of observations	1264	1264	1264
LR/Wald chi2	344.7	254.2	266.9
P-value	0.000	0.000	0.000

Effect of Organizational Structure of foreign R&D on Innovation Performance (II)

Dependent Variable: Share of sales due to …

	New Products	Market novelties	Firm novelties
	1	3	5
Home-based R&D only	0.053 ***	0.022 ***	0.044 ***
R&D: Centralized in 1 region	0.064 ***	0.031 ***	0.051 ***
R&D: Medium Centr. in 2 regions	0.070 **	0.038 ***	0.058 **
R&D: Decentralized in 3 or more regions	0.062 *	0.013	0.078 **
Pseudo R2	0.257	0.0284	0.237
No. of observations	1264	1264	1264
LR/Wald chi2	343.3	252.6	266.2
P-value	0.000	0.000	0.000

Marginal effects (change in conditional expected value) of tobit regressions reported. Full set of control variables included. Industry dummies are included but not reported.

Research Question 3

Do firms benefit from R&D abroad in terms of higher profits?

Effect of Home-Based and Foreign R&D on Firm Performance (Profits)

Dependent Variable: Profits (rate of return)

	1	2	3
Continous inhouse R&D	0.557	-	-
R&D Location: Home-based R&D only	-	0.442	0.444
R&D Location: R&D at home and abroad	-	-0.857	-
R&D Organization Abroad: Centralized	-	-	-0.864
R&D Organization Abroad: Medium cent.	-	-	-1.234
R&D Organization Abroad: Dezentralized	-	-	-0.170
Firm size	-0.394 ***	-0.322 ***	-0.323 ***
Export intensity	1.940 **	2.230 **	2.220 **
Capital intensity	0.188 **	0.201 **	0.201 **
National Group	0.163	0.170	0.171
International group, HQ: Germany	2.257 ***	2.461 ***	2.456 ***
International group, HQ: abroad	1.411 **	1.435 **	1.452 **
Human capital	0.231	0.452	0.436
East Germany	-0.809 **	-0.823 **	-0.823 **
Competition: Price	-1.727 ***	-1.795 ***	-1.806 ***
Competition: Technological lead	-0.700 **	-0.647 **	-0.650 **
LR/Wald chi2	78.1	81.4	81.9
P-value	0.000	0.000	0.000

Ordered probit regression with known thresholds (profits are categorial variable). Industry dummies are included but not reported.

Conclusion

- This paper contributes to the literature by analysing the effect of R&D *location* and *organizational structure* of foreign R&D on innovation performance and firm performance.

- Strong effect of foreign R&D on innovation performance compared to non-R&D performers.
- Innovation performance effect tends to be higher for foreign R&D than home-based R&D (though stat. not significant).
- Last result mainly driven by firms with one foreign R&D lab only.

Conclusion

- A higher degree of decentralization in R&D activities is associated with a innovation success due to new products
  - Result does not allow to disentagle the effect of larger markets and the effect of the larger knowledge base available.
  - Linear relationship for firm novelties, invers U-shape for market novelties

- In contrast to the strong impact on the innovation performance, there is no effect of location or organizational structure of foreign R&D on profits.
  - Time lag of one year for profits may be too short.

Agenda

- Accounting for longer lags
- Distinction between introduction of new products and share of sales due to innovative products (Heckman approach)
- Alternative firm performance measures