Regional location of business sector research and development

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Background and motivation I

- R&D is expected to increase access to new knowledge, promote growth and create high-skilled, well-paid jobs
- What affects the localization to and the size of enterprise groups' R&D activities in different FA-regions in Sweden?
- How to retain and attract R&D activity to a country/region?

Background and motivation II

- Spatial proximity and opportunities for face-to-face meetings assumed particularly important when transferring knowledge between individuals and companies
- Do business groups locate their R&D within the same region as other business groups conduct their R&D or where universities and colleges have extensive R&D activities?
- Are knowledge transfers among business groups or between academia and business groups (*external agglomeration*) within regions an explanation for business groups' location of R&D?

Background and motivation III

- Do enterprise groups colocate their R&D and manufacturing within in the same FA-regions (*internal agglomeration*)
- How important is the availability of qualified R&D personnel in a FA-region for the location of enterprise groups' R&D activities there?

Assets and contributions I

- Register data at the plant level on the employees' occupations and their level and orientation of education

  → helps us to allocate R&D expenses to various FA-regions

  → create measures of the availability of potential R&D labor at the regional level

  → enable us to examine what extent an enterprise group co-locate manufacturing and R&D within the same region

Assets and contributions II

- Data on universities' and colleges' expenditures on R&D, in total and in science and technology, at the regional level
- Universities and colleges in a region, especially if they have extensive R&D activities and postgraduate studies, can also contribute to the supply of skilled labor for enterprise groups with R&D activities in the region

Assets and contributions III

- In addition to an econometric analysis, we provide results from from a survey among Swedish multinational enterprises about their underlying motives for locating their R&D to a certain country (Sweden included)

- The results from the econometric analysis and what the enterprise groups state in the survey matches quite well

  → Overall, this strengthens the conclusions about which factors that are important for regional location of business sector R&D

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Business sector R&D at industry level

Industry/sector	2021		2009		Change	
	billion	share	billion	share	billion	share
Transport equipment	32.7	24.9	19.0	19.2	13.7	5.7
Information and communication	30.5	23.2	5.6	5.7	24.9	17.5
Research and development	14.1	10.7	12.2	12.3	1.9	-1.6
Other machinery	10.6	8.1	7.0	7.0	3.6	1.1
Pharmaceuticals	9.8	7.5	7.8	7.9	2.0	-0.4
Wholesale and retail trade, hotel and restaurants	7.4	5.6	3.0	2.8	4.6	2.8
Computer, electronics and optical products	3.9	2.9	22.5	23.1	-19.0	-20.2
Total business sector	131.5	100.0	99.1	100.0	32.4	

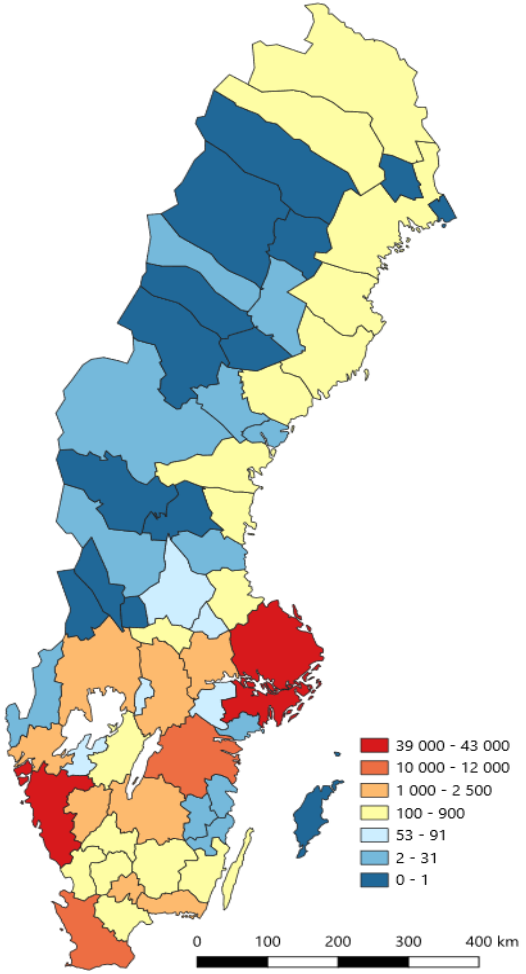
Notes: R&D expenditure is in SEK and 2021 prices. Shares in percent. In 2015 Ericsson has been moved from Computer, electronics and optical products to Information and communication

Source: Statistics Sweden, Research and development in Sweden – the business sector

Business sector R&D in FA-regions I

- FA-region: Economically integrated regions where people tend to both live and work. Municipalities are merged so that commuting flows between FA-regions are minimized. 60 FA-regions in Sweden.
- R&D expenditure at enterprise group level is available at county level. In most cases, it is possible to directly identify the municipality in the county. Sometimes distribution takes place at the municipality with the help of employees in the "R&D occupations" at plant level.
- R&D expenditure at the regional level is highly concentrated in a few FA-regions. The four FA-regions with the largest R&D expenditures account for over 80 percent of R&D expenditures in Sweden.

Business sector R&D in FA-regions 2021



Notes: R&D expenditure in million SEK and 2021 prices.

Source: Own calculations based on SCB, Research and development in Sweden – the business sector (survey data)

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Business sector R&D FA-regions II

FA-region	2021		2001		Change	
	billion	share	billion	share	billion	share
Stockholm-Uppsala	42.3	34.8	40.9	39.4	1.4	-4.6
Göteborg	39.6	32,5	28.4	27.4	11.2	5.1
Malmö-Lund	11.1	9.1	11.0	10.6	0.1	-1.5
Linköping-Norrköping	10.2	8.4	6.6	6.4	3.6	2.0
Västerås	2.5	2.0	2.0	1.9	0.5	0.1
Other FA-regions	16.1	13.2	14.8	14.3	1.3	-1.1
All FA-regions	121.6	100.0	103.7	100.0	17.9	

Notes: R&D expenditure in SEK and 2021 prices. The figures presented in the table above have been aggregated directly from the individual enterprise groups and are not comparable with the figures in the previous table.

Source: Statistics Sweden, Business sector R&D (survey)

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Academic R&D in FA-regions

FA-region	2021		2001	
	S&T	Total	S&T	Total
Stockholm-Uppsala	7,232 (39.2)	18,927 (42.9)	4,520 (40.7)	12,213 (45.5)
Göteborg	3,468 (18.8)	8,226 (18.6)	2,167 (19.5)	4,463 (16.6)
Malmö-Lund	2,878 (15.6)	6,564 (14.9)	1,796 (16.2)	4,168 (15.5)
Linköping-Norrköping	1,441 (7.8)	2,364 (5.4)	611 (5.5)	1,317 (4.9)
Luleå	816 (4.4)	963 (2.2)	513 (4.6)	589 (2.2)
Other FA-regions	2,637 (14.3)	7,064 (16.0)	1,485 (13.4)	4,113 (15.3)
All FA-regions	18,472	44,108	11,092	26,863
Share S&T	41.9		41.3	

Notes: R&D expenditure in million SEK and 2021 prices. S&T is science and technology. Within parentheses FA-region's share of total R&D expenditure in percent

Source: Statistics Sweden, R&D in the university and college sector

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Factors explaining the regional location of business sector R&D I

- Dependent variable: R&D expenditures (2019 prices) in enterprise group *i*, in FA-region country *r* at time *t*, RD_{irt}

Variable	Definition/measure of	Expected sign
	External agglomeration	
SRD_{nrt-1}	Potential knowledge transfers (spillovers) *within* industries	+
$SRD_{(n)rt-1}$	Potential knowledge transfers (spillovers) *between* industries	+
SRD_{rt-1}^{uni}	Potential knowledge transfer (spillovers) from R&D carried out at universities and colleges	+
	Internal agglomeration	
SE_{irt-1}^{man}	Colocation of R&D and manufacturing	+

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Factors explaining the regional location of business sector R&D II

Variable	Definition/measure of	Expected sign
	Relative endowment of qualified labor	
$SE_{rt-1}^{r\&d}$	Share of potential R&D labor	+
	Other control variables	
E_{it-1}	Employment in enterprise group i	?
GRP_{rt-1}	Labor incomes in the business sector in FA-region r	?

Unbalanced panel that we create for the period 2003 to 2019

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Correlation matrix with a selection of explanatory variables

	SRD_{nrt-1}	$SRD_{(n)rt-1}$	SE^{man}_{irt-1}	SRD^{uni1}_{r}	$SE^{r\&d}_{rt-1}$	E_{it-1}	GRP_{rt-1}
SRD_{nrt-1}							
$SRD_{(n)rt-1}$	0.59						
SE^{man}_{irt-1}	0.25	0.27					
SRD^{uni1}_{r}	0.64	0.95	0.28				
$SE^{r\&d}_{rt-1}$	0.63	0.96	0.28	0.99			
E_{it-1}	-0.11	-0.17	-0.23	-0.17	-0.16		
GRP_{rt-1}	0,60	0.91	0.27	0.93	0.94	-0.16	

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Factors explaining the regional location of business sector R&D III

- Econometric analysis is plagued with severe multicollinearity problems

  → we cannot include all the variables we wish to include in our specifications at the same time

- The estimated coefficients should rather be considered as correlations than as causal effects

Estimates of factors explaining the regional location of business sector R&D

Variable	(1)	(2)	(3)	(4)	(5)
Knowledge transfers *within* an industry SRD_{nrt-1}	0.306 (0.24)				
Knowledge transfers *between* industries $SRD_{(n)rt-1}$	3.649 (2.77)				
Co-location of R&D and manufacturing SE_{irt-1}^{man}	3.200 (1.92)	3.270 (1.93)	3.265 (2.00)	3.280 (1.96)	3.273 (1.95)
Share of academic R&D (total) SRD_r^{uni1}		2.152 (5.14)			1.801 (0.63)
Share of academic R&D (natural sciences and technology) SRD_r^{uni2}			9.116 (10.80)		
Share of potential R&D labor $SE_{rt-1}^{r\&d}$				4.996 (6.59)	0.864 (0.14)
Employment in enterprise group i E_{it-1}	0.032 (1.26)	0.029 (1.50)	0.027 (1.48)	0.028 (1.49)	0.029 (1.51)
Labor incomes in FA-region r GRP_{rt-1}	0.003 (0.67)	–0.001 (–0.99)	–0. 006 (–1.72)	–0.000 (–0.19)	–0.001 (–0.98)
Number of observations	22,537	22,537	22,537	22,537	22,537
Enterprise groups	912	912	912	912	912

Notes: The estimated specifications contains enterprise group specific-effects and year-specific fixed effects. Reported z-values within parentheses are based on robust standard deviations calculated according to Wooldridge (1999).

- If an enterprise group i has employment in a region r but no R&D expenditures zero observations are included for RD_{irt}
- The number of observations in all specifications is 22,537, where 78 percent is zero for RD_{irt}
- The models are estimated with Poisson pseudo-maximum-likelihood (PPML). The method handles problems with heteroskedasticity and conveniently includes zero observations.
- Explanatory variables are lagged relative to the dependent variable. An attempt (futile) to take care of prevalent endogeneity problems.

Econometric results in brief

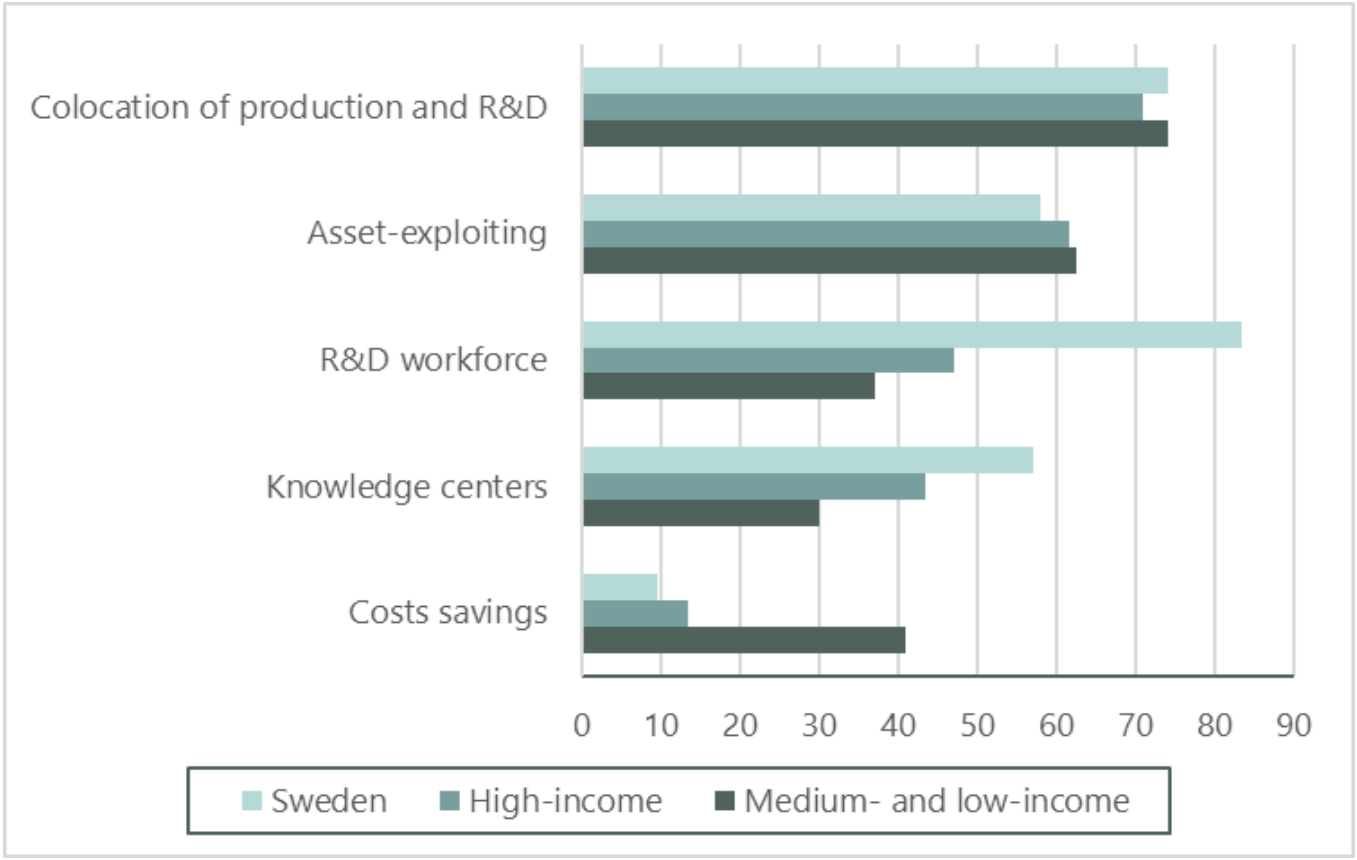
- Enterprise groups are inclined to locate their R&D in FA-regions where other enterprise groups conduct their R&D, although not necessarily enterprise groups within the same industry
- Enterprise groups tend to locate their R&D in regions where they themselves have significant manufacturing activities
- Enterprise groups invest in R&D in FA-regions where there is extensive academic research and in FA-regions with good access to potential R&D employees

What do the enterprise groups themselves say is important?

- Compare our econometric results with a survey carried out among 20 Swedish (R&D-intensive) MNEs about their motives for locating their R&D activities to a certain country
- Motives examined:

  1) *Colocation of production and R&D*
  2) *Asset-exploiting*
  3) *R&D workforce*
  4) *Knowledge centers*
  5) *Costs savings*

Driving forces behind Swedish MNEs' location of their R&D activities



Note: Share who answered that the motive matches fairly well or very well

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Summary and conclusions I

- 93 percent of reported R&D in Swedish business sector carried out by multinationals. Moreover, concentrated to a few enterprise groups in some large, densely populated FA-regions (Stockholm-Uppsala, Göteborg, Malmö-Lund and Linköping-Norrköping)
- Agglomeration effects play a central role in generating new knowledge and spreading knowledge between enterprise groups within the same FA-region and is an important attraction factor in the location of business sector R&D

Summary and conclusions II

- 80 percent of the R&D expenditure in universities/colleges is carried out in the above four FA-regions.
- Considerable source of knowledge transfer to the surrounding business community in these FA-regions. Also, contributes strongly to the competence supply in enterprise groups conducting R&D (research-trained personnel)
- The supply of potential R&D employees is particularly high in the large and dense FA-regions. This is due to extensive training activities, but also significant net immigration to these FA-regions of young highly educated people from other FA-regions.

Summary and conclusions III

- Enterprise groups with manufacturing operations in an FA-region are inclined to have R&D in the same FA-region (*internal agglomeration*)
- Colocation of manufacturing and R&D contributes positively to joint problem solving and transfer of tacit knowledge between R&D employees and workers in production and vice versa

Summary and conclusions IV

- The large and dense FA-regions must be given the conditions to continue growing and developing. Companies can then take advantage of the agglomeration effects that occur there, which are so important for R&D activities.
- A number of enterprise groups located in medium-sized FA-regions have both considerable production and R&D activities in the same FA-region. In order to be able to maintain the latter and remain internationally competitive, it is essential to meet the for competence.

Thanks for listening!

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