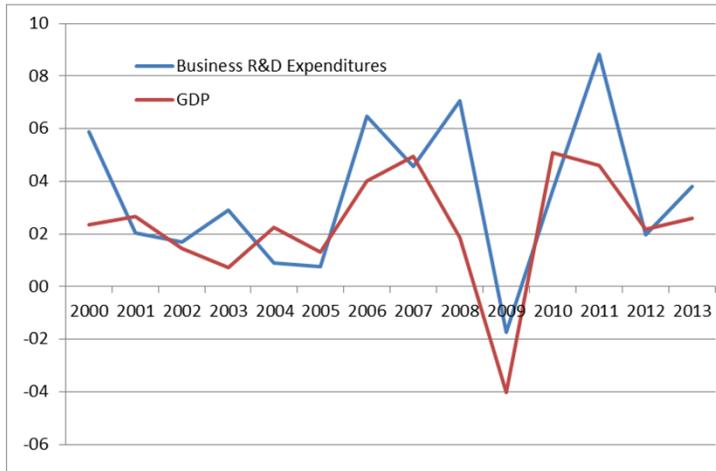


R&D Behavior of Manufacturing Companies during the Recession 2008/2009: Weak Slump, Fast Recovery

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Change in R&D may be the result of different behavior of companies.

Companies may

- reduce (pro-cyclical) or expand R&D (counter-cyclical) or
- not react as they see R&D as a strategic long term investment.

The aim of the paper is to investigate to what extent the R&D behavior of manufacturing companies was influenced by the 2008/2009 crisis.

- Data: Cost Structure Survey in Manufacturing (KSE)
- Methodology
- Results
 - Change in R&D activities 2008 to 2010
 - Determinants of R&D activities 2008 to 2010
- Conclusion

Further results in: DIW Discussion Paper No. 1357 (www.diw.de/publikationen)

Cost structure survey in manufacturing, in mining and extraction (KSE):

- Annual survey conducted by the Federal Statistical Office
- Information on R&D expenditures and staff according to Frascati Manual, turnover, employment, and cost structure
- Stratified (branch and size class) random sample survey of companies with 20 to 499 employees; Comprehensive survey for companies with 500 employees and more
- Sample selection changed in 2003 and in 2008

Individual company data provided by FDZ

- Only manufacturing companies
- In 2010 almost 18,000 companies surveyed (45% of all manufacturing companies)
- Panel only for 2008 to 2010, i.e. without years before the crisis

Companies in Manufacturing Captured by KSE 2008 to 2010

Frequencies	Percent	Cum.	Pattern
15,414	86.7	86.7	111
854	4.8	91.5	1..
827	4.7	96.1	11.
323	1.8	97.9	.11
293	1.7	99.6	..1
52	0.3	99.9	1.1
23	0.1	100.0	.1.
17,786	100.0		

Pattern: Company participated in all years ("111"), in 2008 only ("1."), in 2008 and 2009 only ("11."), in 2009 and 2010 only (".11"), etc.
Source: FDZ, KSE, own calculations.

Companies with 500 and more employees in Manufacturing Captured by KSE 2008 to 2010

Frequencies	Percent	Cum.	Pattern
1,357	72.6	72.6	111
169	9.0	81.6	1..
129	6.9	88.5	11.
102	5.5	94.0	.11
77	4.1	98.1	..1
21	1.1	99.2	1.1
15	0.8	100.0	.1.
1,870	100.0		

Dependent Variables:

- Occurrence of R&D as a binary variable and
- Intensity of R&D expenditures (as percentage of production) and R&D staff (as percentage of total employment)

Two steps:**Changes in R&D activities**

- Descriptive analysis 2008 to 2010

Determinants of R&D activities

- Test of the hypothesis whether R&D in 2009 (2010) is dependent on the change in the demand for companies' products or on historic R&D activity.

Independent variables

<i>Independent variables</i>	
R&D	in t-1 and in t-2 (if applicable)
Turnover	t compared to t-1 and t-1 to t-2 (if applicable)
Turnover in sector	t compared to t-1 and t-1 to t-2 (if applicable)
Size	Persons employed in t-1
Size squared	Persons employed squared in t-1
Surplus	Gross operating surplus in t-1 (% of production)
Interest	Interest of borrowed capital in t-1 (% of production)
Productivity	Value added per employee in t-1
Human capital	Labor costs per employee in t-1
Diversification	Purchased and resold goods in t-1 (% of turnover)
Subsidies	Subsidies in t-1 (% of production)
Part time	Part time employees (% of persons employed)
Ownership	Dummies for German (0) or foreign (1) ownership (from 2008 onwards)
Region	Dummies for location in East (0) or in West Germany (1)
Legal status	Dummies for single business (0) or corporate entity (1)
Market	Dummy for affiliation to non-research intensive business lines (0) or research-intensive business lines (1; 2-digit divisions according to NACE Rev. 2)

Occurrence of R&D, R&D Expenditures, Production and Intensity 2008-2010

Companies with R&D ...	Com- panies	R&D Expenditures (m Euros)			Production (m Euros)			R&D intensity (%)	
		in t	in t+1	t+1 % of t	in t	in t+1	t+1 % of t	in t	in t+1
2008 to 2009									
in current and in subsequent year	5,039	44,785	42,276	-5.6	1,037,569	849,133	-18.2	3.05	3.63
in current and not in subsequent year	431	193	-	-	16,692	13,946	-16.5	1.99	0
not in current but in subsequent year	438	-	201	-	18,415	15,836	-14.0	-	1.77
not in current and not in subsequent year	10,333	-	-	-	434,338	362,202	-16.6	-	-
Comparison not possible	906	1,244	-	-	55,796	-	-	1.05	-
Total	17,147	46,221	42,476	-8.1	1,562,810	1,241,116	-20.6	1.00	1.18
2009 to 2010									
in current and in subsequent year	4,994	41,847	43,859	4.8	837,386	984,553	17.6	3.57	3.27
in current and not in subsequent year	379	406	-	-	22,109	20,766	-6.1	1.73	-
not in current but in subsequent year	434	-	234	-	16,119	18,785	16.5	-	2
not in current and not in subsequent year	9,930	-	0	-	351,715	387,998	10.3	-	-
Comparison not possible	850	973	0	-	41,593	0	-100.0	1.37	-
Total	16,587	43,226	44,092	2.0	1,268,921	1,412,101	11.3	1.19	1.09

Source: FDZ, KSE, own calculations.

- Only few research based companies “shut down” R&D (7.8% in 2009, 7.0% in 2010)
- Some companies “started” R&D (4.1% in 2009, 4.1% in 2010)
- In companies with R&D both years expenditures less volatile than production

Occurrence of R&D, R&D Staff, Employment and Intensity 2008-2010

Companies with R&D ...	Com- panies	R&D staff (1000)			Employment (1000)			R&D intensity (%)	
		in t	in t+1	t+1 % of t	in t	in t+1	t+1 % of t	in t	in t+1
2008 to 2009									
in current and in subsequent year	4,862	263	266	1.1	2,881	2,788	-3.2	7.29	7.55
in current and not in subsequent year	442	3	-	-	80	75	-5.4	4.94	-
not in current but in subsequent year	448	-	3	-	81	81	-0.3	-	5.11
not in current and not in subsequent year	10,489	-	-	-	1,431	1,391	-2.8	-	-
Comparison not possible	906	9	-	-	178	0	-	2.29	-
Total	17,147	275	269	-2.2	4,652	4,336	-6.8	2.31	2.4
2009 to 2010									
in current and in subsequent year	4,822	266	273	3.0	2,772	2,777	0.2	7.5	7.6
in current and not in subsequent year	381	4	-	-	78	77	-1.6	4.96	-
not in current but in subsequent year	434	-	3	-	68	71	3.3	-	5.78
not in current and not in subsequent year	10,100	-	-	-	1,364	1,376	0.9	-	-
Comparison not possible	850	8	-	-	173	0	-	2.33	-
Total	16,587	278	276	-0.4	4,455	4,302	-3.4	2.41	2.49

Source: FDZ, KSE, own calculations.

- R&D staff less volatile than R&D expenditures
- Increase of R&D staff 2008 to 2009

Results: Determinants of R&D Activities

Probit Regression of R&D Activity of German Manufacturing companies (0=no,1=yes)

	(1) 2009	(2) 2010	(3) 2009 and 2010	(4) 2010
Occurrence of R&D t-1 (d)	0.859*** [0.000]	0.867*** [0.000]	0.863*** [0.000]	0.733*** [0.000]
Turnover t % t-1	0.0167 [0.389]	0.00926 [0.586]	0.0128 [0.329]	0.0231 [0.130]
Turnover of sector t % t-1	-0.156* [0.043]	0.219** [0.009]	0.0588 [0.278]	0.142 [0.200]
Persons employed	0.0000992*** [0.000]	0.0000563*** [0.001]	0.0000773*** [0.000]	0.0000483** [0.006]
Persons employed squared	-6.60e-10*** [0.000]	-3.75e-10** [0.001]	-5.14e-10*** [0.000]	-3.21e-10** [0.007]
Surplus t-1 % of production	0.135** [0.008]	0.0831 [0.087]	0.100** [0.004]	0.0743 [0.153]
Interest t-1 % of production	0.832 [0.056]	1.112** [0.007]	0.994*** [0.001]	0.994* [0.014]
Productivity t-1 Euros	-0.000000105*** [0.001]	-0.000000119** [0.006]	-0.000000109*** [0.000]	-0.000000113* [0.010]
Human capital t-1 Euros	0.00000359*** [0.000]	0.00000314*** [0.000]	0.00000340*** [0.000]	0.00000275*** [0.000]
Trade t-1 % of turnover	0.142*** [0.001]	0.0878 [0.053]	0.113*** [0.000]	0.0548 [0.254]
Subsidies t-1 % of production	0.279 [0.648]	0.844 [0.060]	0.678 [0.052]	0.712 [0.085]
Part time employees t-1 % of employees	0.0190 [0.695]	-0.0973 [0.057]	-0.0496 [0.156]	-0.0782 [0.136]
German ownership (d)	0.0193 [0.218]	-0.0156 [0.373]	0.00266 [0.821]	-0.0133 [0.475]
East Germany (d)	0.0324 [0.058]	0.0286 [0.103]	0.0292* [0.016]	0.0315 [0.085]
Single business (d)	-0.0191 [0.098]	0.0110 [0.372]	-0.00534 [0.526]	0.0158 [0.215]
Other branches of industry (d)	-0.0668*** [0.000]	-0.0986*** [0.000]	-0.0886*** [0.000]	-0.0838*** [0.000]
Year			-0.00194 [0.890]	
Occurrence of R&D t-2 (d)				0.338*** [0.000]
Turnover t-2 % t-1				0.00941 [0.710]
Turnover of sector t-1 % t-2				-0.0628 [0.562]
Pseudo R ²	0.690	0.699	0.694	0.717
Observations	16180	15662	31842	15357

Main results:

- Companies with R&D in previous period are significantly more likely to do R&D
- Development in sales not significant

Marginal effects; p -values in brackets, (d) for discrete change of dummy variable from 0 to 1. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: FDZ, own calculations.

Fractional Probit Regressions on R&D Expenditure Intensity of German Manufacturing companies

	(1) 2009	(2) 2010	(3) 2009 and 2010	(4) 2010
R&D expenditure t-1 % of production	0.139*** [17.32]	0.123*** [28.04]	0.132*** [32.85]	0.0924*** [14.30]
Turnover t % t-1	-0.00356*** [-5.54]	-0.00176* [-2.37]	-0.00230*** [-3.68]	-0.00220** [-3.26]
Turnover of sector t % t-1	-0.00328 [-1.35]	0.00356* [2.17]	-0.00116 [-0.85]	0.00346 [1.84]
Persons employed	0.000000191** [2.75]	0.000000124* [2.17]	0.000000157*** [3.39]	0.000000106 [1.81]
Persons employed squared	-1.48e-12* [-2.04]	-9.76e-13 [-1.95]	-1.21e-12** [-2.73]	-8.24e-13 [-1.65]
Surplus t-1 % of production	0.00782** [2.97]	0.00350 [0.95]	0.00514 [1.88]	0.00254 [0.73]
Interest t-1 % of production	0.0260 [1.93]	0.0192 [1.34]	0.0238* [2.20]	0.00711 [0.59]
Productivity t-1 Euros	-1.80e-08*** [-3.66]	-1.15e-08 [-1.49]	-1.37e-08* [-2.55]	-9.99e-09 [-1.46]
Human capital t-1 Euros	0.000000143*** [8.66]	0.000000110*** [7.12]	0.000000124*** [10.39]	9.11e-08*** [6.04]
Trade t-1 % of turnover	0.00425*** [6.46]	0.00331*** [4.17]	0.00375*** [7.24]	0.00346*** [4.48]
Subsidies t-1 % of production	-0.00963 [-0.43]	-0.0129 [-0.69]	-0.0110 [-0.74]	-0.0189 [-0.98]
Part time employees t-1 % of employees	-0.000789 [-0.59]	-0.00276* [-2.14]	-0.00211* [-2.25]	-0.00359** [-2.71]
German ownership (d)	-0.00000351 [-0.01]	-0.000226 [-0.70]	-0.000118 [-0.46]	-0.000173 [-0.54]
East Germany (d)	0.00124** [2.86]	0.00177*** [4.11]	0.00146*** [4.80]	0.00147*** [3.63]
Single business (d)	-0.000396 [-1.66]	-0.000553* [-2.34]	-0.000502** [-2.96]	-0.000434 [-1.79]
Year			-0.000113 [-0.32]	
R&D expenditure t-2 % of production				0.0427*** [5.94]
Turnover t-2 % t-1				-0.000109 [-0.21]
Turnover of sector t-1 % t-2				-0.000223 [-0.11]
AIC	1358.8	1246.8	2575.7	1213.3
Observations	16178	15661	31839	15356

Main results:

- Development in sales significant

Regression on R&D Staff Intensity:

- Development in sales not significant

Marginal effects; p -values in brackets, (d) for discrete change of dummy variable from 0 to 1. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: FDZ, own calculations.

The analyses suggest that most companies see R&D as a long term task necessary to retain competitiveness. This interpretation is supported by the fact that R&D activities are typically organized as mid-term projects.

R&D staff is less volatile than R&D expenditures. This suggest that companies avoid loss of the knowledge base of their company. Further reason may be the usage of short-time allowances (“Kurzarbeitergeld”).

Further research:

- **Extension 2011**
- **Similar estimations for the years 2003-2007 and for the large companies 2003-2011**

Descriptive statistics for Companies with and without R&D 2009

	[0]No	[1]Yes	Total
Occurrence of R&D	0	1	0.339
Occurrence of R&D t-1	0.0400	0.920	0.337
Turnover t % t-1	-0.114	-0.132	-0.120
Turnover of sector t % t-1	-0.151	-0.171	-0.158
Persons employed	132.8	533.4	268.6
Persons employed squared	100495.4	10915991.5	3766953.2
Surplus t-1 % of production	0.0330	0.0365	0.0342
Interest t-1 % of production	0.00964	0.0102	0.00982
Productivity t-1 Euros	57895.3	71687.5	62546.5
Human capital t-1 Euros	36933.0	47059.6	40348.0
Trade t-1 % of turnover	0.0476	0.0769	0.0575
Subsidies t-1 % of production	0.000469	0.00119	0.000713
Part time employees t-1 % of employees	0.123	0.0837	0.110
German ownership	0.909	0.817	0.878
East Germany	0.189	0.160	0.179
Single business	0.342	0.274	0.319
Other branches of industry	0.737	0.429	0.632
Observations	16587		

Source: FDZ, KSE, own calculations.

- Difference in change in turnover small