Innovation Expenditures over the Business Cycle and Innovation Performance

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Introduction

- Economic crisis of 2008 / 2009 in Germany
  - Germany‘s GDP declined by 5.5% in 2009
  - Detrimental effects on German firms‘ performance …
    - 77% of the firms stated an at least slight decrease in sales or profits
    - Almost 50% of the firms laid off at least some of their employees
    - Almost 40% increased short-term employment
  - … and on their R&D / innovation activities (Rammer, 2011)
    - Among the innovators, 36% stated to have cut their innovation expenditures due to the crisis
    - Overall, innovation expenditures of German firms dropped by almost 9%
    - But: Among innovators, 55% stated additional innovation activities as a crisis strategy

Introduction

- Consequences?
  - R&D / Innovation activities are a key contributor to sustained company success (Crépon et al. 1998; Aghion and Howitt, 1998)
  - From a macroeconomic point of view, reducing these activities can hamper knowledge creation and hence an economy‘s productivity growth
  - From a firm perspective, stopping or downscaling innovation projects harms innovation success, thus firm performance

- Open questions
  - Can a crisis-related expansion of innovation activities increase post-crisis innovation success?
  - Is there a difference of that relationship if focussing on other business cycle periods?
  - The answers basically depend on the measures for innovation success and for the business cycle

Literature

- Business cycle effects of R&D / innovation activities:
  - Pro-cyclicality: Schmookler (1966), Shleifer (1986), Hall (1992), Himmelberg and Petersen (1994), Barlevy (2007), Ouyang (2011)
  - Counter-cyclicality: Gali and Hammour (1991), Aghion and Saint-Paul (1998), Brockhoff and Pearson (1998)
  - Mixed: Saint-Paul (1993), Aghion et al. (2010, 2012), Bovha-Padilla et al. (2009); López-Garcia et al. (2012)
- Productivity of R&D / returns to R&D
  - Extensive literature overview on that in Hall et al. (2009)
  - Market value: literature overviews by Hall (2000); Czarnitzki et al. (2006); Grandi et al. (2009)
- Literature addressing innovation success and the business cycle?

Research questions

1. During stable economic conditions, does a positive adjustment in the level of innovation activities translate into short-term innovation success?
   - During growth periods, firms will attempt to maintain an optimal level of innovation activities
   - This allows them to steadily fill their pipelines of new products and keep pace with technological change
   - Effective strategy?

2. Does that relationship basically hold during an economic crisis, is that effect even stronger?
   - Short-term fluctuations in the business environment may make it difficult to achieve the optimal innovation path
   - Recession periods call for cost-cuts, which impedes maintaining (approaching) the optimal level and potentially deteriorates the quality of the innovations
   - Therefore, we expect those firms to be more successful that positively adjusted their innovation expenditures during the crisis

Research questions

3. Independent of the economic condition, will more ambitious innovation projects induce higher innovation success?

   - The more ambitious an innovation project is the more difficult, costly and time-consuming it will be to solve technological challenges
   - If properly finalised and introduced on the market it should promise to be successful, on average
   - Cutting the budgets for those projects will may lead to a weaker performance than for less ambitious projects

Methodology

- Fixed Effects estimation of:

$$IS_{ij,t+1} = \beta_0 + \beta_1 II_{i,t-1} + \beta_2 \Delta II_{i,t|t-1} * HG_{t|t-1} + \beta_3 \Delta II_{i,t|t-1} * MG_{t|t-1} + \beta_4 \Delta II_{i,t|t-1} * LG_{t|t-1} + \beta_5 X_{i,t} + \mu_{i,t}$$

  - Estimations are restricted to product innovating firms
  - As a robsutness check, RE Tobit model is estimated
  - Drawback: RE requires α_i to be independent of $X_{i,t}$
  - Mundlak (1978) allows for Corr(α_i,$X_{i,t}$) ≠ 0
  - Therefore, we also include the individual time-means of the time-variant variables

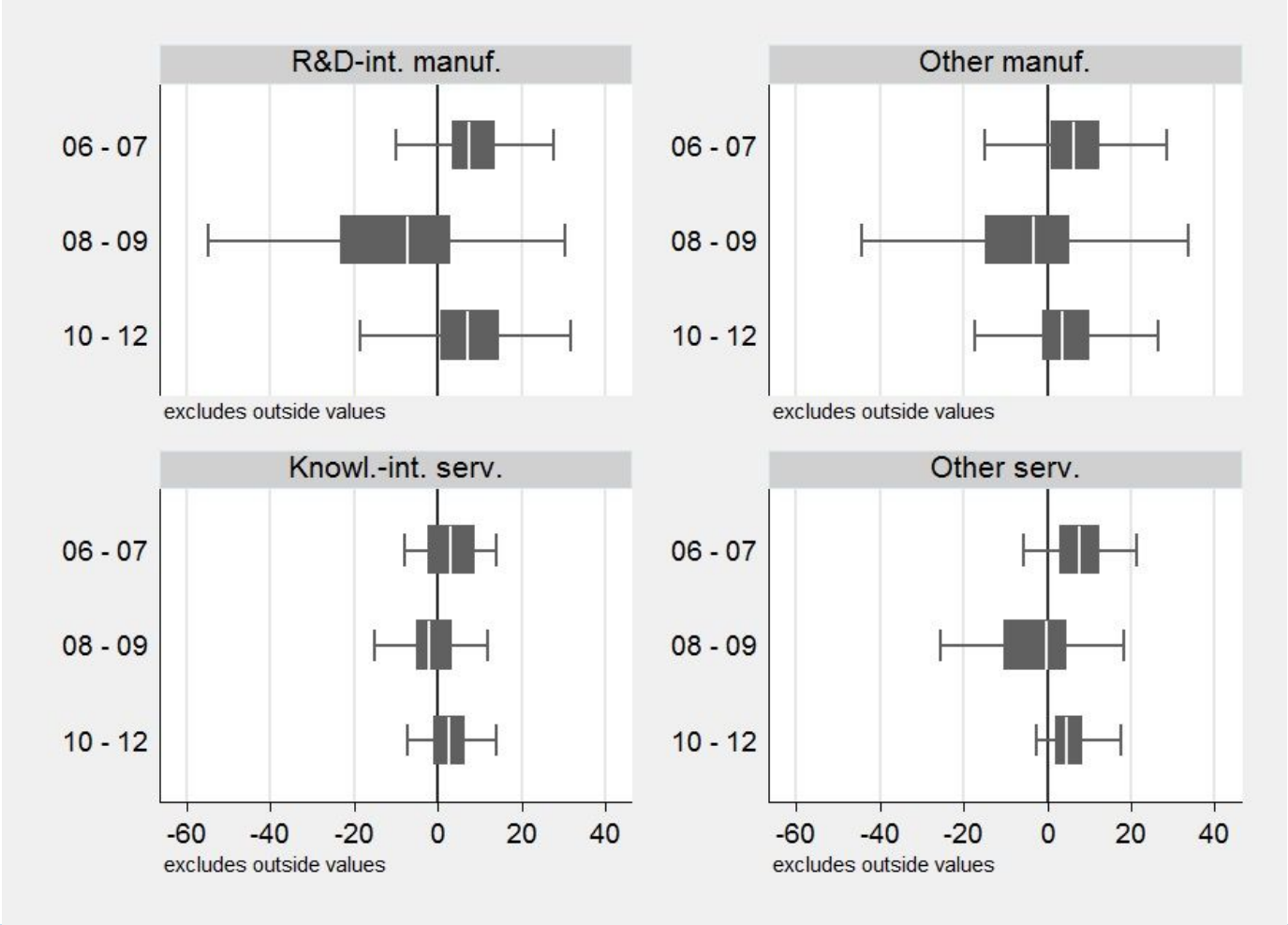
- Business cycle indicators?
  - Heterogeneity between macro-economic growth (GDP) and industry-level growth

Methodology

Figure 1 – Real GDP growth (in percent)

Methodology

Figure 2 – Industry-level sales growth (in percent)



Methodology

Table 1 – Business cycle indicators (in percent)

	Industry-level sales growth		GDP growth
Thresholds:	Strict (10%; 90%)	Tolerant (25%; 75%)	
High growth	>= 16.5	>= 10	>= 3
Medium growth	>= -12.7 & < 16.5	>= -1.4 & < 10	>= 0 & < 3
Low growth	< -12.7	< -1.4	< 0

Data

❑ Databases:

- Mannheim Innovation Panel (MIP)
  - ➢ We cover the years 2006-2012
- Federal Statistical Office of Germany
- Creditreform

❑ Variables:

- Explanatory variables
  - ➢ Intensity_t-1: one-year lag of innovation intensity (innovation expenditures / firm-level sales)
  - ➢ D_intensity_t|t-1: change in innovation intensity between t and t-1
  - ➢ We take the values for the respective growth periods: high growth, medium growth and low growth

Data

❑ Variables:

- Controls
  - ➢ Continuous: firm-level sales growth (**Salesgrowth**), credit rating (**Credrat**), firm age (**Age**) and firm age squared (**Age^2**), capital intensity (**Capitalint**)
  - ➢ Binary: part of a group (**Group**), process innovator (**Pc**), exporting firm (**Export**), R&D activities occasionally or continuously conducted (**RnD**), employee (size) dummies, time dummies, year dummies
  - ➢ Others: for the Mundlak approach time-means of the time-varying variables are also included
- Outcome variables
  - ➢ new: sales share of new products
  - ➢ market: sales share of market novelties
  - ➢ imit: sales share of product imitations

Results

Table 2 – Effect of a change in innovation expenditures on innovation success considerung the business cycle, FE model

Thresholds:	**10% ; 90%**			**25% ; 75%**			**GDP-growth**		
Sales share of:	new	market	imit	new	market	imit	new	market	imit
Intensity_t-1	0.041	0.027	0.014	0.053	0.045	0.008	0.059	0.036	0.022
	(0.066)	(0.059)	(0.064)	(0.067)	(0.067)	(0.068)	(0.066)	(0.062)	(0.064)
D_intensity_t|t-1 during:									
High growth	0.020	0.092	-0.072	0.115	**0.188****	-0.073	**0.104***	**0.084****	0.020
	(0.076)	(0.061)	(0.069)	(0.086)	(0.080)	(0.061)	(0.053)	(0.036)	(0.046)
Medium growth	**0.121*****	**0.098*****	0.023	**0.109****	**0.074****	0.035	**0.112***	**0.108****	0.003
	(0.046)	(0.029)	(0.037)	(0.046)	(0.030)	(0.035)	(0.064)	(0.053)	(0.036)
Low growth	0.024	0.051	-0.027	0.113	0.094	0.018	0.159	**0.131***	0.028
	(0.109)	(0.069)	(0.117)	(0.095)	(0.063)	(0.103)	(0.112)	(0.075)	(0.109)

Results

Table 3 – Robustness check – RE Tobit model

Thresholds:	**10% ; 90%**			**25% ; 75%**			**GDP-growth**		
Sales share of:	new	market	imit	new	market	imit	new	market	imit
High growth	-0.038	**0.249****	-0.118	0.073	**0.300*****	-0.090	0.057	**0.101*****	0.009
	(0.108)	(0.124)	(0.114)	(0.070)	(0.064)	(0.076)	(0.045)	(0.039)	(0.048)
Medium growth	**0.072***	**0.117*****	-0.015	0.065	**0.083****	0.000	0.094	**0.127*****	-0.010
	(0.041)	(0.035)	(0.044)	(0.044)	(0.038)	(0.047)	(0.059)	(0.049)	(0.064)
Low growth	-0.052	0.180	-0.125	-0.047	**0.144***	-0.118	0.028	**0.190****	-0.058
	(0.126)	(0.116)	(0.135)	(0.083)	(0.075)	(0.088)	(0.099)	(0.092)	(0.105)
Individual heterogeneity:									
M_intensity_t-1	**0.335*****	**0.181****	**0.254*****	**0.349*****	**0.173****	**0.260*****	**0.317*****	**0.183****	**0.222****
	(0.087)	(0.076)	(0.090)	(0.087)	(0.076)	(0.091)	(0.086)	(0.075)	(0.089)
M_High	**0.144****	**0.162*****	-0.107	**0.137****	**0.153*****	-0.081	**0.158*****	**0.138*****	-0.005
	(0.062)	(0.049)	(0.104)	(0.060)	(0.048)	(0.082)	(0.056)	(0.045)	(0.061)
M_Medium	**0.199****	0.034	**0.179****	**0.244****	0.125	0.151	**0.298***	**0.305****	-0.002
	(0.090)	(0.076)	(0.090)	(0.113)	(0.095)	(0.112)	(0.180)	(0.145)	(0.177)
M_low	**0.525***	0.124	0.435	**0.428****	-0.114	**0.477*****	0.289	-0.195	0.356
	(0.316)	(0.275)	(0.313)	(0.175)	(0.154)	(0.178)	(0.214)	(0.192)	(0.220)

Findings

- Findings and concluding remarks
  - Expansive innovation budgeting increase short-term innovation success during high-growth and medium-growth periods
  - A positive adjustment effect could be found for more ambitious innovations
  - No effect could be found if the business cycle is measured on an industry-level, though weakly significant in the robustness check
  - Neglecting the industry perspective, our results suggest that increasing innovation expenditures increase the short-term post-crisis innovation success
    - This effect is even strongest for the crisis period
  - Conditioned on the fact that not all industries have been affected by the crisis, a crisis-related adjustment of innovation expenditures seems not to be an effective way to boost short-term innovation performance
    - The industry level only represents a firm‘s primary sales market
    - The macro-level additionally considers changes in labour, capital and supply markets
    - Measured on an industry level, the opp. costs of innovative efforts may not be low enough to benfit from an adjustment; but it seems to be so on the macro-level

Thank you for your attention!

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