Outcomes of Science-Industry Collaboration: Factors and Interdependencies

Uwe Cantner, ***Martin Kalthaus****, Indira Yarullina*

Motivation & Research Question

- Science-Industry collaboration (SIC) are an integral part of knowledge and technology transfer (KTT)
- Research organizations and policy makers encourage and foster such interactions
- Limited understanding of the **types of outcomes**, the **factors** that influence their generation and **interdependencies** between outcomes

Which factors influence outcomes from Science-Industry collaboration and how do outcomes relate to each other?

Theoretical propositions

Three types of outcomes from Science-Industry Collaboration:

1. **Scientific outcomes**: scientific surplus (e.g. publications) (de Fuentes and Dutrénit, 2012)
2. **Commercialisable outcomes**: IPRs, licence revenue for researcher's organisation, ideas for start-ups (de Fuentes and Dutrénit, 2012; Ambos et al., 2008)
3. **Follow-up cooperation**: ideas for follow-up cooperation as an outcome from the project (Grimaldi and von Tunzelmann, 2002)

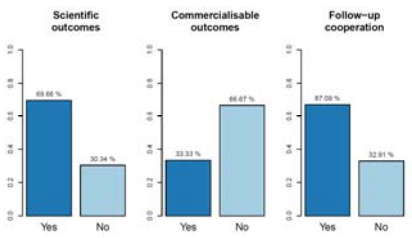
Four propositions on the influence and relationships of outcomes:

1. **Scientific factors** are relevant for the creation of scientific outcomes (Bikard et al., 2019; Stokes, 1997; Dietz and Bozeman, 2005)
2. **Economic factors** are relevant for the creation of commercialisable outcomes (Kauppila et al., 2015; Bodas Freitas and Verspagen, 2017)
3. **Interaction factors** influence the emergence of follow-up cooperation (Cantner and Graf, 2011; Thune, 2007; D'Este et al., 2013)
4. Scientific, commercialisable and follow-up collaboration **outcomes from SIC** project are **co-generated** (Blumenthal et al., 1996; Lee, 2000)

Data

- Survey of 1149 researchers at Thuringian universities and research institutes during December 2019 - January 2020
- 234 researchers are active in or finished an SIC in our sample
- 3 sets of variables: outcomes, factors, controls
- Secondary data: publication data from Web of Science and data from public organisations' webpages

Aggregated outcomes from Science-Industry Collaboration



SIC outcome co-occurrence

	Scientific	Commerc	Follow-up
Scientific	23		
Commerc	13	4	
Follow-up	75	9	21

All outcomes together: 52
Projects without outcomes: 37

Methodology

We apply multivariate probit estimations (Cappellari and Jenkins 2003):

- Estimate the influence of different factors on outcomes simultaneously while controlling for outcome correlations (P1-3)
- Test the relationship between outcome variables of SIC (P4)

$$Scientific^* = X'\beta + \varepsilon_1, \quad Scientific = 1\,(Scientific^* > 0),$$
$$Commerc^* = X'\beta + \varepsilon_1, \quad Commerc = 1\,(Commerc^* > 0),$$
$$Follow-up^* = X'\beta + \varepsilon_1, \quad Follow-up = 1\,(Follow-up^* > 0)$$

$$\begin{pmatrix}\varepsilon_1\\ \varepsilon_2\\ \varepsilon_3\end{pmatrix} \Big| X \sim N\left[\begin{pmatrix}0\\0\\0\end{pmatrix}, \begin{pmatrix}1 & \rho_{1,2} & \rho_{1,3}\\ \rho_{2,1} & 1 & \rho_{2,3}\\ \rho_{3,1} & \rho_{3,2} & 1\end{pmatrix}\right]$$

Results

Multivariate probit estimation:

	Scientific (1a)	Commercialisable (1b)	Follow-up (1c)	Scientific (2a)	Commercialisable (2b)	Follow-up (2c)
Scientific factors (P1)						
Pasteur	0.491**	0.296	0.676***	1.085***	0.368	0.601**
	(0.192)	(0.270)	(0.250)	(0.333)	(0.376)	(0.312)
Bohr	0.133			0.636**	0.082	-0.328
	(0.274)			(0.382)	(0.469)	(0.410)
Numb. of publications (log)	0.062			0.195**	0.049	0.039
	(0.058)			(0.083)	(0.074)	(0.083)
Basic research organisation	-0.091			-0.064	0.084	-0.160
	(0.251)			(0.315)	(0.303)	(0.315)
Knowledge aim	0.059			0.034	0.015	0.035
	(0.170)			(0.187)	(0.188)	(0.190)
Research collaboration	0.418**			0.519**	-0.191	0.292
	(0.197)			(0.210)	(0.210)	(0.229)
Economic factors (P2)						
Edison		-0.062	0.587**	0.826**	0.089	0.558**
		(0.267)	(0.248)	(0.343)	(0.376)	(0.321)
Share of collaborative papers		1.207***		-1.078***	1.021***	0.073
		(0.310)		(0.405)	(0.367)	(0.373)
Experience outside public sector		0.039		0.092	0.057	0.026
		(0.059)		(0.071)	(0.063)	(0.070)
Breadth of transfer experience		0.338***		0.220	0.304**	0.065
		(0.128)		(0.167)	(0.144)	(0.177)
Applied research organisation		-0.052		0.003	-0.176	-0.131
		(0.221)		(0.260)	(0.272)	(0.271)
Entrepreneurial environment		0.958**		-0.117	0.969**	-0.985**
		(0.459)		(0.464)	(0.468)	(0.526)
IPR environment		-0.522**		0.049	-0.582**	0.416
		(0.310)		(0.342)	(0.343)	(0.508)
Economic aim		0.631**		-0.432	0.564	-0.327
		(0.349)		(0.336)	(0.370)	(0.314)
Interaction factors (P3)						
Principal Investigator			0.415**	0.035	0.264	0.371**
			(0.201)	(0.202)	(0.212)	(0.212)
Collaborative environment			0.123**	-0.046	0.038	0.114
			(0.063)	(0.086)	(0.082)	(0.093)
Known company partners			0.172	0.163	0.262	0.239
			(0.182)	(0.198)	(0.192)	(0.200)
Controls						
Discipline	-0.153	0.111	0.119	-0.141	0.171	0.123
	(0.244)	(0.258)	(0.260)	(0.281)	(0.286)	(0.290)
Female	-0.163	-0.480**	-0.624***	-0.036	-0.447**	-0.668***
	(0.186)	(0.193)	(0.190)	(0.192)	(0.198)	(0.192)
Academic position	-0.480**	-0.052	-0.525**	-0.695***	-0.155	-0.619**
	(0.207)	(0.199)	(0.217)	(0.247)	(0.232)	(0.247)
Finished project	0.455**	-0.046	0.330**	0.399**	-0.107	0.304
	(0.187)	(0.184)	(0.187)	(0.202)	(0.189)	(0.194)
Constant	-0.058	-1.498***	-0.251	-0.658	-1.757***	-0.102
	(0.246)	(0.467)	(0.250)	(0.550)	(0.679)	(0.559)
Outcomes Co-generation (P4)						
$\rho_{2\times}$	0.415***			0.403***		
	(0.112)			0.(109)		
$\rho_{3\times}$	0.459***	0.208		0.499***	0.204*	
	(0.103)	(0.126)		(0.104)	(0.122)	
Observations		234			234	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

- Most factors are outcome specific.
- Scientific factors associate with scientific outcomes (P1).
- Economic factors associate with commercialisable outcomes, as well as scientific and follow-up cooperation (P2).
- Interaction factors are relevant only for follow-up cooperation (P3).
- All types of outcomes are co-generated in a SIC in the full model (P4).

Conclusion

- We provide first insights on factors influencing outcomes and the relationships between outcomes from SIC
- Follow-up cooperation are an important benefit of SIC that are largely neglected in previous analysis and by policy makers
- Factors influence the generation of outcomes heterogeneously
- A high complementarity between scientific outcomes and other outcomes exists
- Policy makers should foster the co-generation of SIC outcomes, since benefits of cooperation with industry do not arise independently of each another
- Development of transfer friendly environment should not only foster collaborative projects, but also development other transfer channels

Indira Yarullina[1], corresponding author: indira.yarullina@uni-jena.de
Martin Kalthaus[1]: martin.kalthaus@uni-jena.de
Uwe Cantner[1,2]: uwe.cantner@uni-jena.de

[1]Friedrich Schiller University Jena, Department of Economics
[2]University of Southern Denmark, Department of Marketing and Management