ON UNIVERSITIES' EFFECTS ON REGIONAL VALUE CREATION AND UNEMPLOYMENT THE CASE OF GERMANY

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Background

- Discussion on the regional impact of Higher Education Institutions (HEI) has a long tradition dating back to the 1970s

- Since the late 1980s, an increasing political interest in universities' economic contribution to their environment has added further momentum to the debate

But:

- most studies have focused on the directly observable demand side effects of HEI (e.g. demand by students, employees, or HEI investments), underestimating the effects

- knowledge and human capital creation are the key tasks of HEIs
  ➔ indirect, knowledge-mediated impacts are extremely important (Florax 1992)

- few contributions have sought to take the methodological ambition of estimating impacts on a nationwide level

- the modelling framework of existing cross-section studies (Goldstein and Drucker, 2006; Goldstein and Renault, 2004)

  - leaves room for improvement

  - focused on the US case

Conceptual Framework
What impacts?

- **variety of different outputs**, from tangible (publications, patents) to less tangible ones (regional leadership, influence on regional milieu) (Florax 1992; Goldstein et al. 1995)

- a **broad range of transfer and interaction channels** related to various types of outputs (Abreu et al. 2009; Benneworth et al. 2009; Koschatzky et al. 2011)

- first order effects vs. **second order macroeconomic impacts** (Florax 1992; Garrido-Yserte, Gallo-Rivera 2010)
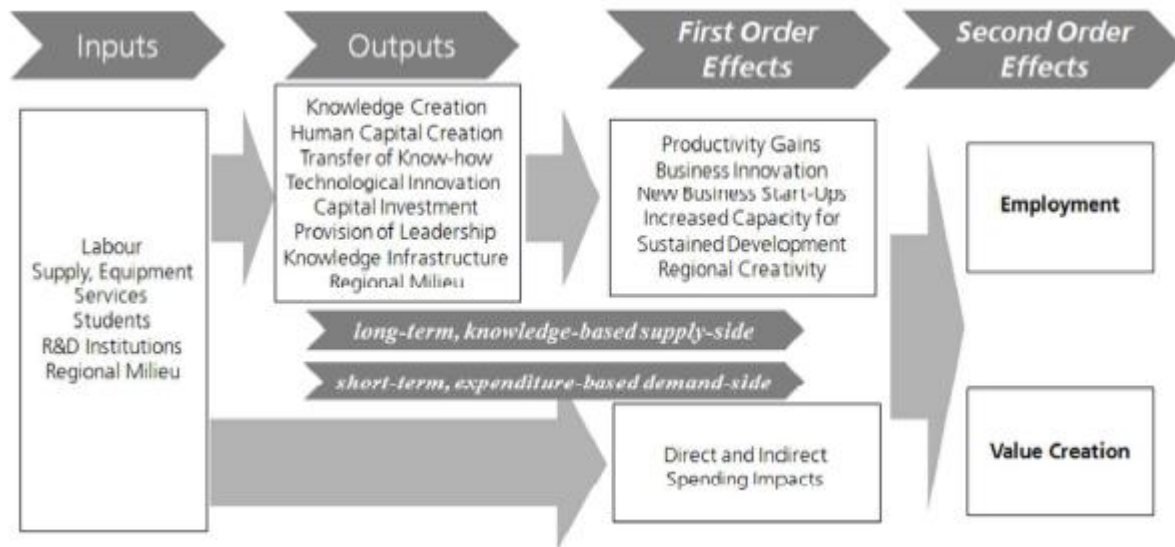
Source: own figure, based on: Goldstein et al. (1995); Stokes and Coornes (1998); Segarra i Blasco (2003)

Contribution to the literature
➔ in several ways

Reflect the multidimensionality of HEI outputs and (to the extent possible)

- empirically identify the marginal effects of investment, employment, education, and knowledge output on regional income and unemployment taking into account a broader part of HEIs' multiple functions discussed in the literature (e.g. Florax 1992, Goldstein et al. 1995, Goldstein, Drucker 2006; Uyarra 2008)

Look at the role of regional spillovers

- not only capture the impact of academic activities within a certain region's boundaries but also that of those in its adjoining vicinity

Take into account the importance of the socio-economic environment

- control for observable regional characteristics and for unobserved regional heterogeneity

➔ **Then use these results to gauge the average impact of higher education institutions' activities on German regions**

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Methodology

- **Panel data set for Germany in the period between 2001 and 2009 (NUTS3 level)**

1. **use regression to estimate average marginal impacts (coefficients)**
2. **multiply (significant) coefficient by regional average of the corresponding variable** to assess effect at the regional or, by aggregation, the national level.

   example: $DE_{stud} = \beta_{stud}\, \overline{stud}$

- Use **fixed effects model** to cancel out unobserved heterogeneity – impact of stable means
    - unobserved heterogeneity is substantial in a dataset composed of regions
    - but: hardly orthogonal to the IV – so random effects is not an option
- Use **spatial econometric regression** models to account for spillovers:
    - Regional spillovers by inclusion of **lagged independent variables**
    - Regional lags in stochastic shocks
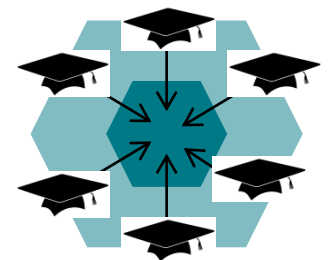
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Hypotheses

- *Hypothesis 1:*
  Key HEI outputs will display a positive effect on regional value creation (as measured by GDP per capita)

- *Hypothesis 2:*
  Key HEI outputs, in particular the education of graduates, will display a significantly positive effect on employment in the long-run, but none or a negative one in the short-run (as measured by unemployment rates)

- *Hypothesis 3:*
  A large part of HEIs' positive effects on value creation and employment spill over to neighbouring regions

- *Hypothesis 4:*
  The socio-economic environment matters

  - *In regions with a high technology-orientation of the local industry the HEIs positive effects on value creation and employment are stronger.*

  - *In regions where local HEIs generate higher shares of their income from private firms the positive effects on value creation and employment are stronger.*

Variables

- **Dependent variables**

    - GDP per capita (pure economic perspective)

    - Unemployment rate (stronger social component)

- **Key independent variables**

    - triggering demand side effects:

        - number of students, HEI investment, number of staff.

    - triggering supply side effects:

        - number of publications, number of graduates, third party funds.

    ➔ all variables as per capita values

- **Control variables**

    - *How relevant? – Economic size (*Total employment*)*

    - *How fertile? – Technology orientation (*High-tech employment*)*

    - *Relative importance of HEI? – Peripherality of the region (*Agricultural employment*)*

    - *How likely to bind outputs? – Brain drain (Net migration)*

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Step 1: Regression Results

Dependent Variable	GDP p.c.		Unemployment rate		Unemployment rate	
	Estimate	**t-value**	**Estimate**	**t-value**	**Estimate**	**t-value**
University characteristics						
Graduates p.c. (l1)	119.4200 ***	6.7686	-14.4370	-0.9204	-45.3030 **	-2.2039
Investment p.c. (l1)	-0.5537	-0.7196	-3.5839 ***	-5.2570	-2.6718 ***	-3.6976
TPF p.c. (l1)	-2.4442	-1.0891	-0.8339	-0.4167	0.4755	0.2301
Students p.c. (l1)	10.7280 **	2.4000	32.8770 ***	8.3040	27.3150 ***	5.5521
Staff p.c. (l1)	10.1560	0.7129	38.9420 ***	3.0639	15.8650	0.8891
Publications p.c. (l1)	142.5900 ***	2.5974	-17.5320	-0.3622	2.6140	0.0528
Graduates p.c. (l3)					10.4530	0.4146
Investment p.c. (l3)					-2.2567 ***	-2.9082
TPF p.c. (l3)					-12.0950	-1.4687
Students p.c. (l3)					8.2911	1.5192
Staff p.c. (l3)					36.7490 *	1.8977
Publications p.c. (l3)					-58.7410 ***	-5.7048
Regional controls						
Net migration	66.8720 **	2.3383	-63.9090 **	-2.5119	-74.4960 ***	-2.8938
Regional employment	0.0325 ***	7.0723	-0.0139 ***	-3.3114	-0.0148 ***	-3.5121
Share hightech employment	0.0290	0.9012	-0.0799 ***	-2.7988	-0.0641 **	-2.2469
Share agricultural employment	-14.6450 *	-1.8528	20.2630 ***	2.9042	22.5740 ***	3.2368

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Step 1: Regression Results (continued)

Spatial lags

Graduates p.c. (l1)	258.1800		1.0910	-967.8700 ***	-3.0790	-546.6500	-1.5739
Investment p.c. (l1)	-17.8550 **	-2.0950	-10.7490	-1.0275	-14.6840	-1.4463
TPF p.c. (l1)	79.9150 **	2.3686	-81.2870 **	-1.9800	-81.1750 *	-1.9533
Students p.c. (l1)	-60.4240	-1.4066	-90.6600	-1.5896	-94.9640	-1.4076
Staff p.c. (l1)	453.6800 ***	5.5146	569.4900 ***	5.0596	182.6000	1.3772
Publications p.c. (l1)	-59.6250	-0.1507	3844.6000 ***	6.3524	2459.5000 ***	4.0963
Graduates p.c. (l3)					-1114.5000 ***	-2.6378
Investment p.c. (l3)					26.6890 **	2.4441
TPF p.c. (l3)					-365.2200 **	-2.2346
Students p.c. (l3)					-49.1490	-0.8344
Staff p.c. (l3)					916.5900 ***	6.2695
Publications p.c. (l3)					-143.4700	-1.0097
Net migration	74.4790	0.3636	-590.0300 **	-2.1658	-806.4000 ***	-3.1054
Regional employment	0.2679 ***	5.3175	-0.1116 *	-1.7156	-0.0999	-1.0962
Share hightech employment	-0.0822	-0.6120	-0.0572	-0.2974	-0.0541	-0.2973
Share agricultural employment	-255.4500 ***	-4.1107	57.2660	0.5615	63.6250	0.6780
Year dummies	YES		YES		YES	
N	429		429		429	
T	19		19		19	
R2	0.9864		0.9560		0.9564	
rho	0.2900		0.9600		0.8600	

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Results –
GDP effects on average regions

$$DE_{stud} = \beta_{stud}\,\overline{stud} \qquad IE_{stud} = \beta_{spatstud}\,\overline{spatstud} \qquad TE_{stud} = DE_{stud} + IE_{stud}\,.$$

	DE	IE	TE
Graduates p.c. (11)	302.12		302.12
Investment p.c. (11)		-406.64	-406.64
Third Party Funding p.c. (11)		4729.92	4729.92
Students p.c. (11)	202.65		202.65
Staff p.c. (11)		2729.62	2729.62
Publications p.c. (11)	297.43		297.43
Total	**802.20**	**7052.90**	**7855.09**

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Results –
Unemployment effects on average regions

$$DE_{stud} = \left(\beta_{stud,-1} + \beta_{stud,-3} \right) \overline{stud} \qquad IE_{stud} = \left(\beta_{spatstud,-1} + \beta_{spatstud,-3} \right) \overline{spatstud}$$

	Lag 1			Lag 1+Lag 3		
	DE	IE	TE	DE	IE	TE
Graduates p.c. (l1)/(l1/l3)		-0.04	-0.04	-0.11	-3.75	-3.86
Investment p.c. (l1)/(l1/l3)	-0.07		-0.07	-0.10	0.61	0.51
Third party funding p.c. (l1)/(l1/l3)		-4.81	-4.81		-4.71	-4.71
Students p.c. (l1)/(l1/l3)	0.62		0.62	0.52		0.52
Staff p.c. (l1)/(l1/l3)	-0.08	3.43	3.35	0.16	-0.30	-0.14
Publications p.c. (l1)/(l1/l3)		6.80	6.80	-0.12	4.35	4.23
Total	**0.47**	**5.38**	**5.85**	**0.35**	**-3.80**	**-3.45**

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Interaction effects: Patent Intensity

Dependent Variable	GDP p.c. Estimate	t-value	Unemployment rate Estimate	t-value
University characteristics				
Graduates p.c. (l1)	202.1000 ***	9.6563	-10.8500	-0.5815
Investment p.c. (l1)	0.7169	0.7204	-6.1065 ***	-6.9439
Tfp p.c. (l1)	2.8063	1.1660	-3.1986	-1.4805
Students p.c. (l1)	-1.2254	-0.2475	33.0940 ***	7.5309
Staff p.c. (l1)	3.5790	0.2198	49.9910 ***	3.4326
Publications p.c. (l1)	139.6200 *	2.5568	-23.3930	-0.4822
Patents p.c. (l1)	21.2490	0.5697	-18.9580	-0.5681
Graduates p.c. (l1)#Patents p.c. (l1)	-31234.0000 ***	-7.3528	-4889.8000	-1.2931
Investment p.c. (l1)#Patents p.c. (l1)	-90.8340	-0.3945	1003.1000 ***	4.9367
Tfp p.c. (l1)#Patents p.c. (l1)	-299.6500	-1.3565	194.8400	0.9975
Students p.c. (l1)#Patents p.c. (l1)	4672.2000 ***	5.7988	-758.5200	-1.0637
Staff p.c. (l1)#Patents p.c. (l1)	9424.4000 ***	4.1223	-3349.0000 .	-1.6588
Publications p.c. (l1)#Patents p.c. (l1)	13845.0000 .	1.9088	8801.0000	1.3721
Regional controls				
Net migration	57.7750 *	2.0387	-63.5050 *	-2.5021
Regional employment	0.0410 ***	8.8120	-0.0174 ***	-4.0854
Share hightech employment	0.0167	0.5217	-0.0787 **	-2.7546
Share agricultural employment	-13.5380 .	-1.7223	21.9420 **	3.1394
Spatial lags				
Graduates p.c. (l1)	190.3100	0.7766	-1156.6000 ***	-3.4320
Investment p.c. (l1)	-13.5170	-0.9292	-14.3580	-0.9102
Tfp p.c. (l1)	35.6790	0.8864	-192.4700 ***	-4.1498
Students p.c. (l1)	-14.0550	-0.2853	0.9178	0.0145
Staff p.c. (l1)	568.5000 ***	4.0247	1167.6000 ***	7.3911
Publications p.c. (l1)	-87.4800	-0.1975	3927.9000 ***	6.4156
Net migration	118.3900	0.5895	-761.6500 **	-2.8325
Graduates p.c. (l1)#Patents p.c. (l1)	-37032.0000	-0.9443	74801.0000 .	1.6657
Investment p.c. (l1)#Patents p.c. (l1)	465.4500	0.1556	947.1200	0.3004
Tfp p.c. (l1)#Patents p.c. (l1)	3637.0000	1.0767	8930.3000 *	2.4178
Students p.c. (l1)#Patents p.c. (l1)	-7891.3000	-0.7717	-24402.0000 *	-2.1563
Staff p.c. (l1)#Patents p.c. (l1)	-22284.0000	-1.1016	-90548.0000 ***	-4.1916
Publications p.c. (l1)#Patents p.c. (l1)	34919.0000	1.4817	101410.0000 **	2.7390
Regional employment	0.2676 ***	5.0653	-0.2294 **	-3.1990
Share hightech employment	-0.1484	-1.1345	-0.2846	-1.5230
Share agricultural employment	-274.0300 ***	-4.4100	171.3700 .	1.7248
Year dummies	YES		YES	
N	429		429	
T	19		19	
R2	0.9868		0.9564	
rho	0.2300		0.9200	

Interaction effects: Third Party Funding from Industry

Dependent Variable	GDP p.c. Estimate	t-value	Unemployment rate Estimate	t-value
University characteristics				
Graduates p.c. (l1)	115.8000 ***	5.2192	-9.8559	-0.5004
Investment p.c. (l1)	0.4322	0.3810	-5.6498 ***	-5.6559
TPF p.c. (l1)	0.3271	0.1081	-3.9698	-1.4772
Students p.c. (l1)	6.8491	1.2288	26.4000 ***	5.3593
Staff p.c. (l1)	37.7010 .	1.7956	66.7900 ***	3.5996
Publications p.c. (l1)	150.7200 ***	2.6841	-2.7211	-0.0548
TPF industry p.c. (l1)	0.3154 ***	3.2886	0.0266	0.3145
Graduates p.c. (l1)#TPF industry p.c. (l1)	-0.3883	-0.1127	0.3878	0.1280
Investment p.c. (l1)#TPF industry p.c. (l1)	-0.1150	-0.7036	0.2708 *	1.8885
TPF p.c. (l1)#TPF industry p.c. (l1)	-0.3510	-1.2570	0.1875	0.7642
Students p.c. (l1)#TPF industry p.c. (l1)	0.8944	1.1993	0.8317	1.2719
Staff p.c. (l1)#TPF industry p.c. (l1)	-3.0189	-1.1075	-4.9440 **	-2.0700
Publications p.c. (l1)#TPF industry p.c. (l1)	6.6088	0.5640	-5.1762	-0.5040
Regional controls				
Net migration	64.2520 **	2.2419	-63.7040 **	-2.4939
Regional employment	0.0368 ***	7.8209	-0.0121 ***	-2.8472
Share hightech employment	0.0210	0.6470	-0.0870 ***	-3.0324
Share agricultural employment	-12.6160	-1.5952	18.4120 ***	2.6352
Spatial lags				
Graduates p.c. (l1)	-1.1142	-0.0029	-1138.5000 **	-2.3939
Investment p.c. (l1)	-22.6960	-0.8786	41.8780	1.5522
Tfp p.c. (l1)	191.9100 ***	4.3170	-201.0500 ***	-3.8181
Students p.c. (l1)	-66.0660	-0.7350	-68.4240	-0.6776
Staff p.c. (l1)	222.8800	0.8708	1977.2000 ***	7.4218
Publications p.c. (l1)	-785.0300	-1.4647	3131.5000 ***	4.3526
TPF industry p.c. (l1)	2.4437	1.5021	0.0663	0.0421
Net migration	-196.2300	-0.8644	-1112.6000 ***	-3.8899
Regional employment	0.2004 ***	3.6488	-0.2350 ***	-3.1685
Share hightech employment	-0.0684	-0.5220	-0.1400	-0.7564
Share agricultural employment	-197.3200 ***	-3.0294	9.6621	0.0979
Graduates p.c. (l1)#TPF industry p.c. (l1)	-0.5610	-0.0025	486.0800 **	2.1093
Investment p.c. (l1)#TPF industry p.c. (l1)	0.5981	0.0338	-36.8430 **	-2.0344
Tfp p.c. (l1)#TPF industry p.c. (l1)	-87.3610 ***	-3.7247	73.9510 ***	3.2603
Students p.c. (l1)#TPF industry p.c. (l1)	9.4454	0.1447	-86.9160	-1.3015
Staff p.c. (l1)#TPF industry p.c. (l1)	132.7900	0.5916	-1155.3000 ***	-5.2707
Publications p.c. (l1)#TPF industry p.c. (l1)	1092.8000 ***	3.5683	950.1600 **	2.7163
Year dummies	YES		YES	
N	429		429	
T	19		19	
R2	0.9867		0.9563	
rho	0.21		0.9076	

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Results –
DE differentiated by technology intensity (max/min)

$$DE_{stud} = \left(\beta_{stud} + \beta_{patstud} \overline{pat} \right) \overline{stud} \quad DE_{stud} = \left(\beta_{stud} + \beta_{patstud} \min(pat) \right) \overline{stud} \quad DE_{stud} = \left(\beta_{stud} + \beta_{patstud} \max(pat) \right) \overline{stud}$$

	GDP p.c.			Unemployment rate		
	DE (mean)	DE (min)	DE (max)	DE (mean)	DE (min)	DE (max)
Graduates p.c. (l1)	395.70	510.61	-3470.60			
Investment p.c. (l1)				-0.09	-0.12	0.89
TPF p.c. (l1)						
Students p.c. (l1)	128.99	0.62	4448.25	0.63	0.63	0.63
Staff p.c. (l1)	59.45	0.29	2050.00	0.20	0.22	-0.52
Publications p.c. (l1)	333.83	291.97	1742.21			
Total	**917.97**	**803.49**	**4769.86**	**0.73**	**0.72**	**1.00**

➔ no similar effect for third party funds from industry

Hypotheses

- *Hypothesis 1:* ✔
  Key HEI outputs will display a positive effect on regional value creation

- *Hypothesis 2:* ✔
  Key HEI outputs will display a positive effect on employment in the long-run, but none or a negative one in the short-run

- *Hypothesis 3:* ✔
  A large part of HEIs' positive effects on value creation and employment spill over

- *Hypothesis 4: (✔)*
  The socio-economic environment matters

  - *high technology-orientation of the local industry* ✔

  - *where local HEIs generate higher shares of their income from private firms* ✘

Summary

- Overall substantial economic effects of universities
in particular for GDP and unemployment in the long-run

- Distribution of marginal effects is broadly in line with what the existing literature
says about types and relevance of effects and channels

- if we multiply GDP per capita effect by population (rough estimate):
directly or indirectly, universities contribute to about 25% of the value creation in Germany

- The majority of the effects spills over between regions

➔ Strong argument for (sustained) government support for higher education

but:

- Effects of higher education institutions are much less localized than sometimes argued.
Effects of local investment will spill over to surrounding regions.

- Effects are likely to take longer periods to manifest themselves .
Higher education investments are long-term strategy rather than short-term remedy.

- No 'blind' justification for green field investments to support regional development
Paper shows marginal effects in running system,
following new establishments other, additional factors may play a role.

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Thank you!

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