The Contribution of Intangible Assets to Sectoral Productivity Growth in the EU*

Thomas Niebel[1] **Mary O'Mahony**[2] **Marianne Saam**[3]
[1]Centre for European Economic Research (ZEW Mannheim), [2]King's College London, [3]Ruhr-University Bochum (RUB)

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Motivation

- Growth in aggregate productivity has been quite unevenly distributed across the advanced economies
- Research focus was on the effect of differences in ICT investment and in multifactor productivity
- Investment in intangibles might explain cross-country differences in labor productivity growth

- This paper:
  - First attempt to quantify the importance of intangible assets, at the sector level for European countries
  - Comparison of the econometrically determined output elasticity of intangibles with the results obtained in growth accounting

Related Research

- Basic framework developed by Corrado, Hulten and Sichel (Corrado et al., 2005, 2009)

- Around that time research at sectoral level for individual or small number of countries:
  - Goodridge et al. (2012): manufacturing, financial and business services are the industries with the highest ratio of intangible investment to value added
  - Chun et al. (2012): share of intangible investment higher in many industries in Japan than in Korea, but higher in some Korean service industries
  - Other country-specific studies at sectoral level: Baldwin et al. (2012), Fukao et al. (2009)

Related Research

- Corrado et al. (2013): Main conclusions (based on the first release of the INTAN-Invest database (Corrado et al. 2012):
  - "Future investment will look much more intangible than tangible"
  - Intangible investment is important for growth. In the US, intangible capital deepening even exceeds tangible capital deepening
- Corrado et al. (2017): Main conclusions (again based on INTAN-Invest database)
  - ICT capital and intangible capital are complementary
  - There is evidence of productivity spillovers from increases in intangible capital
- Thum-Thysen et al. (2017) $->$ Session 2 today.

Figure: Short History on Intangibles Data

- Initial release for total business sector
  - June 2012
  - Years 1995-2009
- Update for total business sector
  - May 2013
  - Years 1995-2010
- Initial release industry-level data
  - **8 industries according to NACE 2**
  - August 2014
  - Years 1995-2010
- Update for industry-level data
  - 21 industries according to NACE 2
  - September 2017
  - Years 1995-2013(2014)
  - SNA 2008

INDICSER

- Split up of INTAN-Invest total business sector data:
  - February 2013
  - **11 industries according to NACE1**
  - Years 1995-2007
  - SNA 1993
  - Linked to EUKLEMS 2009
- Only minor part of total INDICSER project

Description of Data

Figure: Industry and Country Coverage

Industry code	Description	Country code	Country
A–B	Agriculture, hunting, forestry and fishing	AUT	Austria
C	Mining and quarrying	CZE	Czech Republic
D	Total manufacturing	DNK	Denmark
E	Electricity, gas and water supply	ESP	Spain
F	Construction	FIN	Finland
G	Wholesale and retail trade	FRA	France
H	Hotels and restaurants	GER	Germany
I	Transport and storage and communications	ITA	Italy
J	Financial intermediation	NLD	Netherlands
K71–74	Renting of machinery and equipment and other business activities	U.K.	United Kingdom
O	Other community, social and personal services		

- **Years:** 1995 - 2007
- **Sources:** EU KLEMS, INTAN-INVEST, WIOD, EU LFS, OECD BERD and ANBERD

Figure: List of Assets

Acronym	Description	Depreciation rate
INT	**New intangibles**	
R&D	Scientific research and development	0.150
FSHK	Firm-specific human capital	0.400
NFP	New product development costs in the financial industry	0.200
Arch	New architectural and engineering designs	0.200
MKTR	Market research	0.550
ADV	Advertising expenditure	0.550
OKo	Own-account development of organizational structures	0.400
OKp	Purchased organizational structures	0.400
ICT	**ICT assets**	
IT	Computing equipment	0.315
CT	Communications equipment	0.115
Soft	Software	0.315
NonICT	**Non-ICT assets**	
TraEq	Transport equipment	0.092–0.229
OMach	Other machinery and equipment	0.094–0.149
OCon	Total non-residential investment	0.023–0.051
RStruc	Residential structures	0.011
Other	Other assets	0.094–0.149

Notes: Depreciation rates for new intangible assets are taken from Corrado *et al*. (2012, p. 25). "New" intangibles are those not yet included in national accounts. ICT and Non-ICT assets are those covered by national accounts data in the EU KLEMS database.

Construction of Sectoral Data

Sectoral shares of intangible assets are determined as follows:

- FSHK and OKo: survey data on occupations, earnings and training (mainly EU LFS)
- R&D: OECD BERD/ANBERD database
- Investments for each of the intangible assets assumed to be purely purchased (Arch, MKTR, ADV and OKp) are based on WIOD use tables:

$$I_{k,j,t} = I_{k,BS,t} * \text{use share of industry } j \text{ in CPA K74}$$

Investments are in general deflated with an index based on the deflator for value added from the EU KLEMS database. Training capital uses an earnings deflator (O'Mahony 2012.)

Adjustments to National Accounts Data

- Intangibles increase sectoral value added (VA):
  - Gross output ⇑ for own-account assets
  - Intermediate input ⇓ for purchased assets
- VA deflator, nominal rate of return and user-costs need to be adjusted

Figure: Summary Statistics: Share of Industry j in Total Intangible Investment - Mean of Years 1995-2007

Industry	AUT	CZE	DNK	ESP	FIN	FRA	GER	ITA	NLD	U.K.
A–B	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
D	0.39	0.30	0.34	0.39	0.61	0.34	0.57	0.35	0.32	0.23
E	0.01	0.02	0.01	0.03	0.02	0.02	0.02	0.01	0.02	0.01
F	0.05	0.08	0.10	0.07	0.03	0.05	0.03	0.05	0.04	0.05
G	0.16	0.16	0.18	0.12	0.08	0.13	0.09	0.21	0.14	0.14
H	0.02	0.03	0.01	0.03	0.01	0.01	0.01	0.02	0.02	0.03
I	0.05	0.05	0.06	0.08	0.06	0.06	0.03	0.07	0.09	0.09
J	0.09	0.09	0.07	0.11	0.06	0.10	0.10	0.07	0.09	0.15
K71–74	0.17	0.22	0.16	0.12	0.09	0.25	0.13	0.16	0.22	0.22
O	0.04	0.04	0.05	0.04	0.03	0.03	0.02	0.04	0.04	0.06
BS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: EU KLEMS Release 2009, INTAN-Invest, and INDICSER—own calculations.

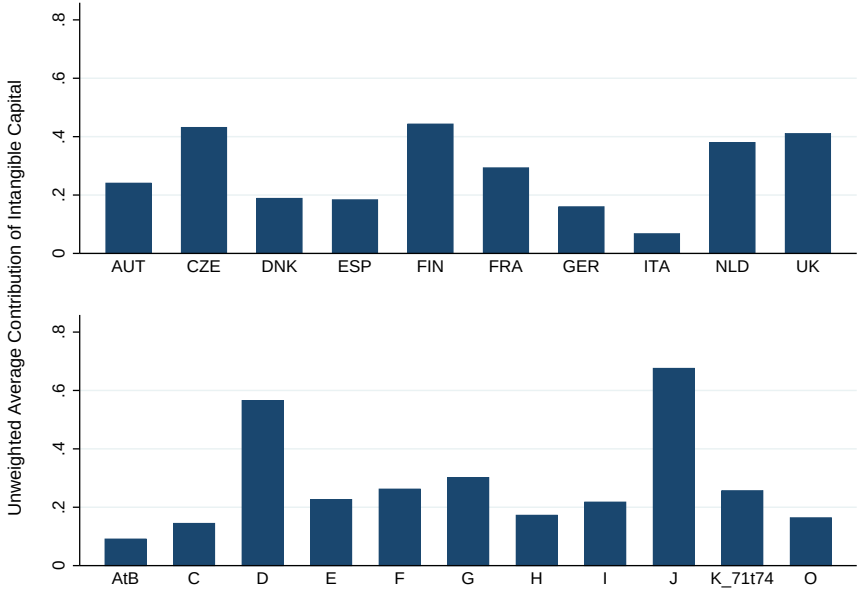
Growth Accounting

$$\Delta \ln y_j = \bar{v}_j^L \Delta \ln l_j^L + \bar{v}_j^{ICT} \Delta \ln k_j^{ICT} + \bar{v}_j^{NICT} \Delta \ln k_j^{NICT} + \bar{v}_j^{\mathbf{INT}} \Delta \ln k_j^{\mathbf{INT}} + \Delta \ln MFP_j$$

- $\Delta \ln y_j$: Growth rate of adjusted value added per hour
- $\bar{v}_j^{INT}$: Factor share of intangible capital in total factor compensation
- $\Delta \ln k_j^{INT}$: Growth rate of intangible capital services per hour

Factor share *x* growth rate of intangible capital services per hour worked = contribution of intangibles to labor productivity growth

Figure: Average Contribution of Intangible Capital to Labor Productivity Growth - Unweighted Averages



Econometric Analysis

Taking logs and first differences we obtain the following equation in growth rates:

$$\Delta \ln VA_{c,j,t} = \mu_t + \mu_{c,j} + \beta^{ict} \Delta \ln Kict_{c,j,t} + \beta^{nict} \Delta \ln Knict_{c,j,t} + \beta^{int} \Delta \ln Kint_{c,j,t} + \beta^{H} \Delta \ln H_{c,j,t} + \epsilon_{c,j,t} \quad (1)$$

Four econometric specifications:

- Pooled OLS regression (POLS) as baseline specification
- Least squares dummy variable specification (LSDV)
- Fixed-effects (FE) panel regressions with each country-industry combination as panel identifiers
- System-GMM dynamic panel regression (SGMM), as an attempt to control for endogeneity

Figure: Production Function Estimation, Full Sample - Dependent Variable: Growth Rate of Value Added

	With intangibles				Without intangibles			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	POLS	LSDV	FE	SGMM	POLS	LSDV	FE	SGMM
Δln (ICT Cap. Serv.)	0.052***	0.058***	0.054***	0.056***	0.060***	0.063***	0.060***	0.052**
	(0.015)	(0.016)	(0.016)	(0.021)	(0.017)	(0.016)	(0.017)	(0.021)
Δln (N.ICT Cap. Serv.)	0.089**	0.087**	0.085**	−0.042	0.105**	0.088**	0.090**	0.001
	(0.045)	(0.037)	(0.042)	(0.093)	(0.048)	(0.036)	(0.042)	(0.092)
Δln (Intan. Cap. Serv.)	0.137***	0.099***	0.120***	0.174***				
	(0.035)	(0.032)	(0.032)	(0.052)				
Δln (Labor Services)	0.317***	0.363***	0.309***	0.538***	0.359***	0.388***	0.334***	0.656***
	(0.045)	(0.060)	(0.057)	(0.115)	(0.051)	(0.062)	(0.060)	(0.119)
L.Δln (Value Added)				−0.048				−0.048
				(0.076)				(0.074)
Constant	0.007**	0.007	0.008***	0.008**	0.010***	0.010	0.011***	0.012***
	(0.003)	(0.006)	(0.002)	(0.003)	(0.003)	(0.006)	(0.002)	(0.004)
N	1,320	1,320	1,320	1,210	1,320	1,320	1,320	1,210
Adjusted R^2	0.216	0.289	0.119		0.173	0.256	0.087	
CRS	0.000	0.000	0.000	0.016	0.000	0.000	0.000	0.033

Notes: Clustered standard errors by country-industry combination in parentheses, $^{*}\ p < 0.10, **\ p < 0.05, ***p < 0.01$.

Conclusion

- Contribution of intangible assets to labor productivity growth tends to be higher in manufacturing than in services
- This is associated with the high share of intangible investment in R&D in manufacturing and might also be somehow driven by the relatively low depreciation rate of R&D (compared to other intangibles)
- Services are responsible for the high overall contribution of intangible assets observed in the UK
- Econometric results find output elasticity of intangibles exceeding factor share, though difference is not as strong as in previous research using country-level data on intangibles

Thanks for your attention!

niebel@zew.de

Digital Economy Research Department at the Centre for European Economic Research (ZEW) in Mannheim, Germany

Appendix

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