Spillovers, intangibles and productivity

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Innovation, intangibles and the productivity puzzle

- Arguments that growth of new ideas has slowed and greater effort needed to develop innovations (Cowen 2011)
- Is it growth in the productivity frontier that is slowing, or knowledge diffusion? (OECD, Andrews et al. 2015)
- Or have opportunities not diminished, but are more complex and require a more diverse set of competences to realize?
- Factors often seen as supply and demand related, but it is more useful to view as internal and external factors (Redek et al. 2019)

Objective

- Examine the role of spillovers and diffusion of intangibles for productivity
  - Productivity gaps – closing of productivity gaps provides indication of diffusion, catching up
  - Industry level spillovers from intangibles investments (knowledge and competition effects)
  - Intangibles worker mobility (within and outside industry)
- Explorative approach looking at three different types of measures of spillovers and diffusion

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Research questions

- *How do industry intangibles inflows affect total factor productivity growth?*
- *How does inter-firm mobility affect total factor productivity growth?*
- *Is there convergence or divergence in total factor productivity growth rates across firms?*

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Data and method

- $\Delta tfp_{it} = \beta_0 + \beta_1 \Delta rnd_{it} + \beta_2 \Delta oc_{it} + \beta_3 \Delta ict_{it} + X_{it} + \varepsilon_{it}$
  - TFP estimated using OP approach
  - TFP growth model estimated with random effects
- Industry spillovers measured from GLOBALINTO Input-Output database (include both separately and interacted with own intangibles)
- Inflows and outflows of intangibles due to inter-firm mobility (within and between industry inflows)
- Gap between own tfp and tfp 95th percentile for industry.
- Sample: Danish firms with 10+ employees, 2000-2016, manufacturing and main service industries

Table 5.3: Total factor productivity and the productivity gap

Note: tfp estimated using OP estimation method. Tfp95 is tfp at 95th percentile of tfp for each NACE2 industry.

Year	tfp		tfp95	Productivity gap	
	Mean	Std.err.	Mean	Mean	Std.err.
2000	-0.041	0.554	0.642	0.683	0.401
2001	-0.046	0.536	0.662	0.709	0.411
2002	-0.042	0.505	0.651	0.693	0.407
2003	-0.012	0.519	0.657	0.669	0.403
2004	0.006	0.520	0.697	0.691	0.433
2005	-0.038	0.510	0.661	0.699	0.414
2006	-0.089	0.500	0.605	0.694	0.443
2007	-0.139	0.526	0.568	0.708	0.460
2008	-0.145	0.508	0.614	0.758	0.506
2009	-0.084	0.492	0.638	0.722	0.455
2010	-0.029	0.474	0.685	0.713	0.423
2011	-0.037	0.480	0.691	0.728	0.460
2012	-0.057	0.463	0.664	0.722	0.455
2013	-0.055	0.448	0.625	0.681	0.434
2014	-0.038	0.437	0.662	0.701	0.424
2015	-0.040	0.434	0.663	0.703	0.462
2016	-0.048	0.447	0.659	0.707	0.439

Productivity gap

Table 6.1: TFP estimation, productivity gap

	(1)	(2)	(3)	(4)	(5)
dln(OC assets)	0.019***	0.022***	0.022***	0.022***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
dln(R&D assets)	0.014***	0.014***	0.014***	0.014***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
dln(ICT assets)	0.005**	0.009***	0.009***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Productivity gap$_{t-1}$		0.220***	-0.120***	0.234***	-0.118***
		(0.003)	(0.011)	(0.009)	(0.014)
*d(*Productivity gap$_{t-1}$*)*		0.027***	0.029***	0.026***	0.028***
		(0.003)	(0.003)	(0.003)	(0.003)
Productivity gap$_{t-1}$ 25			0.384***		0.378***
			(0.01)		(0.01)
Productivity gap$_{t-1}$ 50			0.227***		0.222***
			(0.01)		(0.01)
Productivity gap$_{t-1}$ 75			0.161***		0.158***
			(0.01)		(0.01)
Productivity gap $_{t-1}$ (2003-2007)				0.005	0.018
				(0.01)	(0.01)
Productivity gap $_{t-1}$ (2008-2010)				0.029**	0.047***
				(0.01)	(0.01)
Productivity gap $_{t-1}$ (2011-2016)				-0.066***	-0.037***
				(0.01)	(0.01)
Constant	-0.013*	-0.119***	-0.081***	-0.095***	-0.062***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of obs.	126,398	111,869	111,869	111,869	111,869
R-squared within	0.01	0.099	0.131	0.101	0.132
R-squared between	0.007	0.016	0.024	0.018	0.026
R-squared overall	0.01	0.063	0.083	0.065	0.084
sigma$_e$	0.401	0.373	0.366	0.373	0.366
sigma$_u$	0.157	0.141	0.144	0.137	0.14
rho	0.132	0.125	0.134	0.118	0.128

Table note: Productivity gap 25/50/75 is productivity gap for firms with tfp in lowest/second/third quartile within their industry.
Estimates are obtained by a random effects model. Standard errors are reported in the parenthesis.
Significance level are indicated by ***p<0.01, **p<0.05, *p<0.1.

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Mobility

Table 6.2: TPF estimation, mobility

	(1)	(2)	(3)	(4)	(5)	(6)
*dln(*OC assets*)*	0.016***	0.016***	0.016***	0.019***	0.019***	0.020***
	(0.001)	(0.001)	(0.001)	(0.001)	-0.001)	(0.001)
*dln(*R&D assets*)*	0.011***	0.011***	0.011***	0.011***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	-0.001)	(0.001)
*dln(*ICT assets*)*	0.002	0.002	0.002	0.006**	0.006**	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
*ln(*inflow costs*)*	0.007***			0.009***		
	(0.001)			(0.001)		
*ln(*outflow costs$_{t-1}$*)*	-0.008***	-0.008***	-0.008***	-0.007***	-0.007***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
*ln(*inflow cost w/i*)*		0.005***			0.006***	
		(0.001)			(0.001)	
*ln(*inflow cost b/i*)*		0.005***			0.007***	
		(0.001)			(0.001)	
*ln(*inflow cost ICT*)*			0.003**			0.002*
			(0.001)			(0.001)
*ln(*inflow cost R&D*)*			0.006***			0.009***
			(0.001)			(0.001)
*ln(*inflow cost OC*)*			0.002*			0.002
			(0.001)			(0.001)
Productivity gap$_{t-1}$				0.221***	0.221***	0.221***
				(0.003)	(0.003)	(0.003)
*d(P*roductivity gap$_{t-1}$*)*				0.026***	0.027***	0.027***
				(0.003)	(0.003)	(0.003)
Constant	-0.012*	-0.011*	-0.01	-0.125***	-0.124***	-0.122***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of obs.	126,398	126,398	126,398	111,869	111,869	111,869
R-squared within	0.011	0.011	0.011	0.101	0.101	0.101
R-squared between	0.009	0.009	0.009	0.017	0.017	0.017
R-squared overall	0.011	0.011	0.011	0.064	0.064	0.064
sigma$_e$	0.401	0.401	0.401	0.373	0.373	0.373
sigma$_u$	0.156	0.156	0.156	0.141	0.141	0.141
rho	0.132	0.132	0.132	0.125	0.125	0.125

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Industry spillovers

	(1)	(2)	(3)	(4)
d*ln*(OC assets)	0.019***	0.016***	0.022***	0.018***
	(0.001)	(0.001)	(0.001)	(0.002)
d*ln*(R&D assets)	0.014***	0.007***	0.014***	0.007***
	(0.001)	(0.001)	(0.001)	(0.002)
d*ln*(ICT assets)	0.004**	0.002	0.009***	0.007**
	(0.002)	(0.002)	(0.002)	(0.002)
dln(OC industry inflow$_{t-1}$)	0.015***	0.018***	0.008	0.015*
	(0.003)	(0.003)	(0.005)	(0.007)
dln(ICT industry inflow$_{t-1}$)	-0.008*	-0.011**	-0.005	-0.026**
	(0.004)	(0.004)	(0.005)	(0.008)
dln(*R&D* industry inflow$_{t-1}$)	-0.011***	-0.017***	-0.005	-0.007
	(0.002)	(0.003)	(0.003)	(0.004)
d*ln*(OC assets) x d*ln*(OC industry inflow$_{t-1}$)		0.018***		0.012***
		(0.003)		(0.004)
d*ln*(*ICT* assets) x d*ln*(*ICT* industry inflow$_{t-1}$)		-0.002		-0.012***
		(0.003)		(0.004)
d*ln*(*R&D* assets) x d*ln*(*R&D* industry inflow$_{t-1}$)		0.002		0.002
		(0.003)		(0.003)
Productivity gap$_{t-1}$			0.220***	0.233***
			(0.003)	(0.003)
d(*P*roductivity gap$_{t-1}$)			0.027***	0.031***
			(0.003)	(0.003)
Constant	0.022**	0.009	-0.102***	-0.090***
	(0.007)	(0.005)	(0.011)	(0.005)
Number of obs.	126398	108897	111869	95350
R-squared within	0.01	0.009	0.01	0,083
R-squared between	0.007	0.008	0.016	0.026
R-squared overall	0.01	0.009	0.063	0.076
sigma$_e$	0.278	0.265	0.259	0.244
sigma$_u$	0.109	0.090	0.098	0.086
rho	0.092	0.071	0.087	0.076

Conclusions

- catch up increasing in the distance to the productivity frontier, potentially indicating that firms with lower productivity can gain more from diffusion of new knowledge.
- effects lowest in the years after the financial crisis, suggesting that there has been divergence in productivity, or slowdown in diffusion
- positive effects through worker inflows for knowledge intensive employees, however no difference in mobility within and outside industry.
  - R&D mobility inflows appear to be more important than the two other types
- Results concerning industry inflows of intangibles mixed
  - Most clear is the positive effect of organizational spillovers on firm productivity.