Sources of country-sector productivity growth: Total factor productivity and intangible capital in the EU15 and the US

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Outline

- New country-industry (market and nonmarket) productivity database (SPINTAN and INTAN-Invest)
- It makes possible to develop new analysis on intangibles along multiple dimensions:
  - Theoretical and empirical investigation of the transmission mechanisms through which intangible capital affects **total economy** productivity growth. We analyze this issue looking at both the direct and indirect channels through which intangibles foster productivity growth across countries and between/within industries.
  - Investigate intangible investment dynamics over the business cycle.

Aim

- Sources of growth analysis for the total economy with a complete accounting for intangible capital inputs:
  market and nonmarket productivity performances.

- Intangible investment over the business cycle:
  did the crisis affect the reallocation process of productive inputs across industries?

Data

- Database with multiple dimensions: **country, industry, institutional sector, time**
- Tangible and intangible assets (NA, INTAN Invest and SPINTAN)
- 20 industries (A-U Nace Rev 2), 1995-2013, so far 12 countries:
  - US
  - Big Northern Europe: DE, FR, UK
  - Scandinavian: DK FI, SE
  - Small Europe: AT, CZ, NL
  - Mediterranean: ES, IT

Knowledge based capital in the total economy

Market Sector		Nonmarket Sector	
Computerized Information		Information, Scientific, and Cultural Assets	
1	Software	1	Software
2	Databases	2	Open data
Innovative Property			
3	R&D, broadly defined to include all NPD costs	3	R&D, basic and applied science
4	Entertainment & artistic originals	4	Cultural and heritage, including arch. & eng. design
5	Design		
6	Mineral exploration	5	Mineral exploration
Economic Competencies		Societal Competencies	
7	Brands	6	Brands
8	Organizational capital	7	Organizational capital
	(a) Manager capital		(a) Professional and manager capital
	(b) Purchased organizational services		(b) Purchased organizational services
9	Firm-specific human capital (employer-provided training)	8	Function-specific human capital (employer-provided training)

NOTE—NPD=New Product Development, including testing and spending for new financial products and other services development not included in software or conventional science-based R&D.

Source: Corrado, Haskel, Jona-Lasinio (2014), SPINTAN Working Paper N.1

The scope of intangible assets used by the public sector: industries of interest

Table 1: **SPINTAN Industries of Interest**

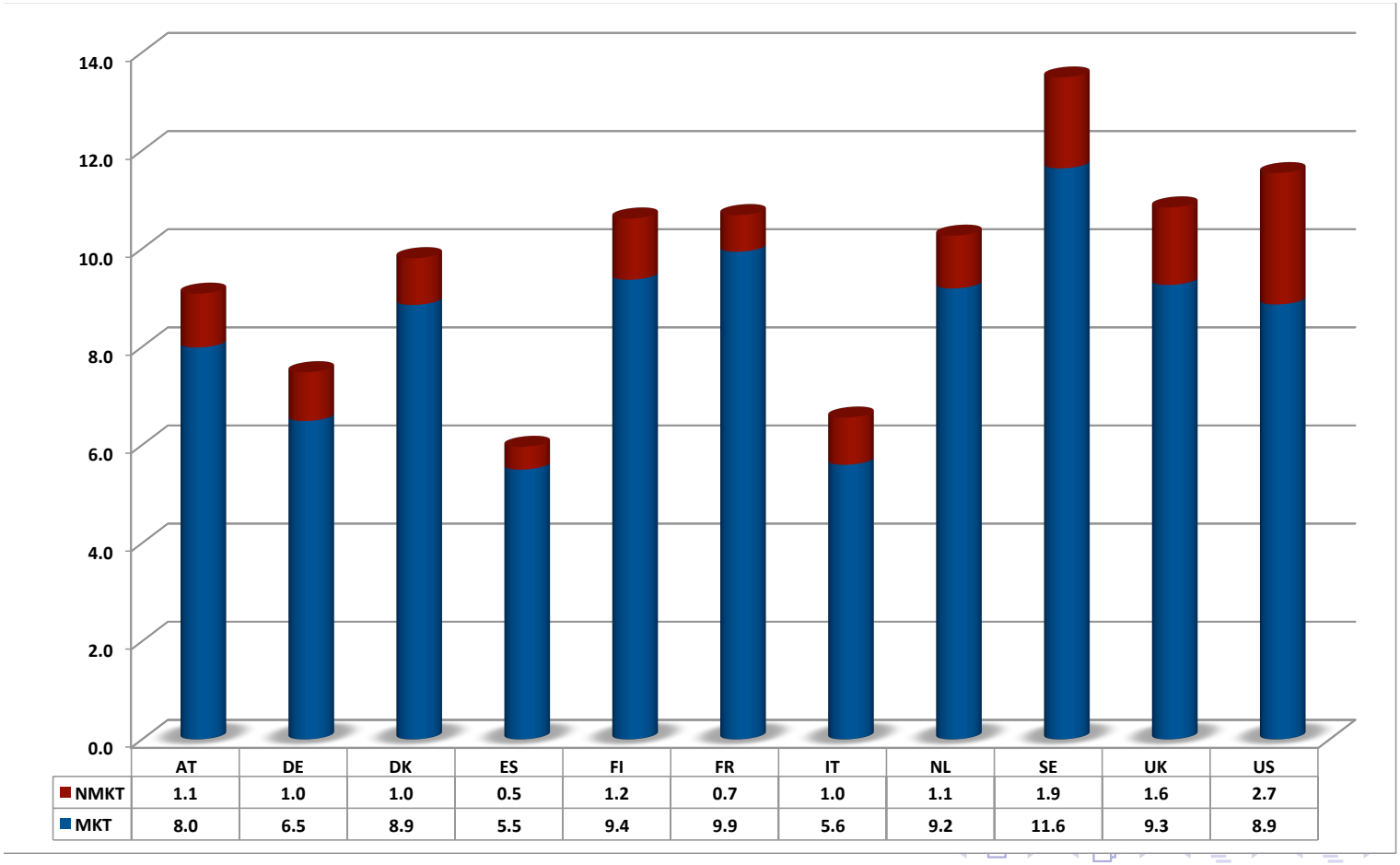
NACE SECTION	INDUSTRY TITLE	NACE NUMBER
MB	Scientific research and development	72
O	Public administration and defence; compulsory social security	84
P	Education	85
QA	Human health activities	86
QB	Residential care and social work activities	87-88
R	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities	90-91
	Gambling and betting activities; sports activities and amusement and recreation activities	92-93

NOTE—NACE Rev. 2.

Besides Public administration and defence, other industries in the table contain a mix of **market** and **nonmarket** producers.

Private and public intangibles: adjusted value added shares (2013)

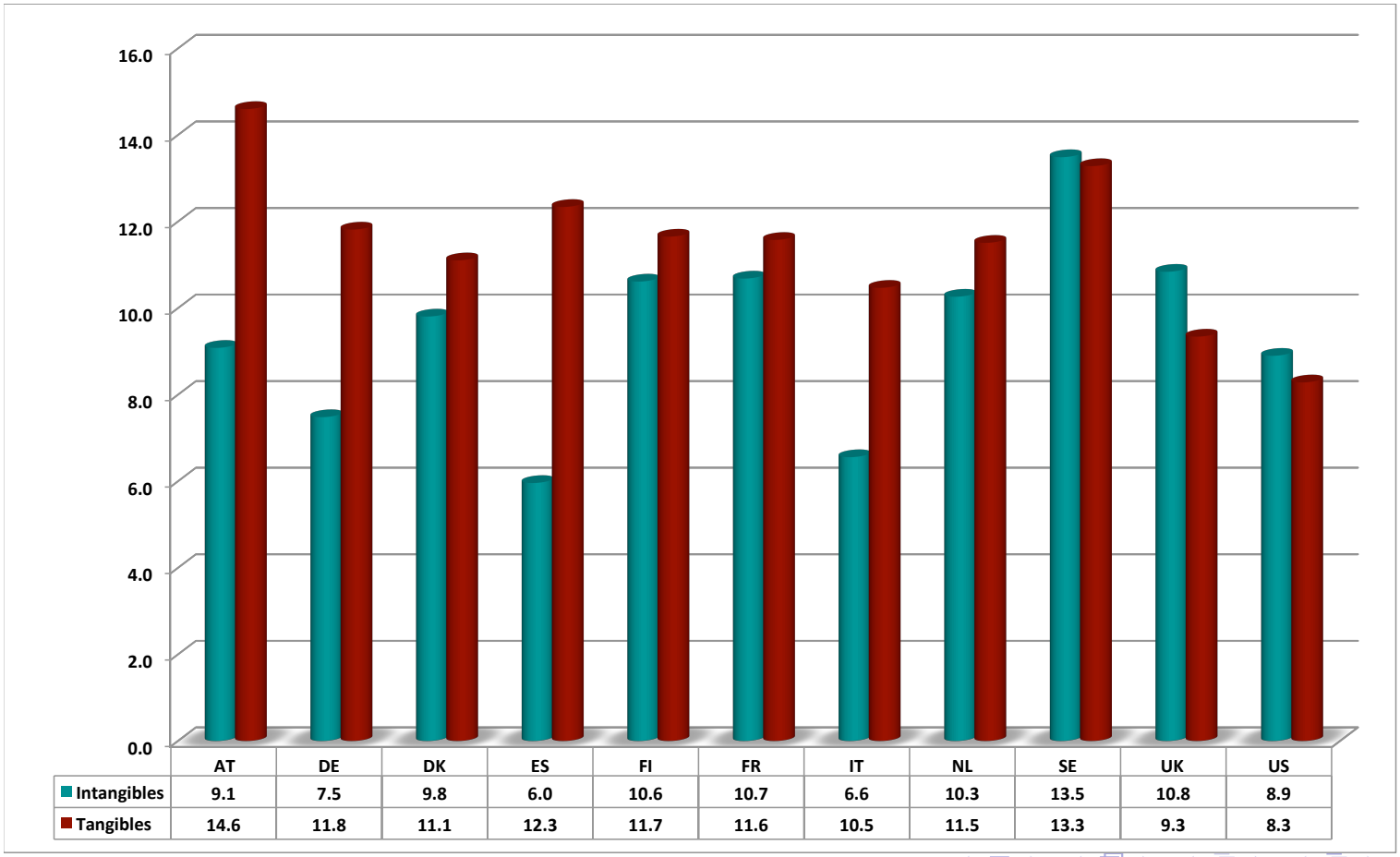
Overall (market and nonmarket) intangible investments account for 14% to 6% of value added with private and public sectors accounting on average for 8% and 1.5% respectively.



	AT	DE	DK	ES	FI	FR	IT	NL	SE	UK	US
NMKT	1.1	1.0	1.0	0.5	1.2	0.7	1.0	1.1	1.9	1.6	2.7
MKT	8.0	6.5	8.9	5.5	9.4	9.9	5.6	9.2	11.6	9.3	8.9

Tangible and intangible investment: adjusted value added shares (2013)

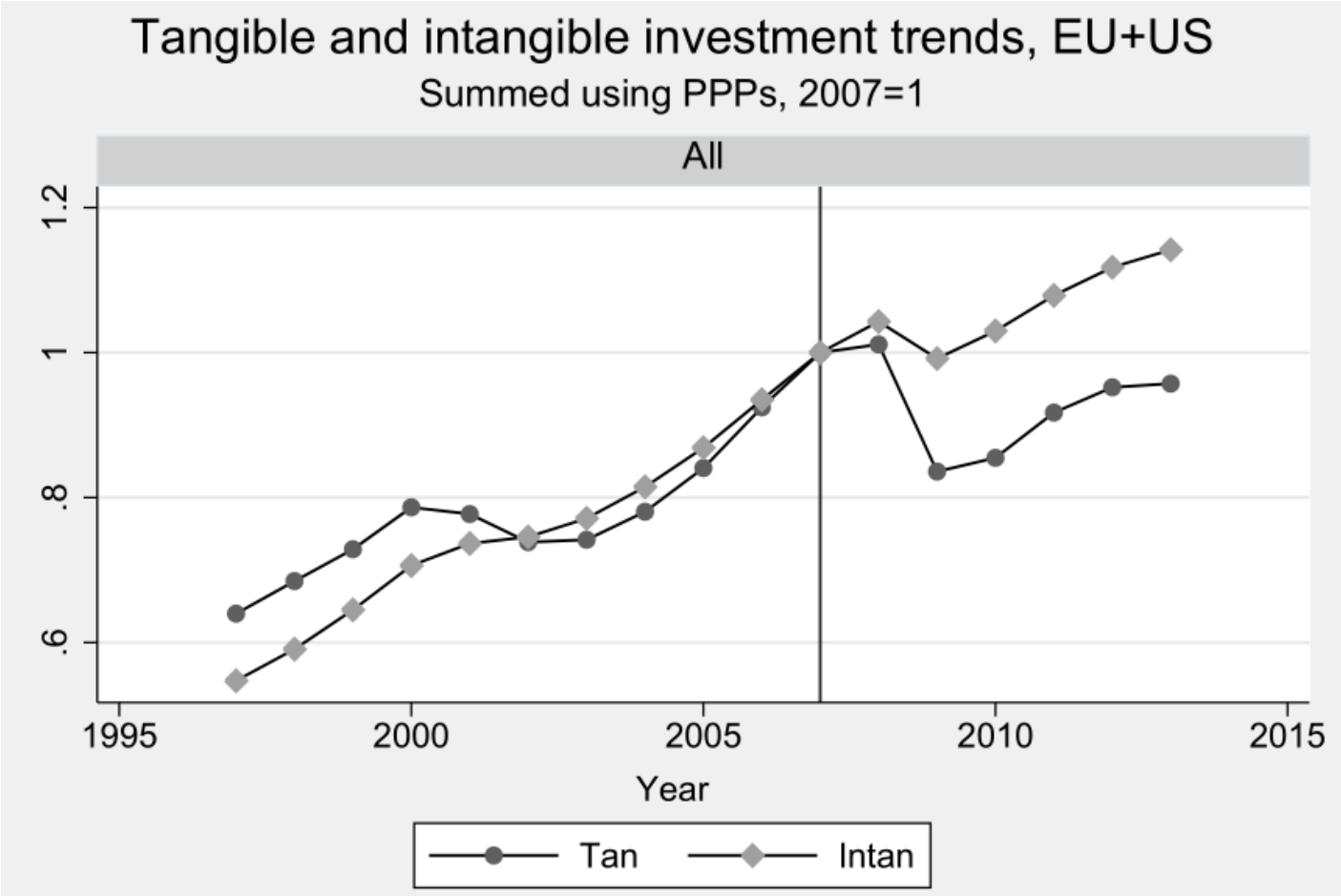
In most advanced economies intangibles account for a larger value added share than tangibles, the opposite holds for the less advanced. The differences in intangible intensity across countries mirror the industrial structure of economies .



	AT	DE	DK	ES	FI	FR	IT	NL	SE	UK	US
Intangibles	9.1	7.5	9.8	6.0	10.6	10.7	6.6	10.3	13.5	10.8	8.9
Tangibles	14.6	11.8	11.1	12.3	11.7	11.6	10.5	11.5	13.3	9.3	8.3

Tangible and intangible investment over the business cycle: EU+US

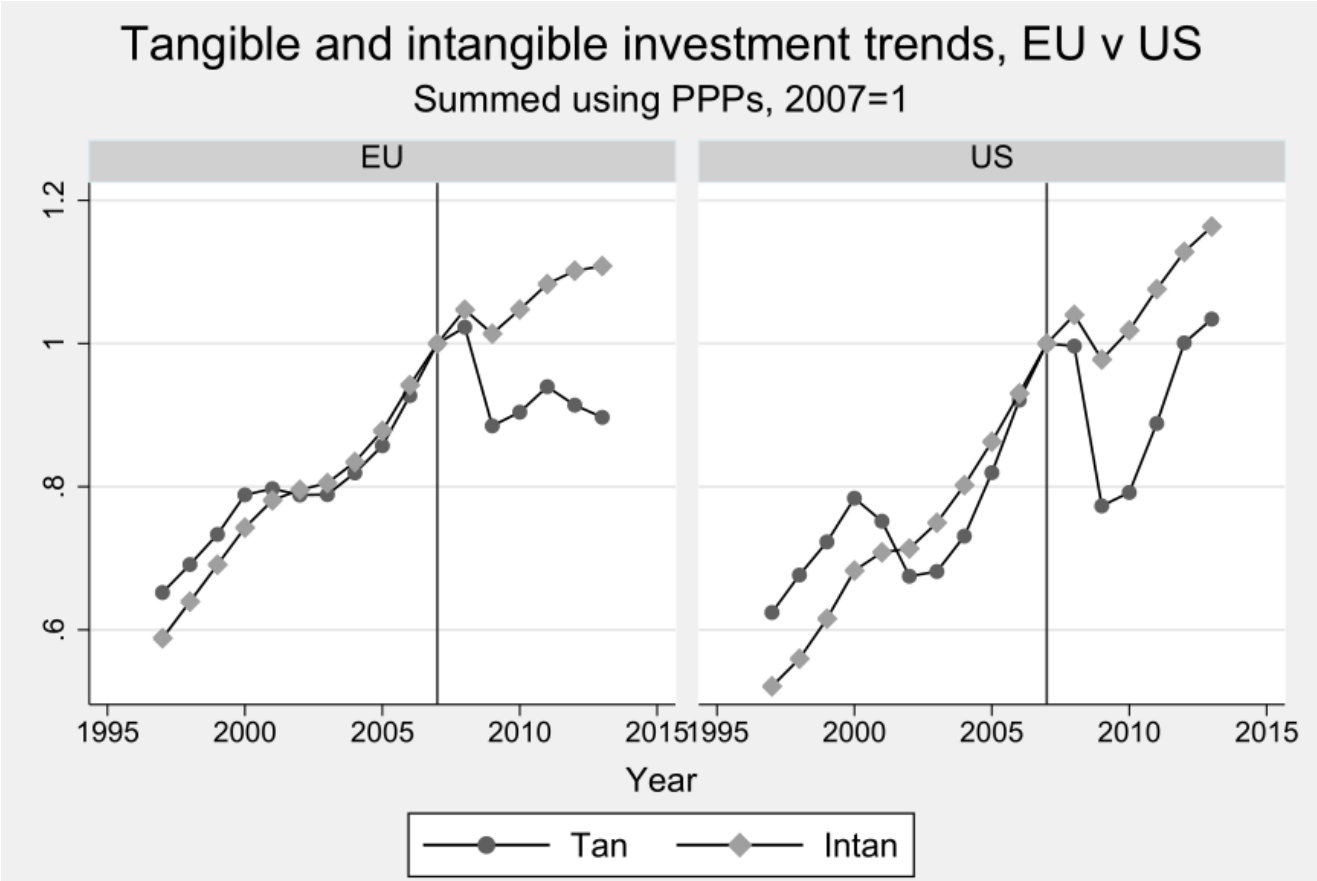
After the crisis, tangible investment experienced a prolonged slowdown while intangible investment a small downturn and go back quickly to pre-crisis levels.



Tangible and intangible investment over the business cycle: EU vs US

The speed of recovery varied between EU and US.:

- Intangibles were relatively resilient during the crisis.
- Intangibles recovered faster in the US and tangibles lagged behind in the EU.



$$\Delta lnQ^{(a)}_{c,i,t} = s^{L(a)}_{c,i,m,t}\Delta lnL_{c,i,m,t} + s^{K(a)}_{c,i,m,t}\Delta lnK_{c,i,m,t} + s^{R(a)}_{c,i,m,t}\Delta lnR_{c,i,m,t} + \Delta lnA_{c,i,m,t}$$

where:

- c=country, i=industry, m=market-nonmarket sector, t=time
- $s = (P_x X / P_q Q)$ shares consistent with capitalized assets
- L is labor input, K is tangible capital and R is intangible capital
- TFP is a residual

Capital inputs: asset prices

$$P^{R(a)}_{c,i,m,t} = P^{N(a)}_{c,i,m,t}(r_{c,i,m,t} - \pi^{R(a)}_{c,i,m,t} + \delta^{R(a)})$$

$$P^{K(a)}_{c,i,m,t} = P^{I(a)}_{c,i,m,t}(r_{c,i,m,t} - \pi^{K(a)}_{c,i,m,t} + \delta^{K(a)})$$

where:

- $P^{N(a)}$ and $P^{I(a)}$are asset deflators (country specific)
  - Exception is ICT equipment deflated with harmonised to US NA accounts (Scheyrer and Colecchia, 2000).
  - When asset deflators are no available we use country-specific GDP deflators
  - Invariant across industries
- δ Depreciation rates for tangibles are gathered from EUKLEMS and from Corrado et al (2009) for intangibles. They are country-industry-time invariant.
- r is an ex post industry specific rate. As for non-market returns we adopt r=social rate of time preferences (Corrado and Jaeger, 2015, SPINTAN WP).

Capital inputs: asset accumulation

$$R^{(a)}_{c,i,m,t} = \frac{(P^{N(a)*}_{c,i,m,t} N^{(a)}_{c,i,m,t})}{P^{N(a)}_{c,i,m,t}} + (1 - \delta^{R(a)}) R^{(a)}_{c,i,m,t-1}$$

$$K^{(a)}_{c,i,m,t} = \frac{(P^{I(a)*}_{c,i,m,t} I^{(a)}_{c,i,m,t})}{P^{I(a)}_{c,i,m,t}} + (1 - \delta^{K(a)}) K^{(a)}_{c,i,m,t-1}$$

- The main issue is the identification of starting capital stock values since investment time series are rather short both for tangibles and intangibles.

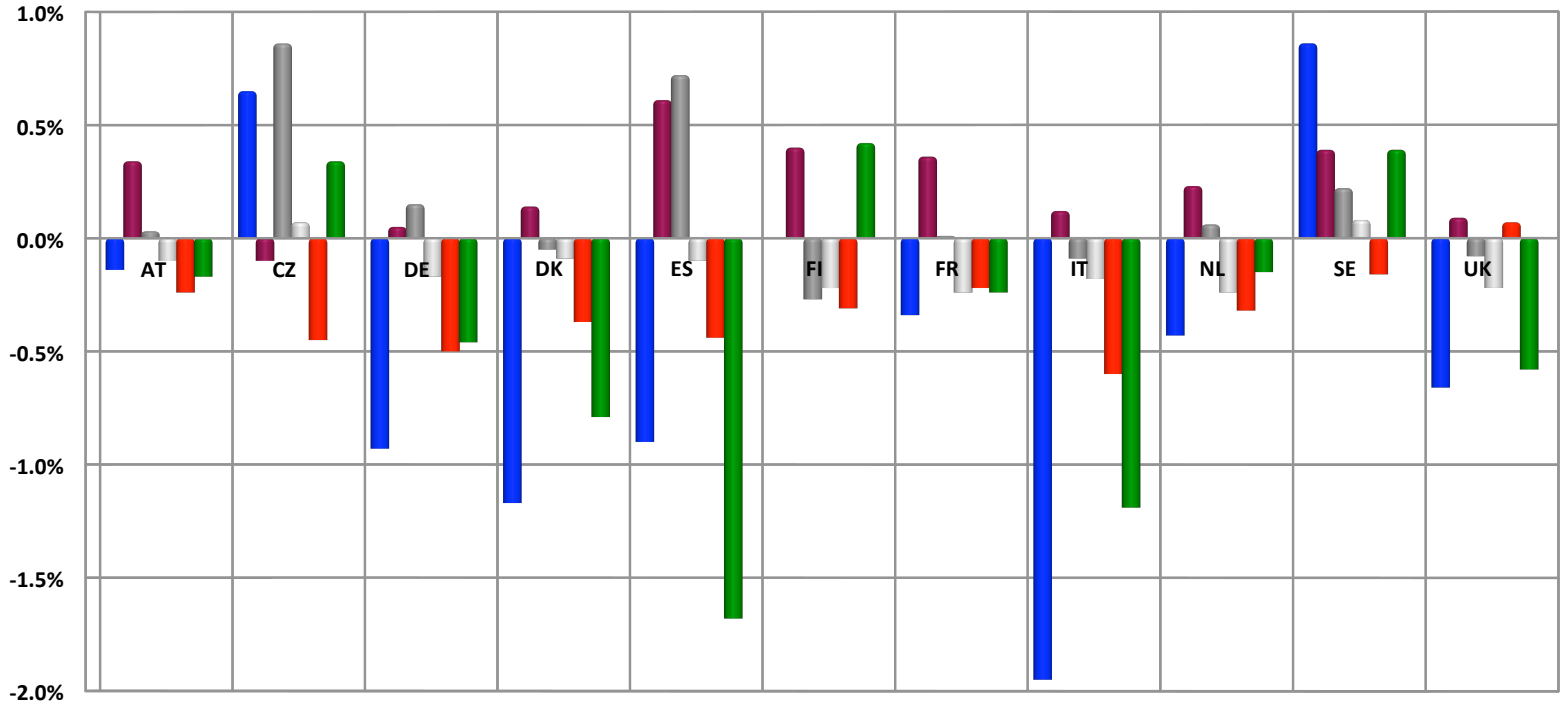
Sources of growth (1999-2013): Non-farm business sector (i.e. excluding Agri, Ed, Health)

In FI, UK and US intangible capital provided relatively higher growth contribution than tangible capital.

Country	DlnQ	ConDlnL	ConDlnK NonICT	ConDlnK ICT	ConDlnK intan	DlnTFP
AT	2.2%	0.3%	0.4%	0.3%	0.5%	0.7%
CZ	2.9%	-0.2%	1.2%	0.4%	0.3%	1.2%
DE	1.4%	0.0%	0.5%	0.2%	0.3%	0.4%
DK	1.1%	0.1%	0.3%	0.3%	0.4%	0.1%
ES	1.4%	0.5%	1.1%	0.3%	0.3%	-0.8%
FI	2.3%	0.3%	0.1%	0.1%	0.4%	1.3%
FR	2.0%	0.3%	0.4%	0.1%	0.5%	0.7%
IT	0.3%	0.1%	0.3%	0.2%	0.2%	-0.3%
NL	1.9%	0.2%	0.4%	0.1%	0.4%	0.7%
SE	3.2%	0.3%	0.6%	0.4%	0.6%	1.3%
UK	1.6%	0.0%	0.3%	0.1%	0.8%	0.3%
US	2.3%	-0.1%	0.4%	0.4%	0.8%	0.9%

Sources of growth (1999-2013): deviations from the US

All countries but UK show smaller growth contributions of intangible capital than the US, even if at a different pace.



	AT	CZ	DE	DK	ES	FI	FR	IT	NL	SE	UK
DlnQ	-0.1%	0.7%	-0.9%	-1.2%	-0.9%	0.0%	-0.3%	-2.0%	-0.4%	0.9%	-0.7%
ConDlnL	0.3%	-0.1%	0.1%	0.1%	0.6%	0.4%	0.4%	0.1%	0.2%	0.4%	0.1%
ConDlnK NonICT	0.0%	0.9%	0.2%	-0.1%	0.7%	-0.3%	0.0%	-0.1%	0.1%	0.2%	-0.1%
ConDlnK ICT	-0.1%	0.1%	-0.2%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	0.1%	-0.2%
ConDlnK intan	-0.2%	-0.5%	-0.5%	-0.4%	-0.4%	-0.3%	-0.2%	-0.6%	-0.3%	-0.2%	0.1%
DlnTFP	-0.2%	0.3%	-0.5%	-0.8%	-1.7%	0.4%	-0.2%	-1.2%	-0.2%	0.4%	-0.6%

Sources of growth (1999-2013): Public sector (i.e. Ed, Health)

Contribution of intangible capital more relevant than contribution of tangible capital both in UK and US.

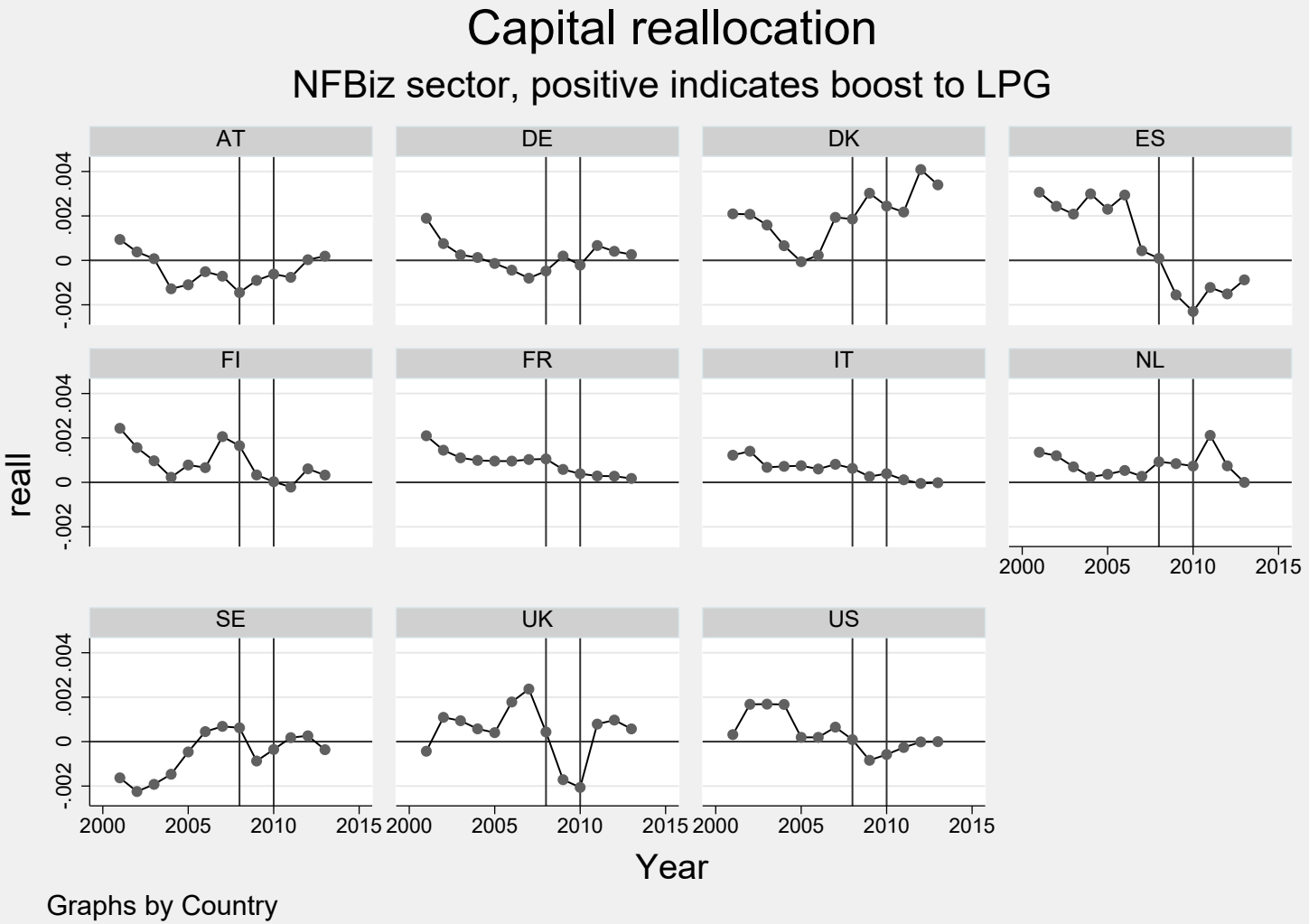
	DlnQ	ConDlnL	ConDlnK NonICT	ConDlnK ICT	ConDlnK intan	DlnTFP
AT	1.2%	0.6%	0.1%	0.3%	0.2%	0.1%
CZ	0.0%	-0.2%	0.7%	0.2%	0.1%	-1.9%
DE	1.1%	0.2%	0.4%	0.1%	0.2%	0.2%
DK	0.5%	0.5%	0.2%	0.1%	0.1%	-0.3%
ES	2.8%	1.5%	0.9%	0.3%	0.2%	-0.1%
FI	0.5%	0.7%	0.4%	0.1%	0.0%	-0.7%
FR	1.2%	0.2%	0.2%	0.0%	0.1%	0.6%
IT	0.2%	0.0%	0.3%	0.1%	0.1%	-0.3%
NL	1.8%	1.1%	0.2%	0.1%	0.2%	0.2%
SE	0.7%	0.6%	0.4%	0.2%	0.1%	-0.5%
UK	1.8%	1.2%	0.5%	0.0%	0.6%	-0.2%
US	1.6%	1.2%	0.1%	0.0%	0.6%	-0.3%

Capital reallocation

Jorgenson and Schreyer (2010):

- ""We follow Jorgenson et al. (2005, ch. 8), and compute **contribution terms** under the assumption of a single price for a particular type of input, independent of the industry in which it is used.
  - This is tantamount to a top-down computation without any industry-specific information.
  - The assumption of a single input price constitutes a benchmark, achievable under full mobility of factors in competitive factor markets.
- This benchmark can then be compared with input aggregates that allow for input-specific input prices, giving rise to a "reallocation" term.""

Capital reallocation



Conclusions

- Creation of a country-industry-sector database for productivity analysis that allows to account for the role of tangible and intangible capital in the total economy (private and public).
- Some findings:
  - Intangible and tangible investment show different sensitivity to the business cycle and across countries: by 2011, intangible growth paths in both EU and US had returned to pre-crisis levels while tangible growth rates recovered more slowly in the US . In the EU tangible gross fixed capital formation is still below pre-crisis levels.
  - In most advanced economies intangible capital provides large contribution both in the market and nonmarket sectors. It is a key variable for the recovery.
  - Reallocation terms indicate differing effects of financial crisis: positive reallocation suggests the presence of industries where capital grew relatively faster than the aggregate economy.