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Intangible Assets and Spanish Economic Growth

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Introduction

- This paper focus on the **role of accumulation of capital as a source of economic growth in the Spanish economy**.
- We distinguish the effect of **different types of capital**:
  - Tangible non-ICT capital
  - ICT capital
  - Public (tangible) capital (infrastructures)
  - Intangible capital (public and private)
- The aim is to:
  - 1) look for the **direct effect of capital on economic growth**
  - 2) look for **complementarities** particularly in the case of intangibles and ICTs.
- We adopt a **cross-industry econometric approach** using a database that comprise **20 market sectors of the Spanish economy**.
- Although data is available from 1995 to 2011 **we primarily focus on the pre-crisis period (1995-2007)**
  - The crisis has implied a break in the growth pattern and in the pace of capital accumulation.

Introduction

- We seek preliminary evidence of the following broad hypothesis:
  - **Is intangible capital** relevant to explain differences in productivity across industries?
  - **Do all intangible assets have the same effect on economic growth**?
  - Are **intangible assets complementary to ICT assets**?
- Although **public intangible** and public capital data are aggregated for the whole economy, we explore **different channels** for their influence on each industry.
- This document is a work in progress. Some **results are very preliminary**.

Background

- **Capital deepening** is recognized as a source of **economic growth**.
- Since the mid-90s the literature has shown **the positive role of ICT** assets in explaining economic growth (Oliner and Sichel, 1994, Jorgenson and Stiroh, 1995; and many others since then). See the extensive survey by Biagi (2013).
- There are also studies that focus on **the indirect (spillover) effects of ICTs**. The evidence is not conclusive:
  - Some papers **do not find evidence of spillovers** (Stiroh, 1998; Inklaar et al, 2008; Acharya and Basu 2010, for example).
  - In other cases, **weak evidence is found** (O'Mahony and Vecchi, 2005).
- Firm level data has also shown that **the relationship between ICT capital and growth is complex**:
  - It requires that the economy, industries and firms change their structures - human capital, management, business models, and so on- to reap the benefits of this new disruptive types of capital (Bresnahan, Brynjolfsson, Hitt, 2001; Brynjolfsson, Hit 1995 and 2000).

Background

- Recently, the attention has also shift to **the role of intangible assets**. Corrado, Hulten and Sichel (2005, 2009).
- CHS framework has been applied to develop **different databases of intangible assets**:
  - Comparative perspective: Innodrive, Coinvest, INTAN-Invest, KBC (OECD), TCB & SPINTAN.
  - Individual countries:
    - Australia: Barnes & McClure (2009) and Barnes (2010)
    - Canada: Baldwin, Gu & Mcdonald (2011)
    - Finland: Julava, Aulin-Ahmavaara & Alanen (2007)
    - Japan: Fukao et al. (2009)
    - Netherlands: van Rooijen-Horsten, van den Bergen & Tanriseven (2008)
    - Sweden: Edquist (2011)
    - UK: Marrano, Haskel & Wallis (2009)
    - Spain: Mas & Quesada (2013)
    - China: Hulten & Hao (2012)
    - India: Hulten, Hao & Jaeger (2012)
    - Brazil: World Bank (Dutz 2012)

Background

- The study of **intangibles and economic growth** have focused in:
  - **The direct impact of intangibles**. This approach follows the seminal paper of Griliches (1979) in which R&D are treated as an additional production factor.
    - Intangible assets account ¼ of growth in the US and in UK, and a lower percentage in the EU and in Japan.
  - **Complementarities**: test whether intangibles and other types of capital reinforce their effects, particularly with ICTs.
    - To reap the most from intangibles, they have to be combined with ICT assets.
  - **Spillovers**: test the existence of externalities of intangibles that goes **beyond the direct use of intangibles in the production function**.

Corrado, Hulten and Sichel (2009), Marrano, Haskel and Wallis (2009), Fukao, Miyagawa, Mukai, Shinoda and Tonogi (2009), Van Ark, Hao, Corrado and Hulten (2009); Corrado, Haskel, Jona-Lasinio and Iommi (2013), Corrado, Haskel and Jona Lasinio (2014), Venturini (2015).

Background

- The last piece of our puzzle is **public capital**.
  - Aschauer (1989) adopted the production function approach in which public capital is included as an additional factor of production.
  - It is also argued that economies of scale exist due to **network externalities** (World Bank (1994)).
  - Barro (1990) points that public capital will have a positive effect on growth if the **expected increase in private investment returns exceed the cost of the associated increased fiscal costs**.
  - Aschauer, Bom y Ligthart (2014) and Bom y Ligthart (2014) survey the recent literature dealing with the effect of public capital on growth based on the production function framework, **finding large variation in the results**.
  - Furthermore, despite the fact that public capital generally has a positive effect on growth, **results with negative contributions are relatively frequent**.

Data and methodological approach

- We will follow an **econometric production function approach**.
- The analysis is carried out for the **market non-farm sector of the Spanish economy at industry level**.
- To this end, we need data on value added, employment, (private and public) tangible capital and (private and public) intangible capital.
- We use **several datasets** to tests the hypothesis:
  - **Capital services of tangible non-residential capital (Pubic and private)**. FBBVA-Ivie. 1995-2013
    - ICT capital (K^{ICT})
      - $K^{software}$
      - $K^{communications}$
      - $K^{hardware}$
    - **Non-ICT capital ($K^{non\text{-}ICT}$)**: motor vehicles, other transport material, metal products, machinery and mechanical equipment, other machinery and equipment nec
    - **Public capital: Infrastructures**: (roads, water infrastructure, railways, airports, ports, urban infrastructures and other non-residential infrastructures)
      - Public capital is not available at industry level.

Data and methodological approach

- **Intangible assets**: Mas and Quesada (2014). 1995-2011
  - 24 market sectors of the economy
  - The database follows the **CHS taxonomy**. Similar methodology than **INTAN-Invest**
    - **Only departs from INTAN-Invest** methodology to make data compatible with the statistics of the Spanish tangible capital, and because of the different data sources.
  - We use the following assets:
    - **Total intangible capital**: total CHS intangibles except for Software, and mineral exploration already included in the tangible capital
    - **R&D**
    - **Training**
    - **Organizational structure**
- **Public Intangibles: SPINTAN project**. 1995-2011.
  - Aggregate data of intangibles in the non-market sector: Public sector + Health + Education.

Data and methodological approach

- In the case **of public tangible and intangible capital there is no information at industry level** but at the economy wide level.
- Hence, **we need to test different channels by which these variables affect economic growth at industry level**.
- We explore **the following hypothesis**:
  - **Public infrastructures** will affect each industry depending on the **share of Transport tangible capital on total capital**.
  - **Public intangible capital** may affect industry performance depending on:
    - **Industry's human capital** (% share of tertiary education employees).
    - **Industry's ICT use**.

Data and methodological approach

- **Value added *(Y and Y*)***: EU KLEMS. 1995-2011.
  - Standard NA industry VA is used.
  - An **additional VA indicator** is also considered **for accounting for intangibles**.
  - Each industry value added is extended (Y^*) to account for **capital compensation of intangible assets**:
    - **Total economy intangible investment** (the increase in value added associated to intangibles) for each year **is broken down by industries**
    - To this end, the **capital compensation of intangible assets** (aggregated capital services) by industry is used.
    - To calculate the intangible capital compensation, it is necessary to calculate the **capital intangibles user costs** (depreciation rates similar to INTAN-Invest; 4% of rate of return) and, **its prices** (GVA deflator, as in INTAN-Invest) and **the intangible capital** (PIM).
- **Employment *(L)***: Total hours worked. EU KLEMS. 1995-2011.

Data and methodological approach

Industrial classification and correspondence with CNAE 2009/NACE Rev. 2. Ivie's estimation

	code
AGRICULTURE, FORESTRY AND FISHING	A
MINING AND QUARRYING	B
ELECTRICITY, GAS AND WATER SUPPLY	D-E
Food products, beverages and tobacco	10-12
Textiles, wearing apparel, leather and related prodcuts	13-15
Wood and paper products; printing and reproduction of recorded media	16-18
Coke and refined petroleum products	19
Chemicals and chemical products	20-21
Rubber and plastics products, and other non-metallic mineral products	22-23
Basic metals and fabricated metal products, except machinery and equipment	24-25
Electrical and optical equipment	26-27
Machinery and equipment n.e.c.	28
Transport equipment	29-30
Other manufacturing; repair and installation of machinery and equipment	31-33
CONSTRUCTION	F
WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	G
TRANSPORTATION AND STORAGE	H
ACCOMMODATION AND FOOD SERVICE ACTIVITIES	I
Publishing, audiovisual and broadcasting activities	58-60
Telecommunications	61
IT and other information services	62-63
FINANCIAL AND INSURANCE ACTIVITIES	K
PROFESSIONAL, SCIENTIFIC, TECHNICAL, ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	M-N
ARTS, ENTERTAINMENT, RECREATION AND OTHER SERVICE ACTIVITIES	R-S

We include all industries of the market non-farm economy. We also exclude mining and quarrying (B) and the financial and insurance sector (K)

Data and methodological approach

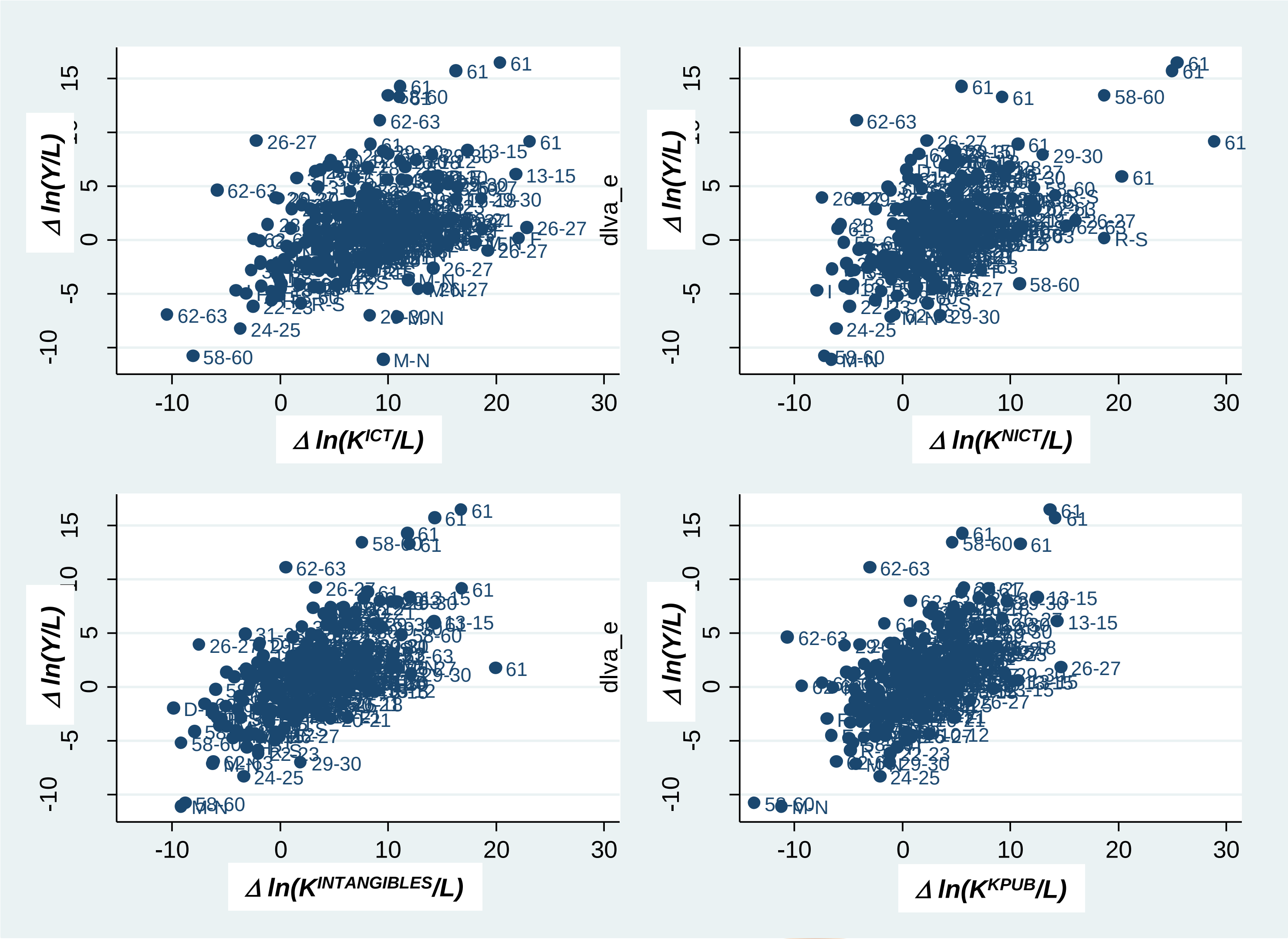
- We use a **production function framework** (Corrado, Haskel and Jona-Lasinio, 2014) to test the direct effect of each type of capital and to measure the complementarities among them.
  - We have implemented Pesaran (2007) **panel unit root tests** for the different variables and in different specifications (levels, logs and log-differences of absolute values and of per-hour-worked terms).
    - In general the **null of nonstationarity is rejected and no evidence of cointegration** (panel data cointegration test by Westerlund, 2007) is found among GVA and the dependent variables is found.
    - The null **that ICT and non-ICT capital are cointegrated cannot be rejected**.
    - However, **the log difference of per hour-worked variables with a trend is stationary for all the variables previously described**.
  - Therefore we estimate the following panel data production function:

$$\Delta \ln\left(Y_{it}^{*} / L_{it}\right) = \alpha\left(K_{it}^{TIC} / L_{it}\right) + \beta\left(K_{it}^{NTIC} / L_{it}\right) + \gamma\beta\left(K_{it}^{INTANGIBLE} / L_{it}\right) + \eta_i + u_{it}$$

    - **Fixed or random -Hausman test- panel data models are used**. Additionally, **instrumental variables** estimation is used to control for endogeneity. Instruments are the first and second difference of the productive factors.
    - We impose **constant returns to scale**.

Descriptives

- Correlations. 1995-2007



Descriptives

Average values across industries and dispersion (%)

	Mean		p25		p75	
	1996	2007	1996	2007	1996	2007
Δ ln (Y/L)	-1.42	2.42	-3.58	0.35	0.99	3.55
Δ ln (KTIC/L)	6.07	9.08	2.96	6.29	8.15	10.89
Δ ln (KNTIC/L)	0.05	4.41	-4.88	1.36	3.68	7.13
Δ ln (KINTANGIBLE/L)	-0.54	6.20	-2.82	4.45	1.83	7.66
Δ ln (KPUB/L)	-0.48	4.58	-2.76	2.66	2.19	6.03

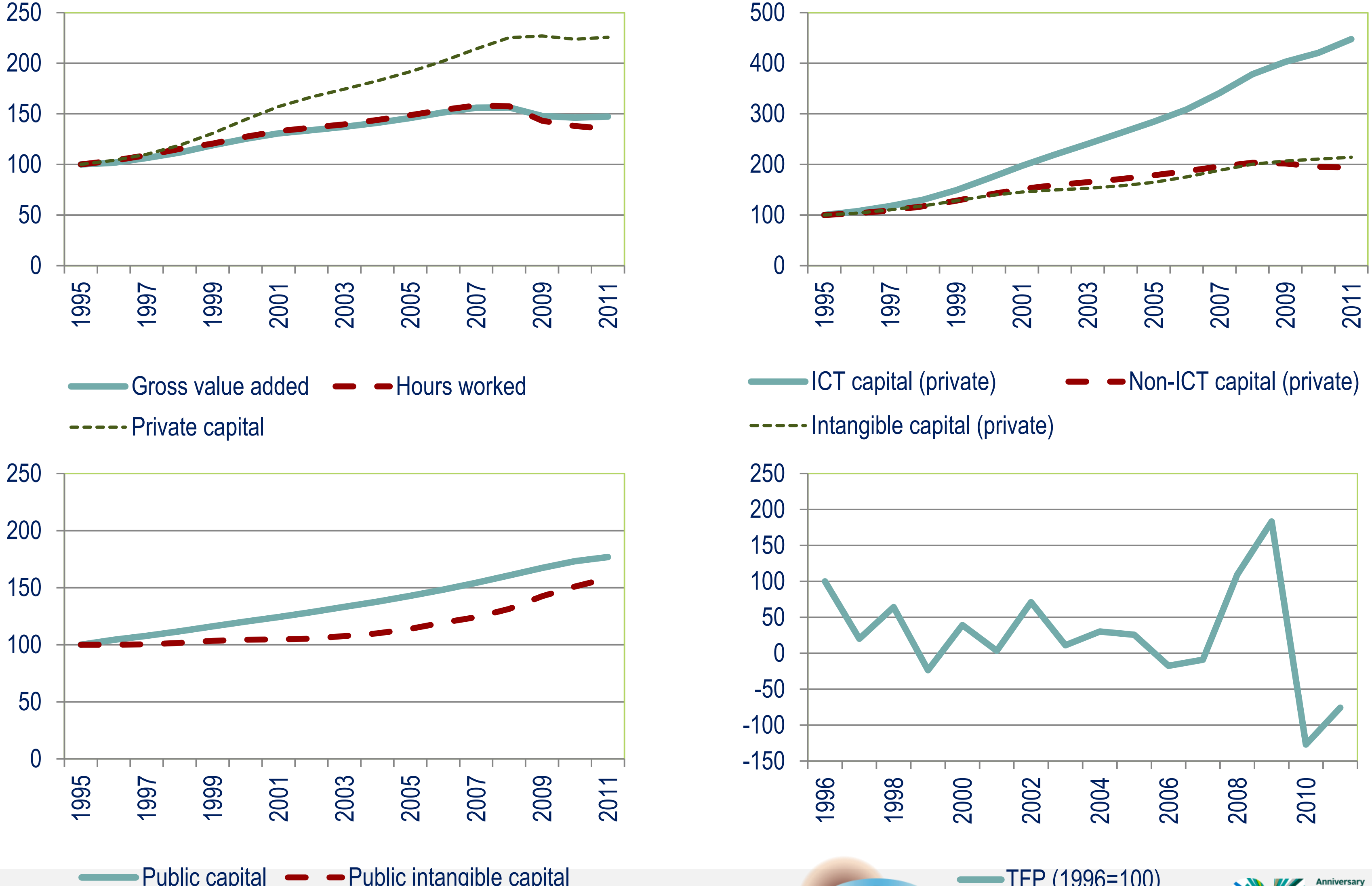
Correlations

	Δ ln (Y/L)	Δ ln (KTIC/L)	Δ ln (KNTIC/L)	Δ ln (KINTA/L)	Δ ln (KPUB/L)
Δ ln (Y/L)	1				
Δ ln (KTIC/L)	0.42 *	1.00			
Δ ln (KNTIC/L)	0.53 *	0.58 *	1.00		
Δ ln (KINTANGIBLE/L)	0.64 *	0.54 *	0.64 *	1.00	
Δ ln (KPUB/L)	0.60 *	0.52 *	0.54 *	0.71 *	1.00

* Significant at 5% level

Descriptives

Evolution of GVA, ICT, non-ICT tangible, intangible and public capital and TFP
(1995=100)



Results. Production function. Basline estimation

- We impose constant returns to scale, and use as a first approach total capital.
- Capital elasticity is higher than expected: 0.44 - 0.47

Dependent variable: Δ *ln* (Y / L)

	OLS (RE) (3)	IV (4)
Δ ln (K / L)	0.439***	0.474***
	(0.071)	(0.089)
Trend	0.002**	0.002***
	(0.001)	(0.001)
Constant	-0.018***	-0.026***
	(0.005)	(0.009)
Obs.	240	200
R2 for overall model	0.339	0.343

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Basline estimation

- **Is the distinction of capital between ICT and non-ICT relevant? Is the distinction of the different types of ICT capital relevant?**
  - Yes, it is relevant: coefs. of ICT and non-ICT capital are statistically significant. The elasticity is now below 0.4
  - Different types of ICT capital are not relevant: very close relationship among them.

Dependent variable: Δ *ln* (Y / L)

	OLS (RE) (1)	IV (2)	OLS (FE) (3)	IV (4)
Δ ln (K^{NonICT}/ L)	0.288 ***	0.161 *	0.271 ***	0.274 ***
	(0.078)	(0.089)	(0.083)	(0.101)
Δ ln (K^{ICT}/ L)	0.102	0.190 **		
	(0.092)	(0.076)		
Trend	0.002 *	0.002 **	0.002 *	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Δ ln ($K^{ICT: Hardware}$/ L)			0.018	-0.012
			(0.028)	(0.042)
Δ ln ($K^{ICT: Communic.}$/ L)			0.045	0.034
			(0.049)	(0.082)
Δ ln ($K^{ICT: Software}$/ L)			0.015	0.017
			(0.042)	(0.039)
Constant	-0.019 ***	-0.025 **	-0.021 **	-0.014
	(0.006)	(0.010)	(0.010)	(0.014)
Obs.	240	200	240	200
R2 for overall model	0.317	0.277	0.302	0.331

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Intangibles & ICT complementarities

- **Are private intangible assets relevant to explain economic growth?**
  - Yes, they are.
  - The coefficient of Intangibles reap all the significativity of the coefficients of the three types of capital.
- **Are private intangible capital and ICT capital complementary?**
  - No, they do not seem to be complementary. Just the opposite.
  - Why? Is it a matter of the types of intangibles?

Dependent variable: Δ *ln* (Y* / L)

	OLS (FE) (1)	IV (2)	OLS (FE) (3)	IV (4)
Δ ln (K^{NonICT}/ L)	0.089	0.015	0.097	0.067
	(0.080)	(0.087)	(0.081)	(0.088)
Δ ln (K^{ICT}/ L)	0.048	0.117 *	0.060	0.183 **
	(0.072)	(0.069)	(0.076)	(0.078)
Δ ln (K^{INT}/ L)	0.388 ***	0.319 ***	0.431 ***	0.438 ***
	(0.074)	(0.087)	(0.089)	(0.109)
Trend	0.001	0.001	0.001	0.001 **
	(0.001)	(0.001)	(0.001)	(0.001)
*Δ ln (K^{ICT}/ L) * Δ ln (K^{INT}/ L)*			-0.617	-1.871 **
			(0.597)	(0.929)
Constant	-0.011 **	-0.015	-0.011 **	-0.021 **
	(0.005)	(0.009)	(0.005)	(0.010)
Obs.	240	200	240	200
R2 for overall model	0.498	0.464	0.495	0.430

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Factor shares

Hours worked	0.60
ICT K	0.05
Non ICT capital	0.29
Intangibles	0.06

The net effect of intangibles is positive (at the average values and in the P25 and P75)

Results. Production function. Different types of intangibles

- **Are all private intangible assets equally relevant?**
  - No, they are not.
  - Coefficients of Training and organizational capital are statistically significant, whereas R&D is not.
    - R&D is the result of a complex process with uncertain results (Hall, Mairesse and Mohen, 2010)

Dependent variable: Δ *ln* (Y* / L)

	OLS (RE) (1)	IV (2)	OLS (RE) (3)	IV (4)	OLS (FE) (5)	IV (6)
Δ ln (K^{NonICT}/ L)	0.350 ***	0.346 ***	0.194 **	0.107	0.104	-0.006
	(0.061)	(0.086)	(0.086)	(0.092)	(0.074)	(0.086)
Δ ln (K^{ICT}/ L)	0.048	0.121	0.059	0.175 **	0.048	0.115 *
	(0.084)	(0.076)	(0.076)	(0.072)	(0.088)	(0.069)
Trend	0.002 **	0.003 ***	0.001 **	0.002 ***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δ ln ($K^{INT: R\&D}$/ L)	-0.013	0.007				
	(0.013)	(0.028)				
Δ ln ($K^{INT: Training}$/ L)			0.205 ***	0.162 **		
			(0.074)	(0.070)		
Δ ln ($K^{INT: Org.K}$/ L)					0.448 ***	0.380 ***
					(0.070)	(0.095)
Constant	-0.018 ***	-0.037 ***	-0.007	-0.019 *	-0.008 **	-0.009
	(0.006)	(0.009)	(0.007)	(0.010)	(0.004)	(0.009)
Obs.	228	190	240	200	240	200
R2 for overall model	0.379	0.402	0.350	0.312	0.512	0.487

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Different types of intangibles & ICT complementarities

- **Are all types of intangible capital equally relevant to explain growth?**
  - Again, training and organizational capital are, wheras R&D no evidence.

- **Are all types of capital really not complementary with ICTs?**
  - No evidence, except partially for R&D.

Dependent variable: $\Delta ln\ (Y^* / L)$

	OLS (RE) (1)	IV (2)	OLS (RE) (3)	IV (4)	OLS (FE) (5)	IV (6)
$\Delta\ ln\ (K^{NonICT} / L)$	0.346 ***	0.345 ***	0.194 **	0.133	0.106	0.014
	(0.060)	(0.086)	(0.083)	(0.093)	(0.076)	(0.088)
$\Delta\ ln\ (K^{ICT} / L)$	-0.006	0.106	0.056	0.173 **	0.051	0.142 *
	(0.093)	(0.096)	(0.074)	(0.072)	(0.090)	(0.080)
Trend	0.002 **	0.003 ***	0.001 **	0.002 ***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ ln\ (K^{R\&D}/L)$	-0.035	0.003				
	(0.021)	(0.034)				
$\Delta\ ln\ (K^{ICT} / L)\ \Delta\ ln\ (K^{INT:\ R\&D} / L)$	0.501 **	0.086				
	(0.252)	(0.395)				
$\Delta\ ln\ (K^{INT:\ Training}/L)$			0.217 **	0.226 **		
			(0.099)	(0.094)		
$\Delta\ ln\ (K^{ICT} / L)\ \Delta\ ln\ (K^{INT:\ Training} / L)$			-0.180	-0.995		
			(0.621)	(0.927)		
$\Delta\ ln\ (K^{INT:\ Org.K} / L)$					0.465 ***	0.453 ***
					(0.092)	(0.144)
$\Delta\ ln\ (K^{ICT} / L)\ \Delta\ ln\ (K^{INT:\ Training} / L)$					-0.240	-0.995
					(0.717)	(1.398)
Constant	-0.016 **	-0.035 ***	-0.007	-0.021 **	-0.008 **	-0.012
	(0.007)	(0.011)	(0.007)	(0.010)	(0.004)	(0.010)
Obs.	228	190	240	200	240	200
R2 for overall model	0.385	0.406	0.349	0.309	0.510	0.476

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses.

***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Public intangibles

- **What about public intangibles?**
  - Public intangibles are only available at the economy-wide aggregate. We interact them with the human capital of the industry (% of highly educated employees).
  - No evidence.

Dependent variable: Δ *ln* (Y* / L)

	OLS (FE) (1)	IV (2)	OLS (FE) (3)	IV (4)
Δ ln (K^{NonICT}/ L)	0.083	0.009	0.091	0.061
	(0.087)	(0.089)	(0.087)	(0.090)
Δ ln (K^{ICT}/ L)	0.044	0.115 *	0.055	0.181 **
	(0.066)	(0.069)	(0.070)	(0.078)
Δ ln (K^{INT}/ L)	0.397 ***	0.330 ***	0.440 ***	0.449 ***
	(0.082)	(0.094)	(0.094)	(0.114)
Trend	0.001	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
*Human Capital*Δ ln ($K^{INT\ PUBLIC}$/ L)*	-0.004	-0.002	-0.004	-0.002
	(0.009)	(0.007)	(0.009)	(0.007)
*Δ ln (K^{ICT}/ L) * Δ ln (K^{INT}/ L)*			-0.622	-1.877 **
			(0.604)	(0.931)
Constant	-0.012 **	-0.015 *	-0.012 **	-0.022 **
	(0.004)	(0.009)	(0.005)	(0.009)
Obs.	240	200	240	200
R2 for overall model	0.492	0.460	0.490	0.427

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Public intangibles & ICT complementarities

- **What about public intangibles? Are they complementary with industry ICT assets?**
  - No evidence.
- **We need to look for additional channels for measuring the contribution of public capital**.
  - Types of intangible public assets
  - Types of industries: education, health and public administration.

Dependent variable: Δ *ln* (Y* / L)

	OLS (FE) (1)	IV (2)	OLS (FE) (3)	IV (4)
Δ ln (K^{NonICT}/ L)	0.087	0.013	0.096	0.054
	(0.081)	(0.091)	(0.081)	(0.091)
Δ ln (K^{NonICT}/ L)	0.045	0.118 *	0.057	0.188 **
	(0.069)	(0.069)	(0.073)	(0.078)
Δ ln (K^{INT}/ L)	0.389 ***	0.328 ***	0.438 ***	0.467 ***
	(0.075)	(0.086)	(0.091)	(0.112)
Trend	0.001 *	0.001	0.001 *	0.002 **
	(0.001)	(0.001)	(0.001)	(0.001)
*Δ ln (K^{ICT}/ L) * Δ ln ($K^{INT\ PUBLIC}$/ L)*	0.000	0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
*Δ ln (K^{ICT}/ L) * Δ ln (K^{INT}/ L)*			-0.694	-1.995 **
			(0.627)	(0.968)
Constant	-0.012 **	-0.015 *	-0.012 **	-0.022 **
	(0.004)	(0.009)	(0.005)	(0.010)
Obs.	240	200	240	200
R2 for overall model	0.486	0.456	0.477	0.387

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Results. Production function. Public capital

- **What about public capital (infrastructures)?**
  - Mixed evidence –even negative- is found in the interaction of public capital with transport equipment in total capital (% $K^{transport}$).
  - Too many infrastructures in Spain?

Dependent variable: Δ *ln* (Y* / L)

	OLS (RE) (7)	IV (8)
$\Delta \ln (K^{NonICT} / L)$	0.111	0.016
	(0.072)	(0.087)
$\Delta \ln (K^{ICT} / L)$	0.033	0.114
	(0.067)	(0.070)
$\Delta \ln (K^{INT} / L)$	0.411 ***	0.320 ***
	(0.052)	(0.088)
Trend	0.001	0.001
	(0.001)	(0.001)
$\%K^{trasport} \Delta \ln (K^{public})$	-0.564 **	-0.312
	(0.226)	(1.415)
Constant	-0.008	-0.013
	(0.006)	(0.012)
Obs.	240	200
R2 for overall model	0.515	0.485

Note: Labour productivity has been calculated using extended GVA and employment corrected by the composition of human capital and hours worked. All variables in logarithmic differences and weighted by employed person. Specifications include sector fixed effects. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

Main findings

- In this paper we show **preliminary results** of the **role of different types of intangibles on economic growth**.
- Our approach:
  - **Seek to assess the contribution of the different types of capital assets**: tangible ICT, tangible non-ICT, intangibles (public and private) and public capital (infrastructures).
  - Based on **industry data** (20 market non-farm industries) for the period **1995-2007**.
- Our results suggest that:
  - **Intangible capital has a positive and significant role** in explaining industry differences in labour productivity.
  - We **do not find complementarities between the intensity of use of ICT assets and of intangible assets**.
  - **Different intangible assets have a different effect on labour productivity**: we do not find evidence on the effect of R&D, whereas organizational capital and training are relevant.
- We additionally consider **public capital** (**intangible** and **infrastructures**).
  - Given the nature of our data (industries) **we need to explicit the mechanism by which this aggregated capital influence industries**.
  - **We postulate that their influence will be channeled through human capital and ICT capital** (public intangible) and through the share of transport equipment within the industry (public capital).
  - However, no evidence is found that this are the channel for their influence.

Main findings

- To complement our results we need to progress in the analysis. **We are considering several directions**:
  - Look for **additional channels** by which public capital and intangibles affects growth.
  - Test the **existence of spillovers**.
  - Identify the precise effect of each type of capital.