Intangible Assets and Spanish Economic Growth

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INTRODUCTION

- This paper focus on the **role of capital accumulation of capital as a source of economic growth in the Spanish economy**.
- We distinguish the effect of **different types of capital**:
  - IT capital
  - Tangible non-IT 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.
  - 3) look for **spillovers** associated to private and public intangibles and of public capital.
- We adopt a **cross-industry econometric approach** using a database that comprise **24 market sectors of the Spanish economy**
- We focus on the period 1995 to 2014.

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 IT assets?**
  - Have **intangible public assets** affect **productivity in the market sector**?
  - What is the role of **public capital (infrastructures)** on growth?
  - Does intangible capital or public capital generate **spillovers** beyond their direct productive contribution?
- Although **public intangible** and **public capital** data are aggregated for the whole economy, we explore **different channels** for their influence on each industry

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 on:
  - **The direct impact of intangibles**. This approach follows the seminal paper of Griliches (1979) in which R&D istreated 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 scale economies exist due to **network externalities** (World Bank [1994])
  - Barro (1990) points that public capital will have a positive effect on growth only 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 a two steps procedure; 1) econometric production function approach**;** 2) Spillovers: analysis of the determinants of growth accounting TFP.
- The analysis is carried out for the **market sector of the Spanish economy both at the aggregated and at the industry level.**
- To this end, we need data on value added, employment, (private and public) tangible capital and (private and public) intangible capital
- We combine **several datasets** to tests the hypothesis:
  - **Capital services of tangible non-residential capital (Pubic and private)** FBBVA-Ivie. 1995-2013
    - IT capital (K^{IT}): Computer equipment and Communications equipment
    - **Non-ICT capital ($K^{non\text{-}IT}$)**: 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)

DATA AND METHODOLOGICAL APPROACH

- **Intangible assets**: Mas and Quesada (2014). (Updated to1995-2014)
  - 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 mineral exploration already included in the tangible capital
    - **Software**
    - **R&D**
    - **Design**
    - **Advertising & Marketing**
    - **Organizational capital**
    - **Training**

- **Public Intangibles: SPINTAN project**. 1995-2014
  - Aggregated data onintangibles in the non-market sector: General Administration (Heath and Education not included).
  - We have extended Spanish SPINTAN data using data coming from Spanish SBS and applying the use table structure from 2010-2011, National Accounts and BBVA Foundation.

DATA AND METHODOLOGICAL APPROACH

- **Value added *(Y and Y*)***: National Account statistics (INE). 1995-2014
  - Standard NA industry VA is used.
  - An **additional VA indicator** is also considered **for accounting for intangibles**.
  - Each industry value added is expanded (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 compute 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. National Accounts. 1995-2014.

- **We carried all the test for the following datasets**:
  - **Aggregated Spanish market sector**. Time series analysis
  - **24 non-market industries**. Panel data approach

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 24 industries of the market non-farm economy (we exclude Real Estate).

DATA AND METHODOLOGICAL APPROACH

- We follow a twofold approach (Corrado, Haskel and Jona-Lasinio, 2014)

1. A **production function framework** to test the direct effect of each type of capital and to measure the complementarities among them

   – Therefore we estimate the following panel data production function:

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

   - **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**

   – Additionally, we use indicators of the intensity of use of Intangible public capital and tangible public capital (infrastructures)

DATA AND METHODOLOGICAL APPROACH

2. **Spillovers** of intangible and public capital: we **regress TFP on different indicators** of both market and non-market intangibles intensity.

- **Growth accounting TFP at industry level is obtained** using hours worked, IT and non-IT capital, and total market intangible capital as production factors.
  - TFP is smoothed (HP filter, 6.25)
- **We test whether or not spillovers are generated by**:
  - **INTANGIBLE_W**: % of intangible assets on total private capital (tangible and intangible)
  - **IT_W**: % of IT assets on total private capital (tangible and intangible)
  - **PUB_INT_W**: Weight of non-market intangible capital on total capital (market, non-market, tangible and intangible)
    - In the Public intangible capital we do not include Health and Education.
  - **PUB_TAN_W**: Weight of infrastructures on total capital (market, non-market, tangible and intangible)
  - Two additional variables are used to test possible channels through which public intangible capital and infrastructures may generate spillovers:
    - **HK**: Human capital: % of high skilled employment on total employment.
    - **TRANSP_K**: % of private transport equipment on total transport equipment.

DESCRIPTIVES

Correlations (Log differnces). 1995-2014

Market sector aggregation

	Y^*/L	K/L	K^{NonIT}	K^{IT}	$K^{INTAN.}$	$K^{public\ int.}$	K^{pubic}
Y^*/L	1.00						
K/L	0.72*	1.00					
K^{NonIT}/L	0.71*	1.00*	1.00				
K^{IT}/L	0.54*	0.76*	0.75*	1.00			
$K^{INTANGIBLE}/L$	0.79*	0.95*	0.95*	0.84*	1.00		
$K^{public\ int.}$	-0.01	-0.06	-0.06	0.13	0.08	1.00	
K^{pubic}	-0.28	-0.08	-0.07	-0.03	-0.02	0.32	1.00

24 industries

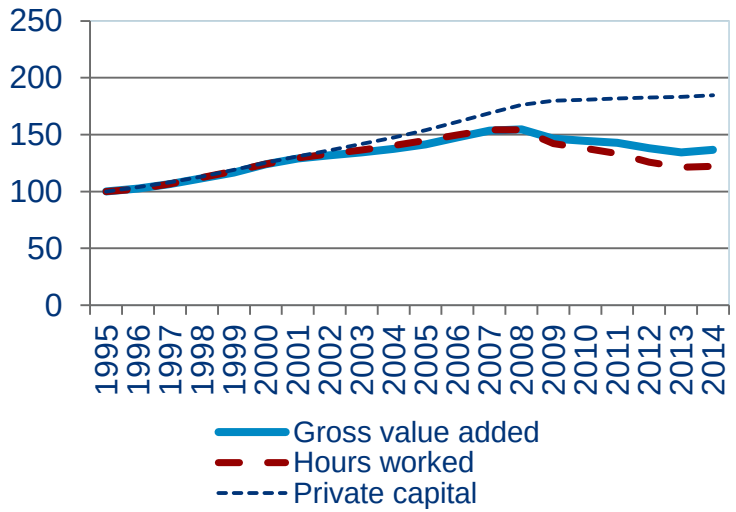
	Y^*/L	K/L	K^{NonIT}	K^{IT}	$K^{INTAN.}$	$K^{public\ int.}$
Y^*/L	1					
K/L	0.22*	1.00				
K^{NonIT}/L	0.21*	0.99*	1.00			
K^{IT}/L	0.08	0.55*	0.50*	1.00		
$K^{INTANGIBLE}/L$	0.28*	0.65*	0.64*	0.33*	1.00	
$K^{public\ int.}$	0.11*	-0.05	-0.05	0.09	0.06	1.00
K^{pubic}	-0.03	0.02	0.03	0.15*	-0.09	0.32*

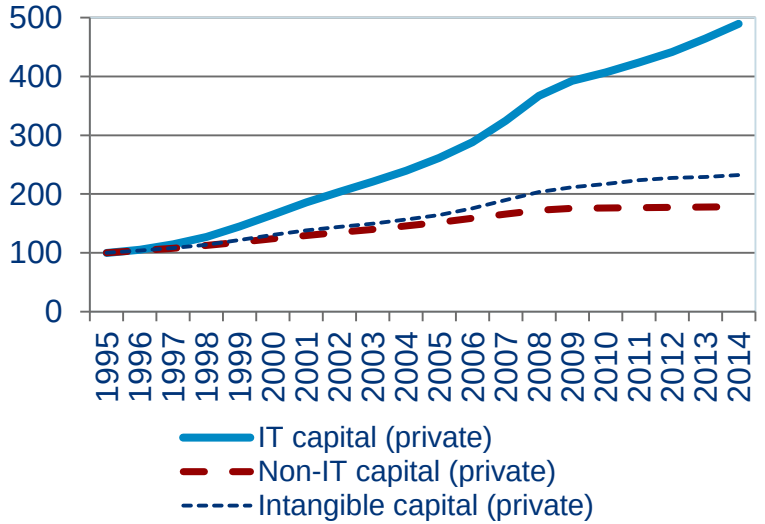
	$K^{intangible}/L$	$K^{software}/L$	$K^{R\&D}/L$	K^{Design}/L	$K^{maketing\&mk\ reseach}/L$	$K^{org.\ capital}/L$
$K^{intangible}/L$	1					
$K^{software}/L$	0.73*	1.00				
$K^{R\&D}/L$	0.85*	0.59*	1.00			
K^{Design}/L	0.79*	0.59*	0.56*	1.00		
$K^{maketing\&mk\ reseach}/L$	0.39	0.11	-0.04	0.24	1.00	
$K^{org.\ capital}/L$	0.97*	0.70*	0.80*	0.84*	0.33	1.00
$K^{training}/L$	0.95*	0.73*	0.75*	0.70*	0.47*	0.93*

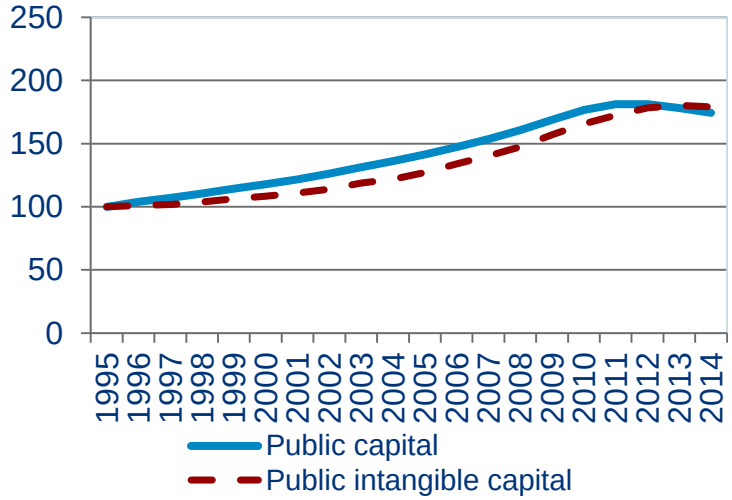
	$K^{intangible}/L$	$K^{software}/L$	$K^{R\&D}/L$	K^{Design}/L	$K^{maketing\&mk\ reseach}/L$	$K^{org.\ capital}/L$
$K^{intangible}/L$	1.00					
$K^{software}/L$	0.47*	1.00				
$K^{R\&D}/L$	0.44*	0.06	1.00			
K^{Design}/L	0.66*	0.33*	0.18*	1.00		
$K^{maketing\&mk\ reseach}/L$	0.49*	0.31*	0.07	0.49*	1.00	
$K^{org.\ capital}/L$	0.69*	0.17*	0.27*	0.50*	0.43*	1.00
$K^{training}/L$	0.59*	0.16*	0.24*	0.37*	0.32*	0.57*

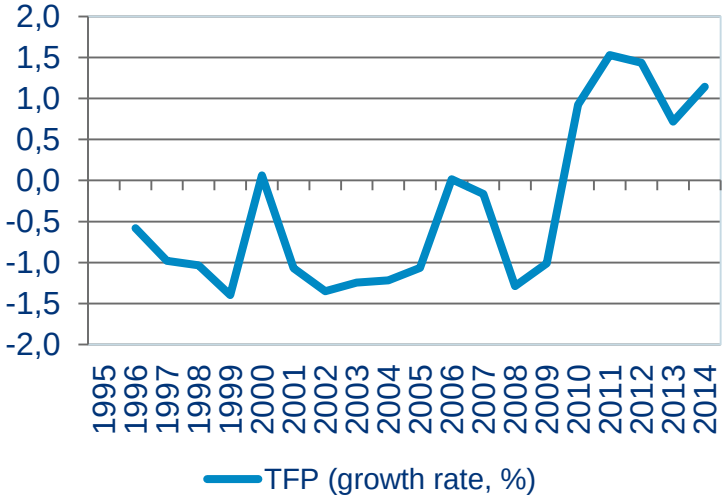
* Significant at 5% level

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









RESULTS. PRODUCTION FUNCTION

- **Do private intangibles help to explain labour productivity growth?**
- It seems so, but the high correlation of the different types of capital prevents from the precise estimation of elasticities.

Dependent variable: Δ *ln* (Y* / L)

	Aggregated market sector. Time series			Panel data approach					
				Fixed or random panel data			Instrumental variables		
	Eq1	Eq2	Eq3	Eq1_re	Eq2_re	Eq3_re	Eq1_iv	Eq2_iv	Eq3_iv
Δ ln (K / L)	0.17 **		-0.279 *	0.236 ***		0.094	0.216 *		0.082
	(0.070)		(0.156)	(0.082)		(0.087)	(0.118)		(0.114)
Δ ln (K^{NonIT}/ L)		0.175 *			0.261 ***			0.247 **	
		(0.098)			(0.091)			(0.122)	
Δ ln (K^{IT}/ L)		-0.007			-0.032			-0.044	
		(0.086)			(0.047)			(0.053)	
Δ ln ($K^{INTANGIBLE}$/ L)			0.466 ***			0.208 ***			0.185 **
			(0.141)			(0.076)			(0.081)
Obs.	19	19	19	456	456	456	432	432	432
R^2	0.686	0.664	0.786	0.038	0.037	0.082	0.039	0.039	0.083
Breusch-Godfrey (pvalue)	0.678	0.721	0.086						

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. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS. PRODUCTION FUNCTION

- **Are private intangible capital and IT capital complementaries?**
- No evidence.
- This results are robust to alternative specifications: average IT intensities, average intangible capital intensities, lags,…

Dependent variable: Δ *ln* (Y / L)

	Aggregated market sector. Time series			Panel data approach					
				Fixed or random panel data			Instrumental variables		
	eq4	eq5	eq6	eq4_re	eq5_re	eq6_re	eq4_iv	eq5_iv	eq6_iv
Δ ln (K / L)	-0.032			0.085			0.071		
	(0.214)			(0.070)			(0.114)		
Δ ln (K^{NonIT}/ L)		-0.173	-0.255		0.119	0.111		0.134	0.18
		(0.165)	(0.219)		(0.079)	(0.080)		(0.129)	(0.145)
Δ ln (K^{IT}/ L)		-0.142	-0.205		-0.03	-0.044		-0.038	-0.137
		(0.092)	(0.141)		(0.038)	(0.041)		(0.051)	(0.101)
Δ ln ($K^{INTANGIBLE}$/ L)	0.556 **	0.444 **	0.387 *	0.196 ***	0.174 ***	0.144 **	0.118	0.156 *	-0.053
	(0.207)	(0.181)	(0.209)	(0.065)	(0.063)	(0.071)	(0.138)	(0.085)	(0.207)
Δ ln ($K^{INTANGIBLE}$/ L) Δ ln (K^{IT}/ L)*	-1.864		1.147	0.156		0.381	0.86		2.529
	(1.285)		(1.930)	(0.376)		(0.429)	(1.476)		(2.319)
Obs.	19	19	19	456	456	456	432	432	432
R^2	0.608	0.753	0.74	0.083	0.058	0.062	0.08	0.059	0.049
Breusch-Godfrey (Pvalue)	0.911	0.282	0.389						

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. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS. PRODUCTION FUNCTION

- **Are the different types of private intangible capital equally relevant to explain economic growth?**

- No clear evidence. Only significant coefficients for Maket research and Organizational capital.

Dependent variable: Δ *ln* (Y* / L)

	Aggregated market sector. Times series					
	eq7	**eq8**	**eq9**	**eq10**	**eq11**	**eq12**
Δ ln (K / L)	0.288 (0.186)	0.361 ** (0.161)	0.032 (0.131)	0.154 ** (0.063)	-0.112 (0.134)	0.014 (0.125)
Δ ln ($K^{Software}$/ L)	-0.084 (0.162)					
Δ ln ($K^{R\&D}$/ L)		-0.134 (0.119)				
Δ ln (K^{Design}/ L)			0.165 (0.107)			
Δ ln ($K^{maketing\&mk\ reseach}$/ L)				0.095 ** (0.033)		
Δ ln ($K^{org.\ capital}$/ L)					0.243 ** (0.092)	
Δ ln ($K^{Training}$/ L)						0.119 * (0.066)
Obs.	19	19	19	19	19	19
R^2	0.626	0.65	0.674	0.763	0.746	0.69
Breusch-Godfrey (Pvalue)	0.834	0.746	0.934	0.148	0.35	0.364

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. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

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- **Are the different types of private intangible capital equally relevant to explain economic growth?**

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Dependent variable: Δ *ln* (Y* / L)

	Panel data approach. Fixed or random effects					
	Eq7_re	Eq8_re	Eq9_re	Eq10_re	Eq11_fe	Eq12_re
Δ ln (K / L)	0.186*	0.235**	0.096	0.193*	0.218*	0.241***
	(0.111)	(0.112)	(0.112)	(0.113)	(0.116)	(0.086)
Δ ln ($K^{Software}$/ L)	0.052					
	(0.037)					
Δ ln ($K^{R\&D}$/ L)		-0.023				
		(0.033)				
Δ ln (K^{Design}/ L)			0.19***			
			(0.069)			
Δ ln ($K^{maketing\&mk\ reseach}$/ L)				0.041		
				(0.046)		
Δ ln ($K^{org.\ capital}$/ L)					0.042	
					(0.076)	
Δ ln ($K^{Training}$/ L)						0.023
						(0.053)
Obs.	432	432	432	432	432	456
R^2	0.064	0.052	0.086	0.068	0.054	0.052
Breusch-Godfrey (Pvalue)	0.186*	0.235**	0.096	0.193*	0.218*	0.241***

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. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

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- **Are the different types of private intangible capital equally relevant to explain economic growth?**

- No clear evidence. Only significant coefficients for Maket research and Organizational capital.

Dependent variable: Δ *ln* (Y* / L)

	Panel data approach. Instrumental variables					
	Eq7_iv	**Eq8_iv**	**Eq9_iv**	**Eq10_iv**	**Eq11_iv**	**Eq12_iv**
Δ ln (K / L)	0.186*	0.235**	0.096	0.193*	0.218*	0.214*
	(0.111)	(0.112)	(0.112)	(0.113)	(0.116)	(0.122)
Δ ln ($K^{Software}$/ L)	0.052					
	(0.037)					
Δ ln ($K^{R\&D}$/ L)		-0.023				
		(0.033)				
Δ ln (K^{Design}/ L)			0.19***			
			(0.069)			
Δ ln ($K^{maketing\&mk\ reseach}$/ L)				0.041		
				(0.046)		
Δ ln ($K^{org.\ capital}$/ L)					0.042	
					(0.076)	
Δ ln ($K^{Training}$/ L)						0.03
						(0.056)
Obs.	0.186*	0.235**	0.096	0.193*	0.218*	0.214*
R^2	(0.111)	(0.112)	(0.112)	(0.113)	(0.116)	(0.122)
Breusch-Godfrey (Pvalue)	0.052					

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. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS. PRODUCTION FUNCTION

- **What about public intangible capital and infraestructures?**
- No evidence of the direct effect influence of these capitals on the private production function.
- IT capital and human capital does not seem to be the channel by which intangible public capital influences labour productivity.
- No evidence of the impact of transport equipment and infraestructures.

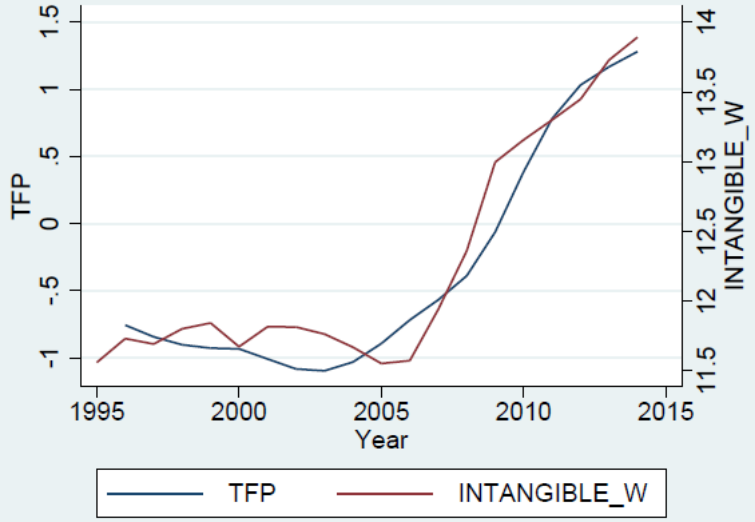
Dependent variable: Δ *ln* (Y* / L)

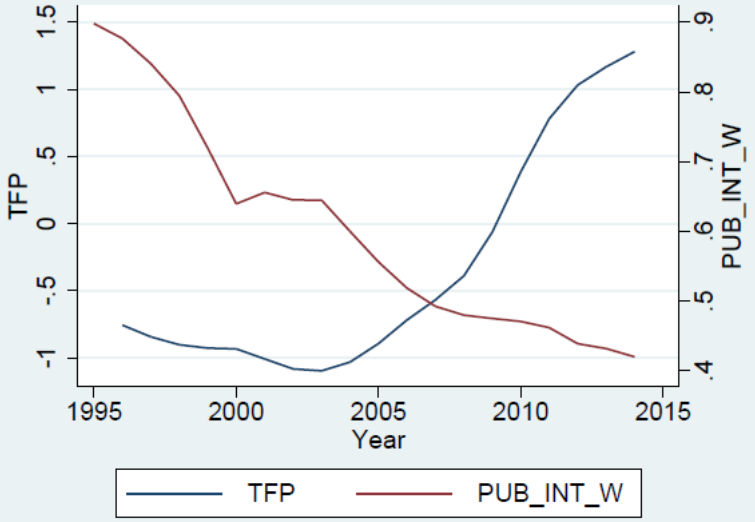
	Aggregated market sector. Time series					Panel data approach									
						Fixed or random panel data					Instrumental variables				
	eq14	eq15	eq16	eq17	eq18	eq14_re	eq15_re	eq16_re	eq17_re	eq18_re	eq14_iv	eq15_iv	eq16_iv	eq17_iv	eq18_iv
Δ ln (K / L)	-0.216 (0.22)	-0.42* (0.21)	-0.236 (0.23)	-0.192 (0.22)	-0.249 (0.20)	0.115 (0.09)	0.129 (0.09)	0.117 (0.08)	0.096 (0.09)	0.096 (0.09)	0.037 (0.11)	0.069 (0.12)	0.143 (0.16)	0.089 (0.12)	0.093 (0.12)
Δ ln ($K^{INTANGIBLE}$/ L)	0.379* (0.19)	0.556** (0.19)	0.405* (0.21)	0.411* (0.23)	0.466** (0.22)	0.202*** (0.07)	0.194*** (0.07)	0.202*** (0.07)	0.212*** (0.08)	0.212*** (0.08)	0.166** (0.08)	0.154* (0.08)	0.166 (0.17)	0.189** (0.08)	0.185** (0.08)
Δ ln ($K^{public\ int.}$)	-0.095 (0.10)	-0.559** (0.23)	0.043 (0.45)			0.607*** (0.17)	0.52** (0.21)	0.196 (0.38)			0.567*** (0.19)	0.412 (0.26)	-1.493 (2.68)		
Δ ln (K^{IT}/ L)* Δ ln ($K^{public\ int.}$)		6.802** (3.10)					1.317 (1.54)					2.333 (2.78)			
Δ ln ($K^{public\ int.}$) *HK			-0.004 (0.01)					0.012 (0.01)					0.047 (0.06)		
Δ ln (K^{pubic}/)				-0.162 (0.22)	1.826 (1.09)				-0.21 (0.24)	-0.174 (0.25)				-0.18 (0.27)	-0.121 (0.28)
% K^{trans}* Δ ln (K^{pubic}/)					-25.26* (13.6)					-0.924 (1.46)					-1.434 (1.55)
Obs.	19	19	19	19	19	456	456	456	456	456	432	432	432	432	432
R^2	0.637	0.715	0.612	0.628	0.684	0.099	0.1	0.101	0.083	0.085	0.099	0.097	0.06	0.084	0.088
B-G (Pvalue)	0.585	0.99	0.576	0.759	0.096										

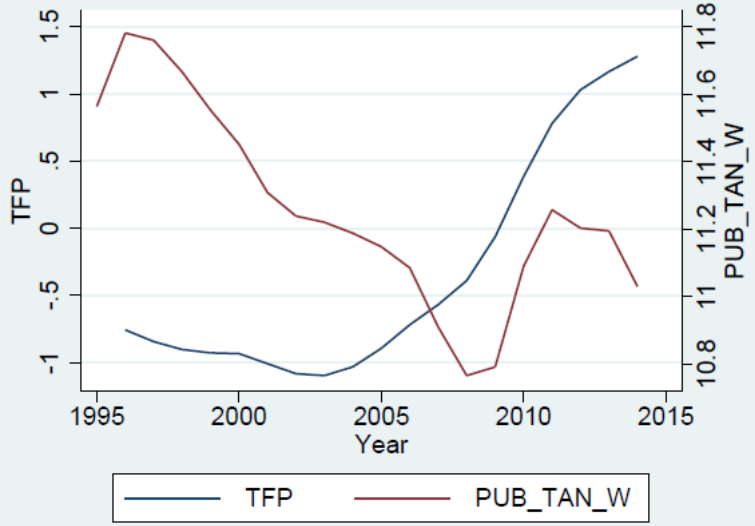
Note: Labour productivity has been calculated using extended GVA and employment (corrected by the composition of human capital and hours worked). All variables in logarithmic differences and weighted by employed person. Panel data specifications include sector fixed effects. We include a trend, a dummy variable for the crisis period (2007-2014), and their interaction. Heteroskedasticity robust standard errors in parentheses.. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

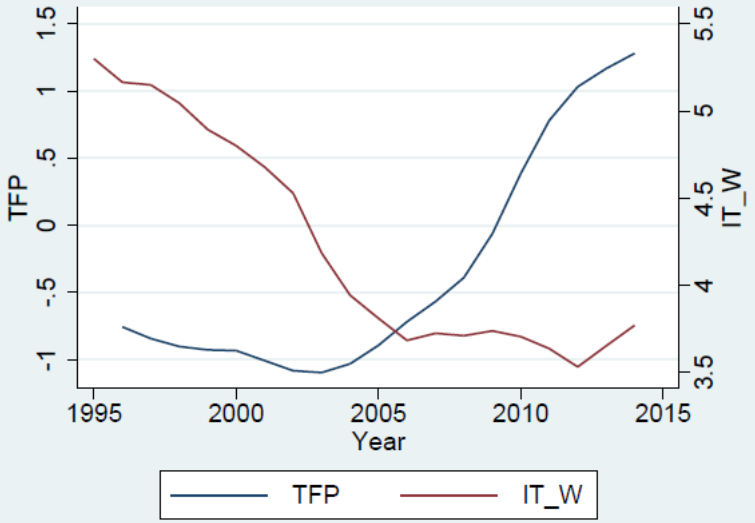
Source: Author's calculations.

RESULTS . SPILLOVERS









RESULTS. SPILLOVERS

- **Do intangible assets, IT capital, public intangible capital and infrastructures generate TFP spillovers?**
- No clear evidence. Depending on the approach different results.

Dependent variable: Δ *ln* TFP

	Aggregated market sector			Panel data approach. Random effects model		
	eq19	eq20	eq21	eq19_re	eq20_re	eq21_re
INTANGIBLE_W	0.329***	3.789***	1.183**	-0.008	-0.094	-0.085
	(0.071)	(1.062)	(0.488)	(0.046)	(0.059)	(0.066)
IT_W		10.823**	2.904		-0.311**	-0.289**
		(3.558)	(1.596)		(0.129)	(0.134)
INTANGIBLE_W* IT_W		-0.909***	-0.236		0.014	0.014
		(0.288)	(0.130)		(0.010)	(0.010)
PUB_INT_W	-2.303***		-1.942***	0.283		0.208
	(0.424)		(0.509)	(1.532)		(1.530)
PUB_TAN_W	0.998***		0.902***	-0.011		0.01
	(0.086)		(0.112)	(0.108)		(0.112)
Obs.	19	19	19	456	456	456
R2	0.998	0.987	0.998	0.015	0.01	0.004
B-G (P-value)	0.773	0.077	0.055			

Note: Panel data specifications include sector fixed effects. We include a trend, a dummy for the crisis period (2007-2014), and teir interaction. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS . SPILLOVERS

- **Are differences between types of intangible assets?**
- No clear evidence. Depending on the approach different results.

Dependent variable: Δ *ln* TFP

	Aggregated market sector						Panel data approach. Random effects model					
	eq22	eq23	eq24	eq25	eq26	eq27	eq22	eq23	eq24	eq25	eq26	eq27
SOFT_W	-0.101 (0.38)						-0.032 (0.085)					
R&D_W		-0.087 (0.23)						-0.047 (0.065)				
DESIGN_W			0.947** (0.31)						0.246** (0.108)			
MARK_W				0.741*** (0.131)						-0.231 (0.383)		
ORGANIZ_W					1.601*** (0.403)						-0.18 (0.365)	
TRAINING_W						2.303*** (0.342)						0.172 (0.381)
PUB_IT_W	-2.045** (0.81)	-2.091** (0.73)	-2.436*** (0.55)	-0.63 (0.45)	-2.625*** (0.481)	-2.414*** (0.324)	0.243 (1.546)	0.301 (1.533)	0.172 (1.512)	0.373 (1.400)	0.304 (1.520)	0.258 (1.519)
PUB_TAN_W	1.061*** (0.20)	1.025*** (0.15)	1.062*** (0.11)	1.186*** (0.08)	0.982*** (0.10)	0.841*** (0.071)	-0.011 (0.105)	-0.008 (0.103)	-0.025 (0.099)	-0.013 (0.105)	-0.009 (0.106)	-0.018 (0.102)
Obs.	19	19	19	19	19	19	456	456	456	456	456	456
Adjusted R2	0.994	0.994	0.997	0.999	0.998	0.999	0.011	0.004	0	0.002	0.003	0.046
B-G (Pvalue)	0.48	0.369	0.499	0.006	0.913	0.473						

Note: Panel data specifications include sector fixed effects. We include a trend, a dummy for the crisis period (2007-2014), and teir interaction. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS . SPILLOVERS

- **Public capital. IT, Human capital and transport equipment.**
- Again no robust evidence. Depending on the approach different results.

Dependent variable: Δ *ln* TFP

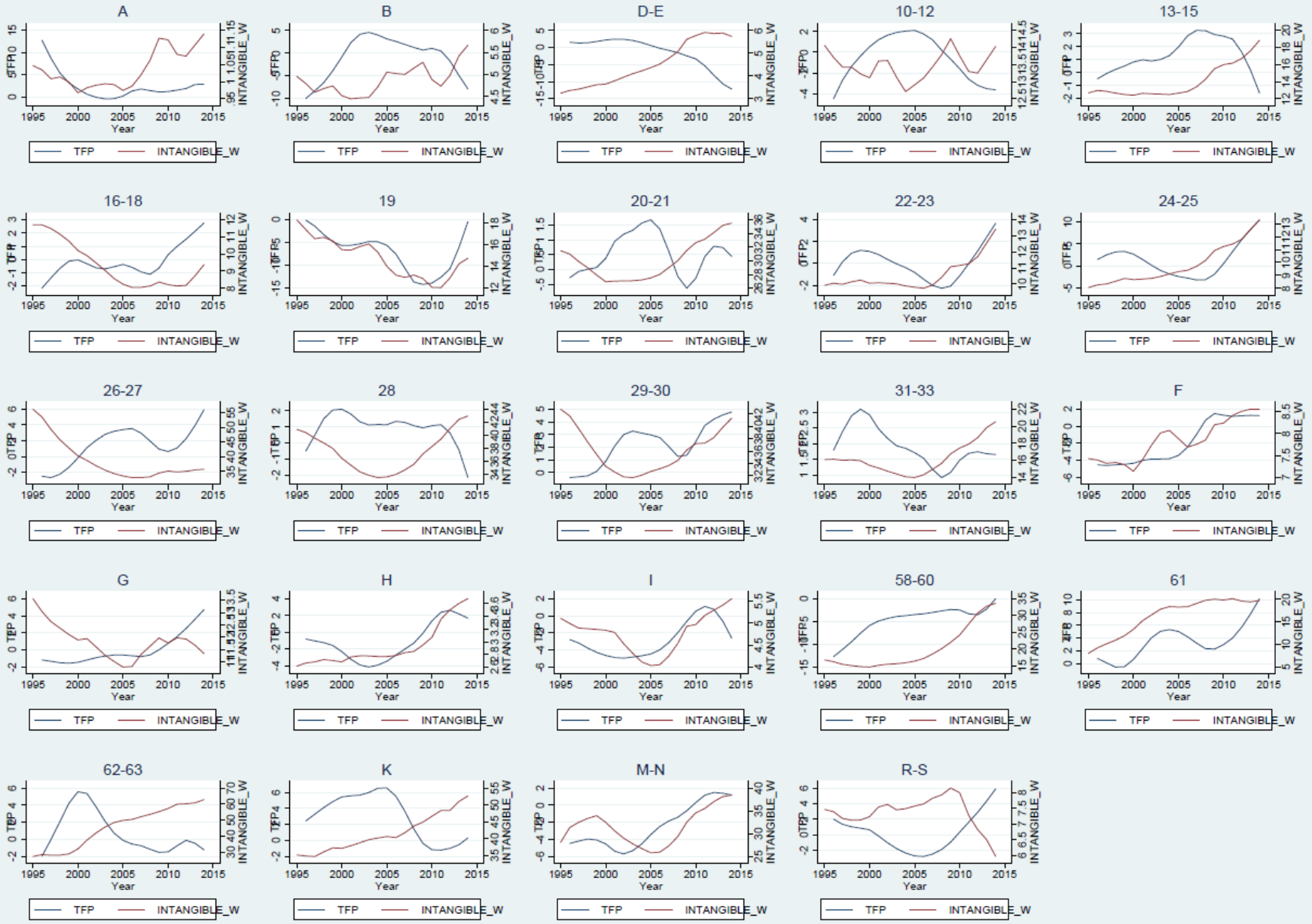
	Aggregaged market sector			Panel data approach. Random effects		
	eq41	eq42	eq43	eq41	eq42	eq43
INTANGIBLE_W	0.366***	0.319**	0.327***	-0.055	-0.004	-0.009
	(0.090)	(0.110)	(0.074)	(0.038)	(0.049)	(0.047)
IT_W	-1.064*	0.042		1.114***	-0.09	
	(0.500)	(0.188)		(0.332)	(0.108)	
PUB_IT_W	-10.24**	-1.998*	-2.359***	1.74	0.294	0.291
	(3.519)	(1.013)	(0.458)	(1.306)	(1.603)	(1.535)
PUB_IT_W * IT_W	1.734**			-0.238***		
	(0.758)			(0.073)		
PUB_IT_W * HK		-0.01			0	
		(0.034)			(0.017)	
PUB_TAN_W	0.876***	1.072***	0.937***	-0.018	-0.011	-0.015
	(0.105)	(0.240)	(0.164)	(0.108)	(0.101)	(0.114)
PUB_TAN_W* TRANSP_K			-0.7			-0.03
			(1.591)			(0.174)
Obs.	19	19	19	456	456	456
Adjusted R2	0.998	0.998	0.998	0.033	0.004	0.013
Breusch-Godfrey (P~)	0.728	0.604	0.783			

Note: Panel data specifications include sector fixed effects. We include a trend, a dummy for the crisis period (2007-2014), and teir interaction. Heteroskedasticity robust standard errors in parentheses. ***, **, *: significant at 1%, 5% and 10% levels, respectively.

Source: Author's calculations.

RESULTS . SPILLOVERS

- Why do we obtain this results?
  - Irregular profile of TFP in the years of analysis?
    - 1995-2007: Poor TFP performance:
      - Over-investment in the expansionary phase of the cycle: all types of capital soared. Hence, there is high correlation among them both in the time series dimension and in the cross-section.
      - High employment creation
    - 2008-2014: TFP recovery
      - Massive employment destruction
      - Abrupt adjustment in investment
    - We carried out the analysis by subperiods (pre and post crisis) and we obtained similar results.
  - Are cross industries differences relevant?


A
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28
29-30
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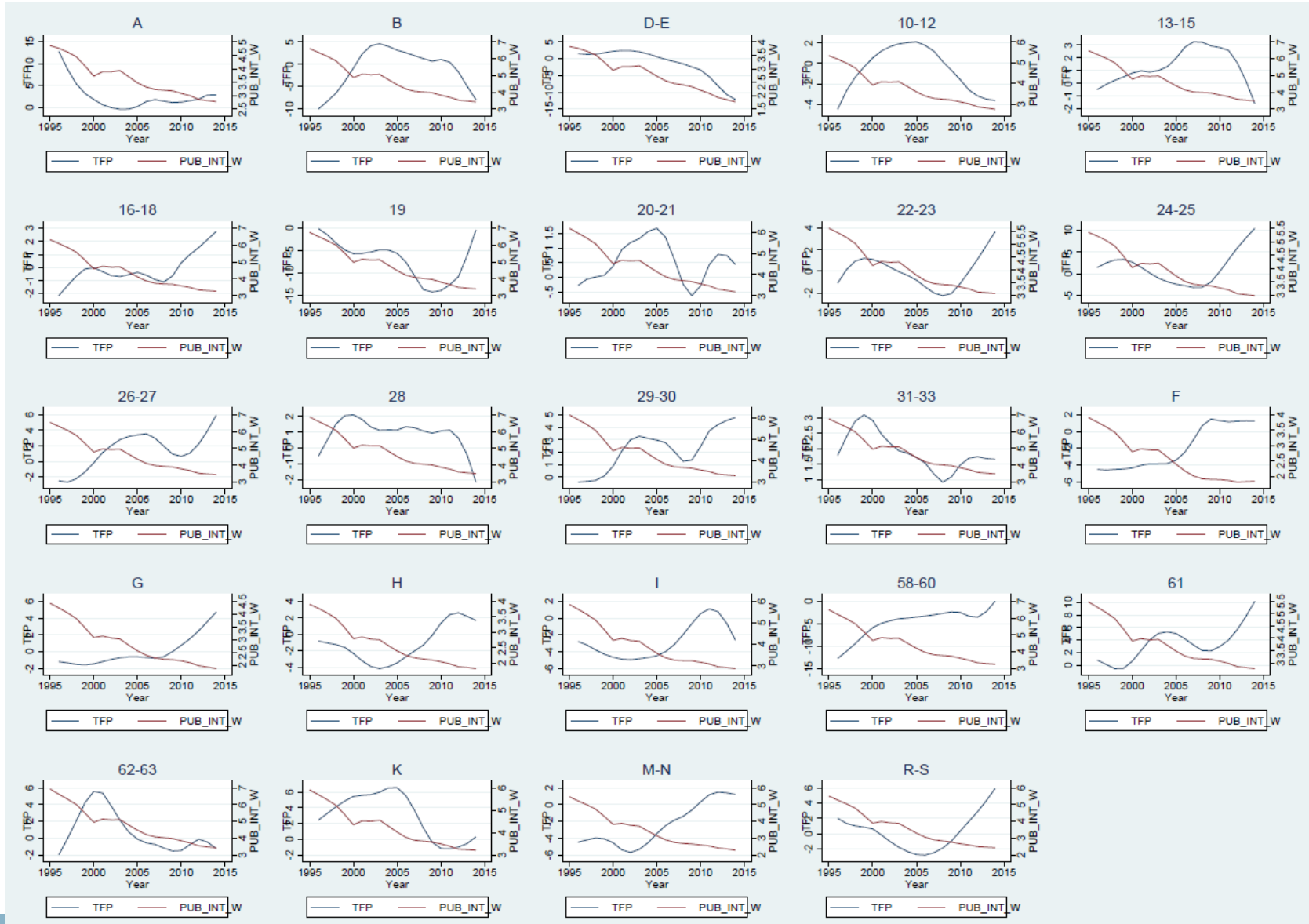
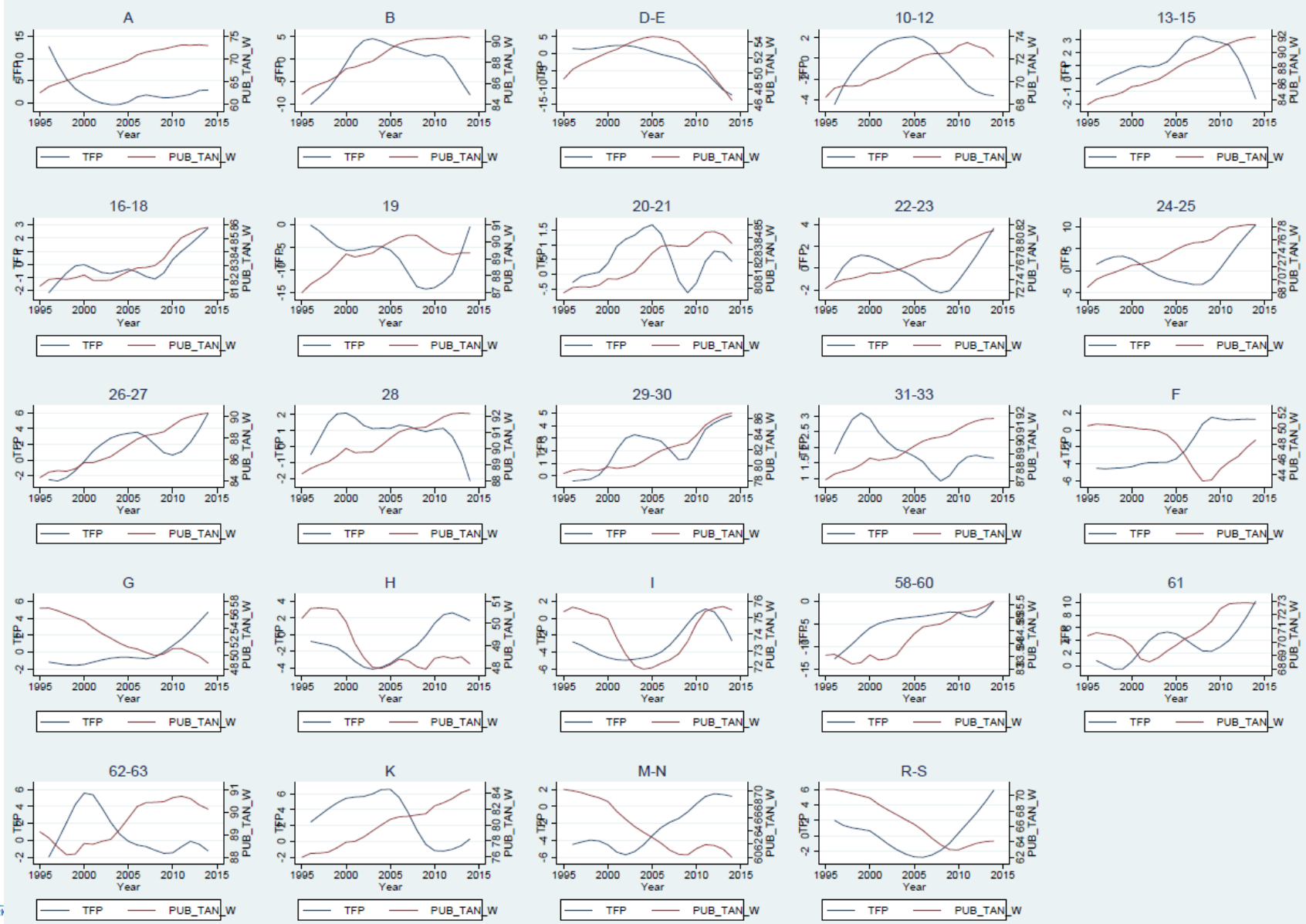
TFP
INTANGIBLE_W

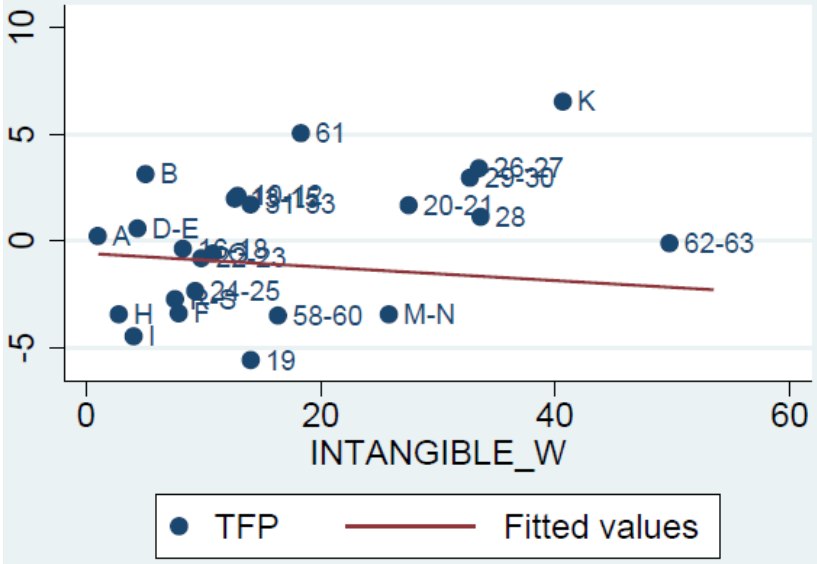
RESULTS . SPILLOVERS

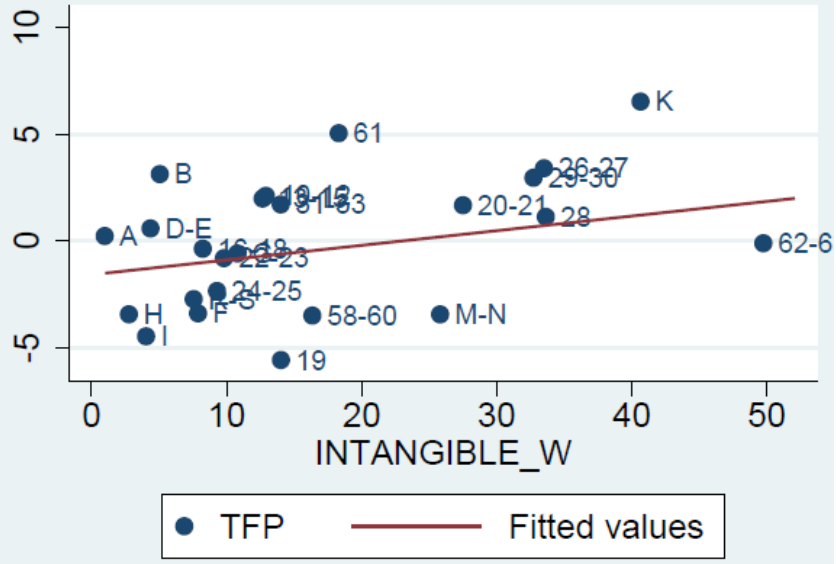


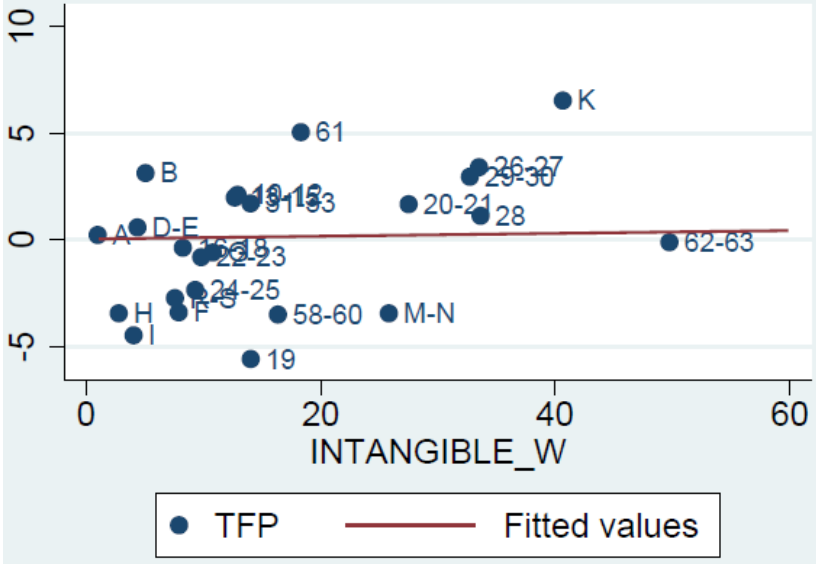
RESULTS . SPILLOVERS

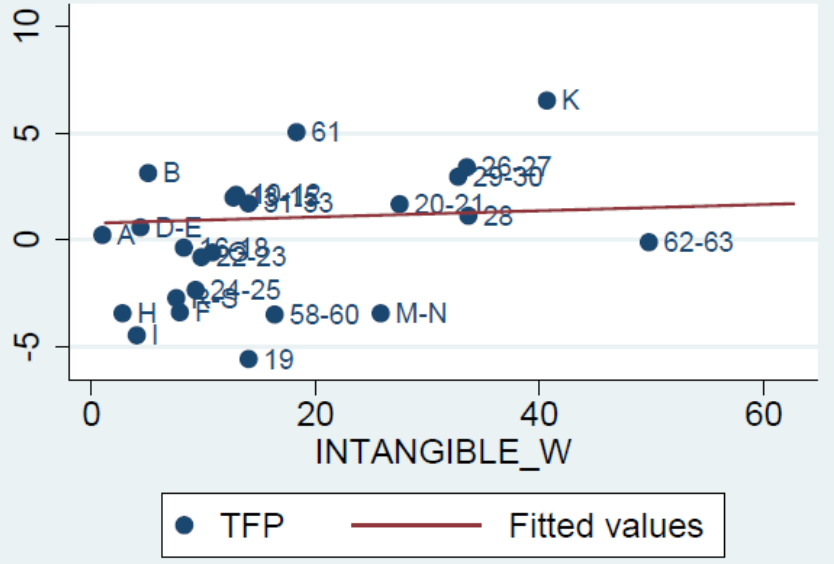


RESULTS . SPILLOVERS









MAIN FINDINGS

- In this paper we show **results** of a research of the **role on different types of intangibles on economic growth**
- Our approach:
  - **Seeks to assess the contribution of the different types of capital assets**: tangible ICT, tangible non-ICT, intangibles (public and private) and public capital (infrastructures)
    - We look for the **direct effect of capital on economic growth**
    - We look for **complementarities,** particularly in the case of intangibles and ICTs.
    - We look for **spillovers** associated to private and public intangibles and of public capital.
  - The evidence is based on both **aggregated** and **industry data** (24 industries) for the period **1995-2014.**
- The results are disappointing as we do not find evidence of the hypothesis raised.
  - Some evidence is found that private intangible capital has effects on labour productivity. However, we cannot properly identify its contribution.
  - We do not obtain any evidence of complementarity between private intangible and IT assets.
  - Different intangible assets have different impact but the evidence is not robust.
  - No clear evidence of the effects of Public capital (intangible and infrastructures) on the private production function is found.
    - We do not find evidence of the role human capital, ITs and share of transport equipment.
  - No evidence of spillovers effects.
- We justify all these results on the grounds of the particularities of the Spanish cycle since 1995.
- Our question here is if it is only a particularity of the Spanish case.

Intangible Assets and Spanish Economic Growth

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