# Does Intangible Capital affect Economic Growth?

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# Structure of the Presentation

1. Theoretical Links
2. Previous Empirical Findings
3. Research Design
4. Descriptive Statistics
5. Econometric Analysis
6. Conclusion

# 1. Theoretical Links

- importance of innovation recognized explicitly in the Lisbon strategy (2009) as well as the Europe 2020 strategy (2010)
- Corrado, Hulten and Sichel (2005) propose a wider concept for measuring innovation and possibly revising national accounts
- they suggest three dimensions: (1) computerized information, (2) innovative property and (3) economic competencies
- these dimensions show that the potential of intangible capital for stimulating productivity growth lies in the provision of knowledge, an increase in the selling potential of a good and the development of a productive environment for the physical production of the good
- and products are becoming more knowledge-intense (Corrado et al (2009))
- Jona, Iommi and Roth (2009) verify why single dimensions of intangible capital should be accounted as Gross Fixed Capital Formation

# 1. Theoretical Links

- *Brand names*: 'image' attached to products is an important aspect of today's products (Canibano, Garcia-Ayuso and Sanchez (2000)) as well as advertising (Comanor and Wilson (1967))
- *Firm-specific human capital*: the value of companies will increase if the quality of their human resources increases (Hand (1998), Huselid (1999), Canibano, Garcia-Ayuso and Sanchez (2000) and Abowd (2005))
- *Organizational Capital*: today's production processes involve highly technological physical capital, which combined with special management, "business practices, processes and design" increase the value of the products; organizational capital is an important asset (Lev and Radhakrishnan (2003 and 2005), Teece (1998), Youndt et al (2004), Subramaniam (2005). Leana and van Buren (1999) come up with "organizational social capital" - an asset crucial for competitiveness

# 2. Previous Empirical Results

Figure 1: Results on the importance of spending on intangibles

| | Corrado,Hulten, Sichel (2005) | Marrano,Haskel (2006) | Jalava, Aulin-Ahmavaara, Alanen (2007) | Fukao, Hamagata, Miyagawa, Tonogi (2007) | Hao,Manole, van Ark (2008) | van Rooijen-Horsten, van den Bergen, Tamriseven (2008) | Edquist (2009) | Nakamura (2009) |
|---|---|---|---|---|---|---|---|---|
| Year | 2003* | 2004 | 2005 | 1995-2002 | 2004 | 2001-2004 | 2004 | 1959-2007 |
| Countries studied | USA | UK | FIN | JAP | D,FR,I,ES | NL | SE | USA |
| Dependent variable | % of GDP | % of GDP | % of GDP | % of GDP | % of GDP | % of GDP | % of GDP | % of GDP |
| Spending on intangible capital as % of GDP | 12.1% | 10.1% | 9.1% | 7.5% | 7.1% in D, 8.8% in FR, 5.2% in I,5.2% in ES | 10.0% | 10.6% | as important as investment in tangible assets |

*Corrado, Hulten and Sichel (2005) report the number from 1998-2000. Hao, Manole and van Ark (2008) requested the estimate for 2003 from them.

# Figure 2: Results in the growth accounting literature

| | Corrado, Hulten, Sichel (2006) | Marrano, Haskel, Wallis (2007) | Jalava, Aulin-Ahmavaara, Alanen (2007) | Fukao, Hamagata, Miyagawa, Tonogi (2007) | Hao, Manole, van Ark (2008) | Corrado, Hao, Hulten, van Ark (2009) | Corrado, Hao, Hulten, van Ark (2009) | Corrado, Hao, Hulten, van Ark (2009) | Corrado, Hao, Hulten, van Ark (2009) | Corrado, Hao, Hulten, van Ark (2009) |
|---|---|---|---|---|---|---|---|---|---|---|
| Period studied | 1973-1995; 1995-2003 | 1979-1995; 1995-2003 | 1975-2000; 2000-2005 | 1980-1990; 1990-2002 | 1995-2003 | 1995-2006 | 1995-2006 | 1995-2006 | 1995-2006 | 1995-2006 |
| Countries studied | USA | USA& UK | FIN | JAP | D,F,I,ES | USA | UK | F | D | D,F,I,ES,AT, DK |
| Dependent variable | Labour productivity growth in the nonfarm business sector | Annual change in labour productivity in the nonfarm business sector | Labour productivity growth in the non-financial business sector | Growth rate of GDP | Growth of labour productivity in the market sector | Labour productivity growth in the market sector | Labour productivity growth in the market sector | Labour productivity growth in the market sector | Labour productivity growth in the market sector | Labour productivity growth in the market sector |
| % of dependent variable accounted for by intangible capital deepening | 26% in 1973-1995, 27% in 1995-2003 | 26% in 1979-1995,27% in 1995-2003 in the US,15% in 1979-1995,20% in 1995-2003 in the UK | 16% in 1995-2000, 30% in 2000-2005 | 11% in 1980-1990, 40% in 1990-2002 | 31% in D,37% in F,59% in I,64% in ES | 28% | 23% | 24% | 21% | 22% |
| Percentage points of dependent variable accounted for by intangible capital deepening | 0.43 in 1973-1995, 0.84 in 1995-2003 | 0.43 in 1979-1995, 0.84 in 1995-2003 in the US; 0.44 in 1979-1995,0.60 in 1995-2003 in the UK | 0.64 in 1995-2000, 0.84 in 2000-2005 | 0.43 in 1980-1990, 0.45 in 1990-2002 | 0.9 in F,0.6 in D, 0.4 in I, 0.2 in ES | 0.83 | 0.69 | 0.48 | 0.38 | 0.3 |
| Increase in growth by adding intangible capital to the asset boundary | 20% in 1973-1995, 11% in 1995-2003 | 20% in 1973-1995, 11% in 1995-2003; 11% in 1973-1995, 13% in 1995-2003 in the UK | 13% in 1995-2000, 2% in 1995-2005 | 3% in 1980-1990, 7% in 1990-2002 | 10% in D, 14% in F,37% in I,40% in ES | 7% | 6% | 9% | 12% | 12% |
| Decrease in the importance of multifactor productivity when adding intangible capital deepening | Declines from 51% to 35% in 1995-2003 | Declines from 51% to 35% in 1995-2003 in the US and from 22% to 16% in 1995-2003 in the UK | Declines from 59% to 42% in 1995-2005 | Declines from 21% to 15% in 1980-1990 and from 10% to -5% in 1990-2002 | Declines from 38% to 21% in D, from 44% to 23% in F | Declines from 64% to 45% | Declines from 53% to 40% | Declines from 48% to 35% | Declines from 61% to 49% | Declines from 31% to 21% |

Figure 3: Recent results for R&D or innovation and economic growth in cross-country growth regressions

| | Kahn, Lunitel (2006) | Bassanini, Scarpetta (2001) | O'Mahony, Vecchi (2003) | Guellec, Van Pottelsberghe (2001) | Griffith, Redding, van Reenen (2004) |
|---|---|---|---|---|---|
| Period studied | 1980-2002 | 1981-1998 | 1976-2000 | 1980-1998 | 1970-1992 |
| Countries studied | 16 OECD countries | 16 OECD countries | 55 separate sectors in the US and the UK | 16 OECD countries | 12 OECD countries |
| Dependent variable | Domestic multifactor productivity | GDP per capita growth | Growth of real output | Multifactor productivity growth | Total factor productivity growth |
| Estimation method | Heterogeneous dynamic panel (GMM) | Pooled mean group estimator | Pooled mean group estimator | Error correction model | Least squares dummy variable estimator, instrumental variables |
| Proxy for intangible capital | Stocks of real R&D expenditures by the foreign and domestic business sectors and domestic public sectors | Total (private and public) R&D expenditure (as a share of GDP) | ICT capital | Business, public and foreign R&D capital stocks | R&D expenditure as a percentage of GDP |
| Reported coefficients | 0.027(business); 0.033(public); 0.010(foreign) | 0.14 (total); 0.26 (business); -0.37 (public) | 0.055 (total); 0.097 (USA); 0.053 (UK) | 0.027 (business); 0.094 (foreign); 0.035 (public) | 0.290-0.446 (depending on control variables) |
| Findings on the effect of R&D | Business, public and foreign R&D stocks augment productivity significantly in all 16 countries | A significant effect of R&D activity on the growth process; business R&D is positively associated with growth | A positive and significant effect of ICE growth on output growth; growth in ICT capital could account for about 40% of output growth | A positive and significant effect of R&D; elasticity of business R&D of 0.13 | R&D affects TFP growth positively and significantly and increases the ability of an economy to absorb new technologies |

# 3. Research Design - the Model

"Cross-country Growth Accounting" - Benhabib&Spiegel (1992) and Temple (1999)

$$Y = AK^{\alpha} H^{\beta} I^{\gamma} N^{\delta} \tag{1}$$

(1) represents a production function,rewriting (1) by taking logs and first differencing and transforming into an econometric model leads to (2):

$$\Delta \ln Y_{it}^{*} = \alpha_{0i} + \alpha \Delta \ln K_{it} + \beta \Delta \ln H_{it} + \gamma \Delta \ln I_{it} + \delta \Delta \ln N_{it} + w_{it} \tag{2}$$

$i$ represents each country, $t$ each time period with $t = 1 - 10$,$\Delta \ln Y_{it}^{*}$ is the annual growth of labour productivity(new GDP) for country $i$ at period $t$, $\Delta \ln K_{it}$, $\Delta \ln I_{it}$, are the growth rates of physical capital stock and intangible capital stock,$\Delta \ln H_{it}$ is the growth rate of human capital,$\Delta \ln N_{it}$ is the growth rate of hours worked,$\alpha_{0i}$ is a country specific time invariant term such as technological progress

# 3. Research Design - Data I

- the sample covers the EU-15 countries over the period 1995-2005
- data on intangible capital were taken from the macro-approach of the INNODRIVE project (Jona, Iommi and Roth 2009) for the business sector NACE c-k+o; the measure includes R&D activities, product development in the financial service industry, market research, advertising, firm-specific human capital and organizational structure; we adjust the data to be expressed in 2000 prices
- data on the macro variables in the model are taken from DG ECFIN's annual macro database AMECO - in particular, the physical capital stock, annual labour productivity growth (adjusted by including intangibles in the asset boundary)
- human capital data is measured as "the percentage of population who attained at least upper secondary education" and taken from Eurostat

# 3. Research Design - Data II

- data on the control variables in the sensitivity analysis - inward FDI, stock market capitalization, inflation, income tax, government expenditure, education expenditure and social expenditure - are taken from Eurostat
- the data on openness to trade is retrieved from the Penn World Tables 6.2.
- the variables on government efficiency and political stability are taken from Kaufmann, Kraay and Mastruzzi. These variables are used as a proxy for trust in a study by the World Bank (2006).

# 4. Descriptive Statistics

Figure 4: Level of intangible capital investment in the EU-15 countries as a percentage of NEWGDP from 1995-2005

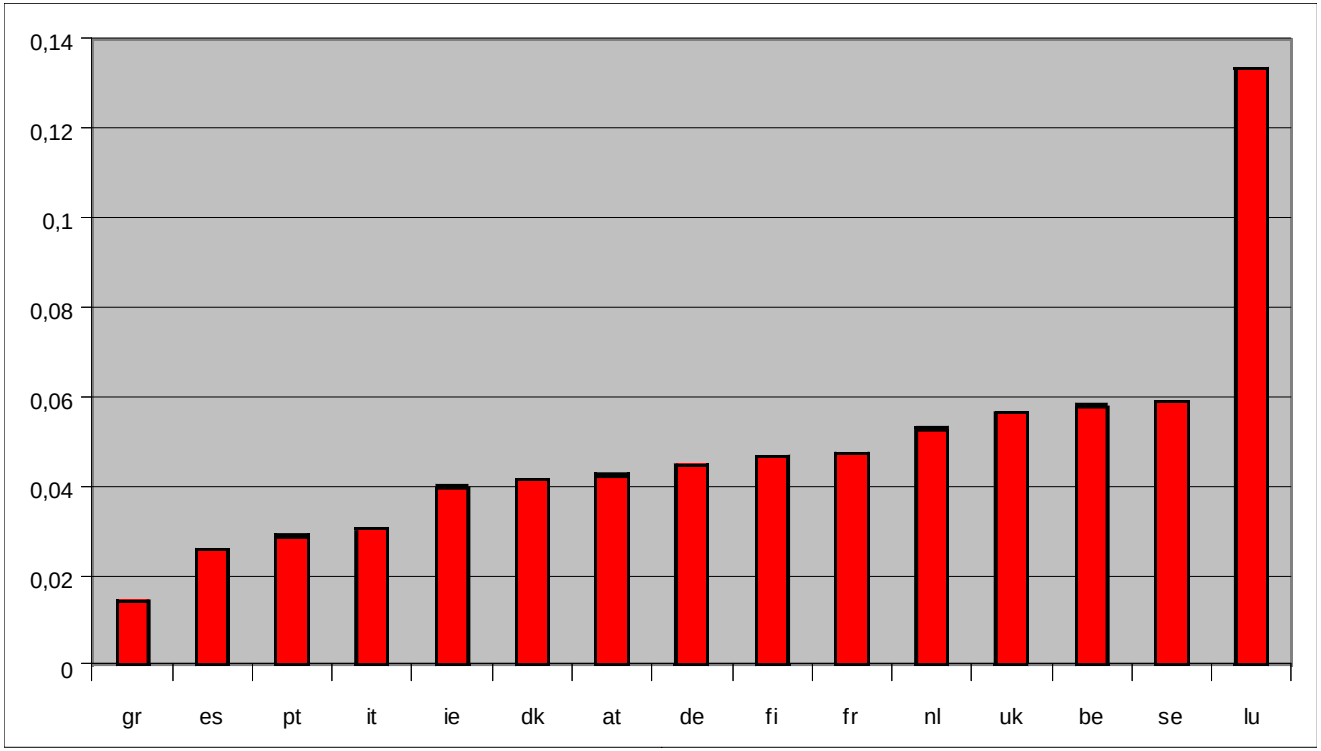


Figure 5: Level of intangible capital stock in the EU-15 countries, as a percentage of NEWGDP from 1995-2005 and normalized

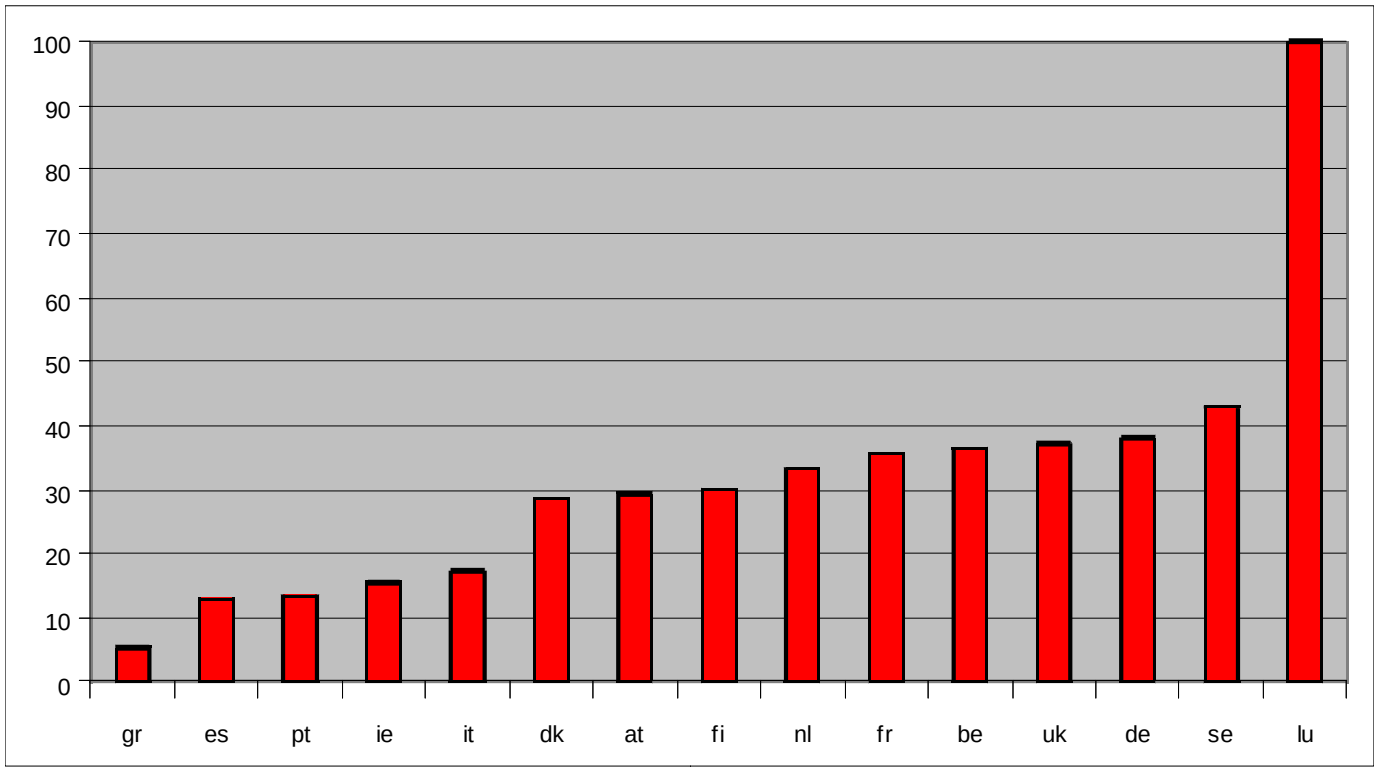
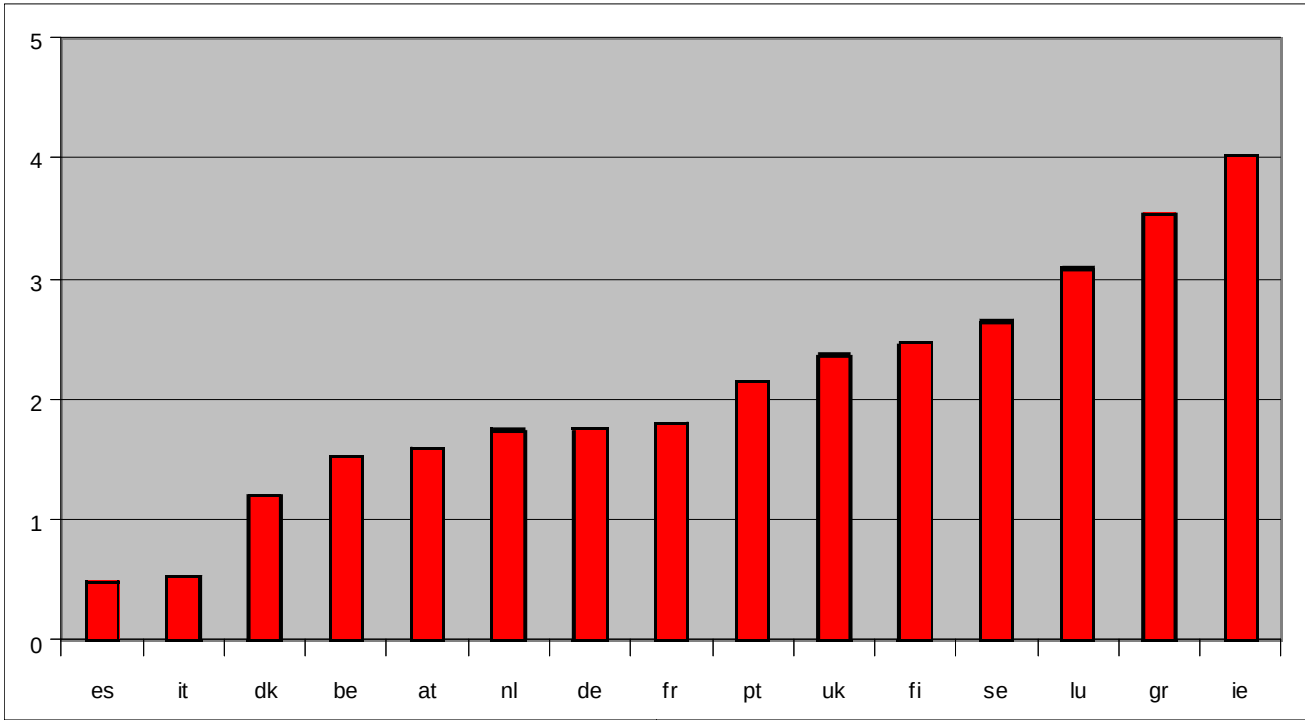
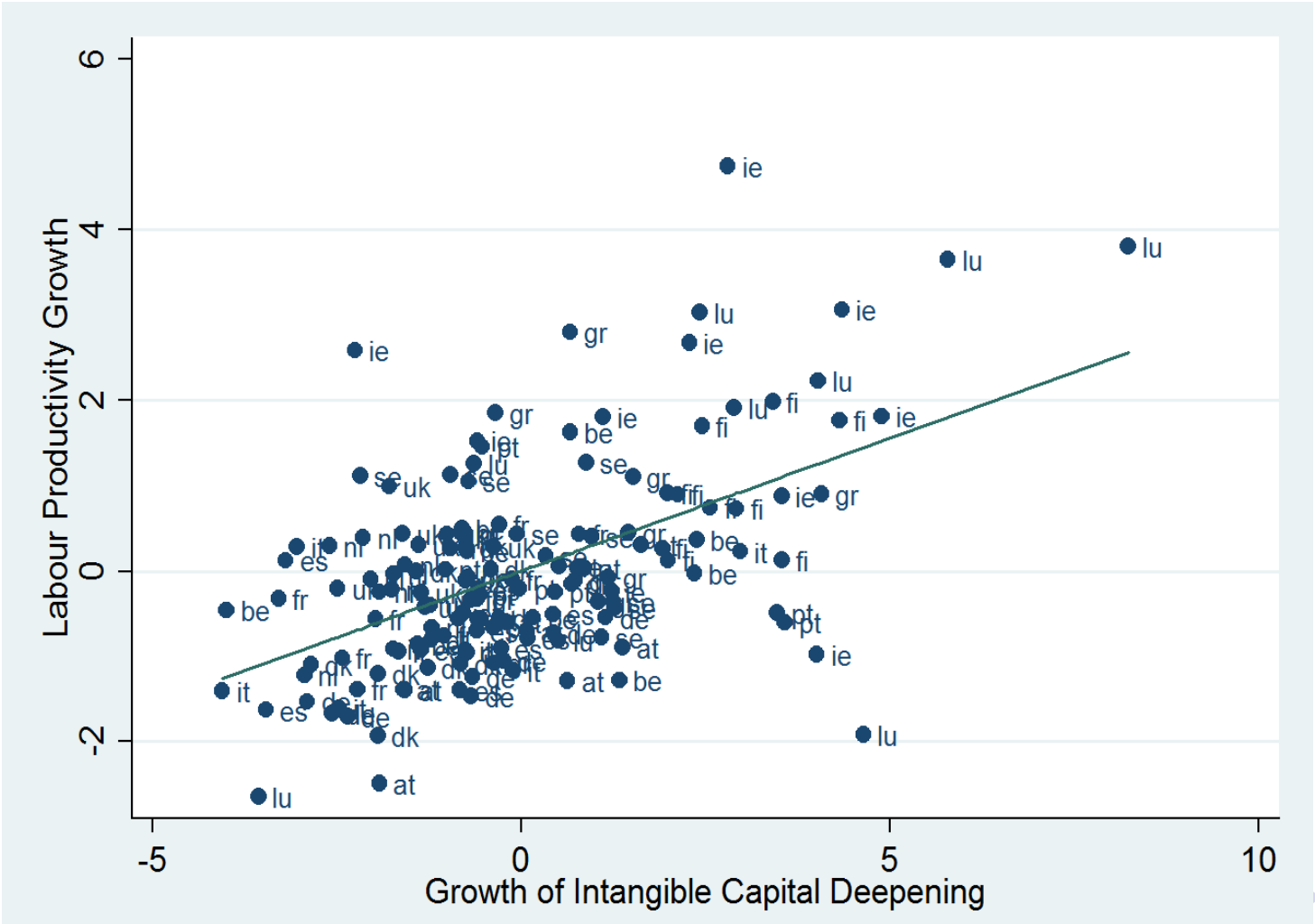


Figure 6: Growth rates of new labour productivity in the EU-15 countries, average over 1995-2005



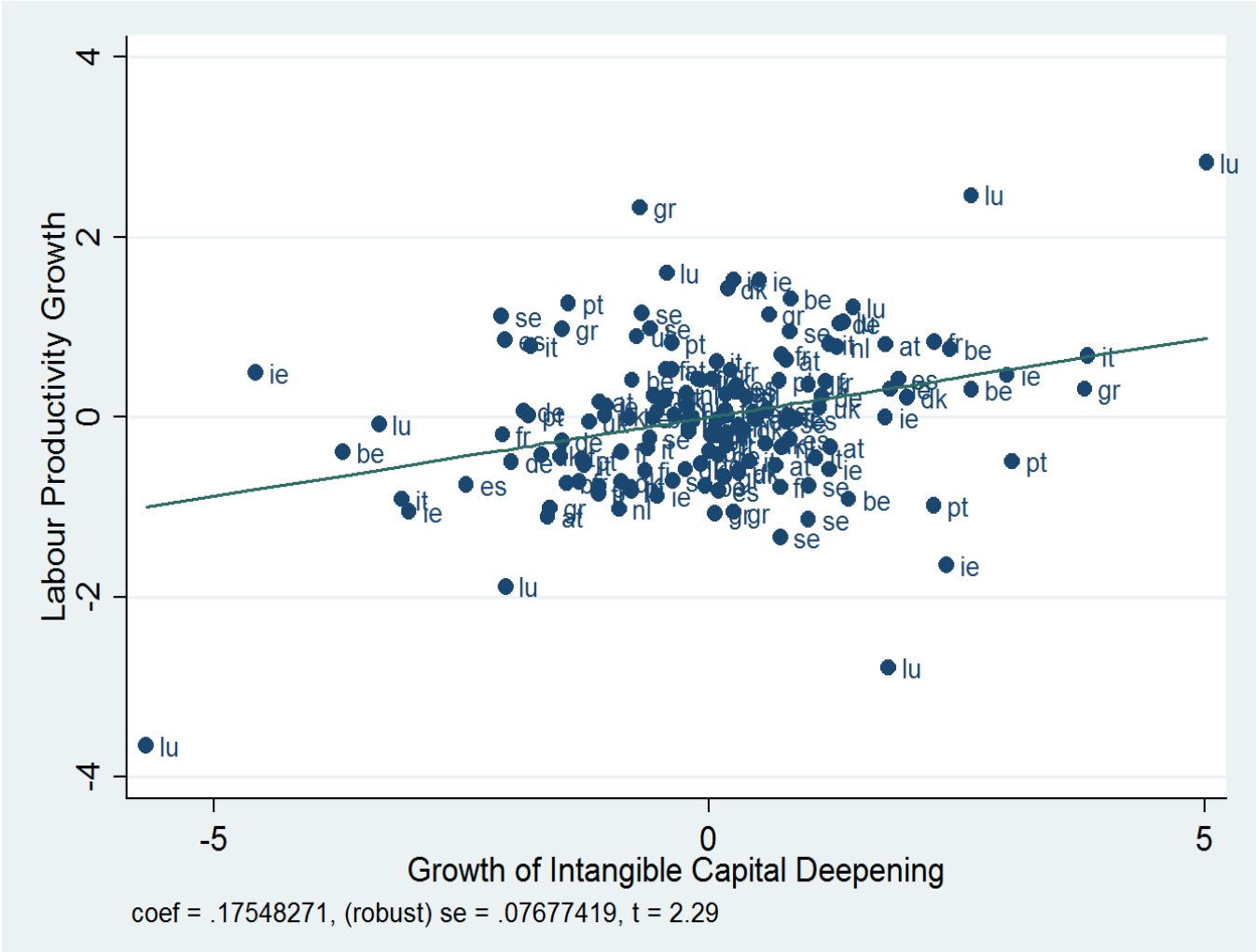
# 4. Descriptive Statistics

Figure 7: Partial regression plot between intangible capital deepening and labour productivity growth - pooled cross-section



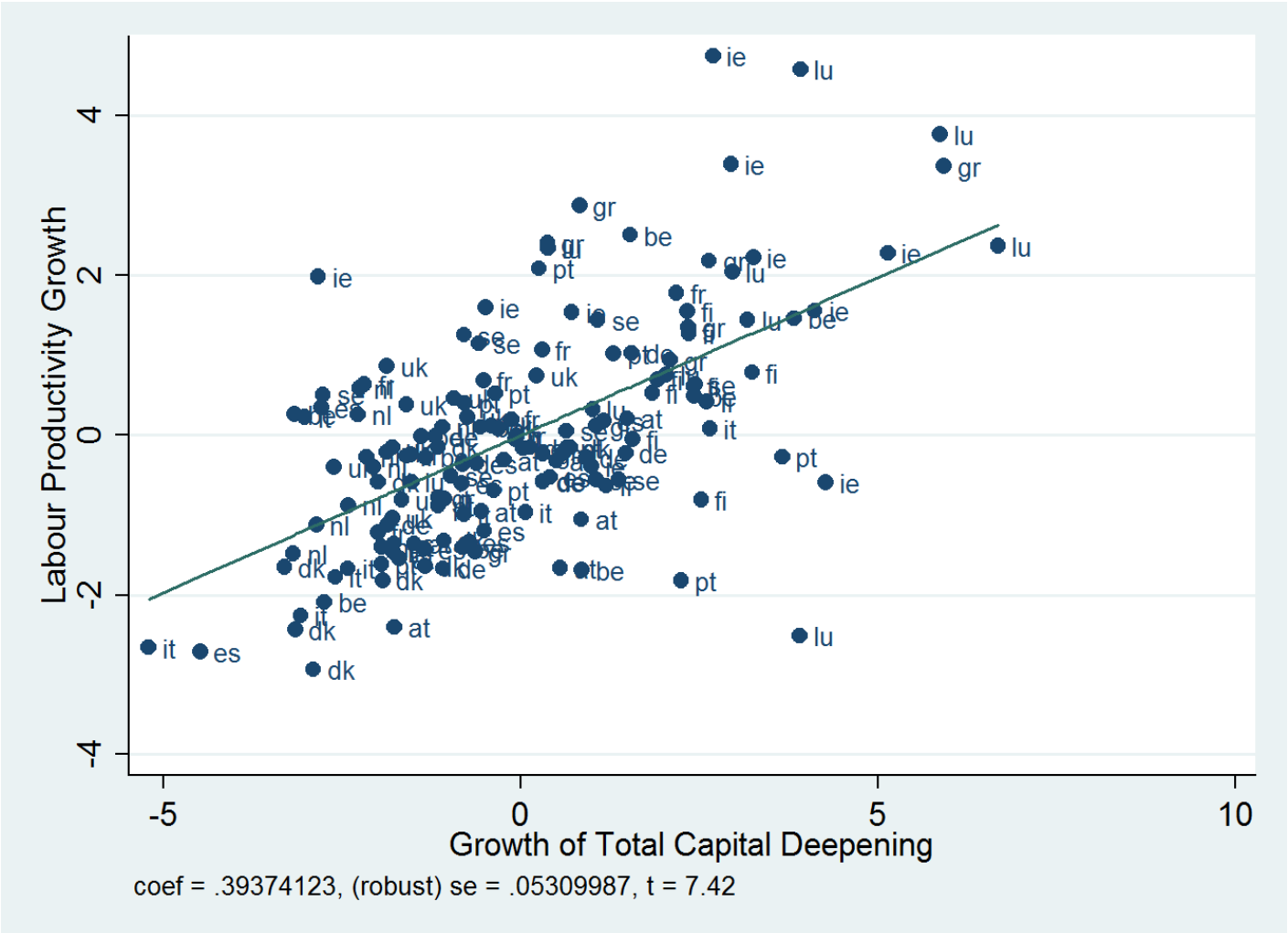
# 4. Descriptive Statistics

Figure 8: Partial regression plot between intangible capital deepening and labour productivity growth - fixed effects



# 4. Descriptive Statistics

Figure 9: Partial regression plot between total capital deepening and labour productivity growth - pooled cross-section



# 5. Econometric Analysis

Table 1: Intangible Capital and Labour Productivity Growth

| | (1) OLS | (2) OLS | (3) FE | (4) FE | (5) RE | (6) RE |
|---|---|---|---|---|---|---|
| Lagged Labour Productivity | -2.641*** | -1.569*** | -8.938*** | -10.32*** | -2.882** | -1.752 |
| | (0.575) | (0.578) | (2.844) | (2.887) | (1.262) | (1.068) |
| Growth of Hours Worked | -0.586*** | -0.693*** | -0.694*** | -0.691*** | -0.681*** | -0.706*** |
| | (0.0988) | (0.0847) | (0.104) | (0.0773) | (0.0945) | (0.0922) |
| Education | 2.639*** | 1.948*** | 1.769 | 1.626 | 2.256*** | 1.903*** |
| | (0.419) | (0.425) | (1.582) | (1.179) | (0.779) | (0.649) |
| Growth of Physical Capital | 0.891*** | 0.605*** | 0.607 | 0.645** | 0.661*** | 0.581*** |
| | (0.125) | (0.141) | (0.350) | (0.282) | (0.171) | (0.191) |
| Growth of Intangible Capital | | 0.290*** | | 0.190* | | 0.237*** |
| | | (0.0528) | | (0.107) | | (0.0707) |
| Proxy Business Cycle | -6.137* | -10.06*** | -22.71** | -26.80*** | -14.47** | -14.01*** |
| | (3.343) | (3.083) | (9.762) | (7.617) | (6.408) | (5.123) |
| Constant | 3.290 | 6.676** | 45.34** | 54.46*** | 15.55** | 12.10** |
| | (3.168) | (2.777) | (16.12) | (10.06) | (6.820) | (4.951) |
| Observations | 150 | 150 | 150 | 150 | 150 | 150 |
| R-squared | 0.513 | 0.602 | 0.613 | 0.604 | 0.416 | 0.5749 |
| R-squared (within) | 0.513 | 0.602 | 0.613 | 0.604 | 0.416 | 0.5749 |
| Time effects | yes | yes | yes | yes | yes | yes |
| Number of countries | 15 | 15 | 15 | 15 | 15 | 15 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# 5. Econometric Analysis

Table 2: Intangible Capital Deepening and Labour Productivity Growth

| | (1) OLS | (2) OLS | (3) FE | (4) FE | (5) RE | (6) RE |
|---|---|---|---|---|---|---|
| Lagged Labour Productivity | -2.040*** | -1.192** | -9.344*** | -9.628*** | -3.227** | -1.545 |
| | (0.511) | (0.543) | (2.976) | (3.166) | (1.319) | (1.091) |
| Education | 1.936*** | 1.477*** | 1.641 | 1.895 | 2.379*** | 1.658*** |
| | (0.332) | (0.326) | (1.375) | (1.408) | (0.735) | (0.580) |
| Capital Deepening | 0.662*** | 0.438*** | 0.683*** | 0.525*** | 0.679*** | 0.488*** |
| | (0.0918) | (0.0949) | (0.130) | (0.152) | (0.0921) | (0.116) |
| Intangible Capital Deepening | | 0.312*** | | 0.175 | | 0.235*** |
| | | (0.0545) | | (0.104) | | (0.0703) |
| Proxy Business Cycle | -4.166 | -9.440*** | -23.54** | -25.09*** | -16.21*** | -13.00*** |
| | (3.162) | (3.010) | (8.104) | (6.176) | (6.190) | (4.792) |
| Constant | 4.338 | 7.190*** | 47.73*** | 49.91*** | 17.74** | 10.40** |
| | (3.016) | (2.726) | (13.07) | (10.89) | (7.144) | (5.033) |
| Observations | 150 | 150 | 150 | 150 | 150 | 150 |
| R-squared | 0.472 | 0.587 | 0.612 | 0.602 | 0.4027 | 0.5607 |
| Number of countries | 15 | 15 | 15 | 15 | 15 | 15 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# 5. Econometric Analysis

Table 3: Total Capital Deepening and Labour Productivity Growth

| | (1) OLS | (2) OLS | (3) OLS | (4) OLS |
|---|---|---|---|---|
| Lagged Labour Productivity | -2.590*** | -2.040*** | -1.578** | -1.578** |
| | (0.699) | (0.511) | (0.793) | (0.605) |
| Education | 1.292*** | 1.936*** | 0.887** | 1.101*** |
| | (0.404) | (0.332) | (0.448) | (0.349) |
| Capital Deepening | | 0.662*** | | |
| | | (0.0918) | | |
| Total Capital Deepening | | | | 0.394*** |
| | | | | (0.0531) |
| Proxy Business Cycle | 5.692 | -4.166 | 8.710** | -5.802* |
| | (3.511) | (3.162) | (3.839) | (3.195) |
| Constant | 0.0451 | 4.338 | -4.110 | 7.624** |
| | (3.470) | (3.016) | (3.914) | (3.060) |
| Observations | 150 | 150 | 150 | 150 |
| Time Effects | yes | yes | yes | yes |
| R-squared | 0.252 | 0.472 | 0.226 | 0.509 |
| Number of Countries | 15 | 15 | 15 | 15 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# 5. Econometric Analysis

Table 4: Arellano and Bond Dynamic Panel Estimation

| | (1) GMM diff | (2) GMM diff | (3) GMM sys | (4) GMM sys |
|---|---|---|---|---|
| Lagged Labour Productivity | -1.127 | -13.99 | -1.774* | -0.654 |
| | (7.941) | (10.49) | (1.037) | (0.472) |
| Education | -2.153 | -3.425 | 1.764** | 1.189*** |
| | (2.403) | (2.598) | (0.697) | (0.449) |
| Capital Deepening | 0.776*** | 0.227* | 0.686*** | 0.459*** |
| | (0.131) | (0.122) | (0.138) | (0.117) |
| Intangible Capital Deepening | | 0.416*** | | 0.330*** |
| | | (0.121) | | (0.0731) |
| Proxy Business Cycle | -23.60 | -2.514 | -6.769 | -15.08* |
| | (20.42) | (33.85) | (5.727) | (8.224) |
| Constant | | | 5.485 | 11.44 |
| | | | (5.702) | (7.849) |
| Observations | 135 | 135 | 150 | 150 |
| Time Effects | yes | yes | yes | yes |
| Number of countryn | 15 | 15 | 15 | 15 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# 5. Econometric Analysis

## Table 5: Sensitivity Analysis

| Row | Specification Change | Intangible Capital | Standard Error | Countries | Obs | Additional Variable | R squared |
|---|---|---|---|---|---|---|---|
| | *Influential Cases* | | | | | | |
| (1) | None | 0.330*** | (0.0731) | 15 | 150 | - | 0.5607 |
| (2) | Out Luxemburg | 0.193** | (0.0965) | 14 | 140 | - | 0.5071 |
| (3) | Out Ireland | 0.285*** | (0.0837) | 14 | 140 | - | 0.6421 |
| | *Restructuring of data* | | | | | | |
| (4) | 1995-2000 | 0.390*** | (0.0873) | 15 | 75 | - | 0.5696 |
| (5) | 2001-2005 | 0.319*** | (0.101) | 15 | 75 | - | 0.6134 |
| | *Restructuring of Sample* | | | | | | |
| (6) | Mediterranean | 0.0854 | (0.138) | 4 | 40 | - | 0.8939 |
| (7) | Coordinated | 0.335*** | (0.0935) | 6 | 60 | - | 0.687 |
| (8) | Scandinavian | -0.0370 | (0.181) | 3 | 30 | - | 0.8058 |
| (9) | Liberal | -0.273 | - | 2 | 20 | - | 0.9735 |
| | *Specifications* | | | | | | |
| (9) | Stocks of inward FDI | 0.235*** | (0.0853) | 14 | 121 | 0.0164*** | 0.6284 |
| (10) | Openness to trade | 0.255*** | (0.0639) | 15 | 135 | 0.0149*** | 0.5231 |
| (11) | Stock Market Capitalization | 0.291*** | (0.0467) | 15 | 139 | 0.00651** | 0.6209 |
| (12) | Inflation | 0.269*** | (0.0565) | 15 | 150 | -0.162** | 0.6094 |
| (13) | Income tax | 0.327*** | (0.0670) | 15 | 150 | 0.0104 | 0.5568 |
| (14) | Government Efficiency | 0.286** | (0.118) | 15 | 105 | 0.442 | 0.6294 |
| (15) | Political Stability | 0.260** | (0.127) | 15 | 105 | 0.977* | 0.6265 |
| (16) | Government Expenditure | 0.254*** | (0.0635) | 15 | 150 | -0.0710*** | 0.5904 |
| (17) | Education Expenditure | 0.295*** | (0.0644) | 15 | 150 | -0.0574 | 0.5602 |
| (18) | Social Expenditure | 0.214*** | (0.0754) | 15 | 149 | -0.133*** | 0.5981 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Conclusion

- Business intangible capital proves to be positively and significantly related to labour productivity growth; the relation seems to be stronger across countries than within countries
- the relation is slightly stronger in 1995-2000 and in coordinated countries
- labour productivity grows faster when including intangible capital in the asset boundary of the national accounting framework
- capital deepening becomes more important when taking intangibles into account
- not only R&D matters for economic growth, but also other elements of intangible capital
- incorporating intangible capital into today's national accounts seems necessary and crucial for the step towards the knowledge economy
- in future work, even more dimensions of intangible capital should be included