TECHNOLOGY AND HETEROGENEOUS CAPITAL: EXPLAINING THE DECLINE OF THE LABOR SHARE

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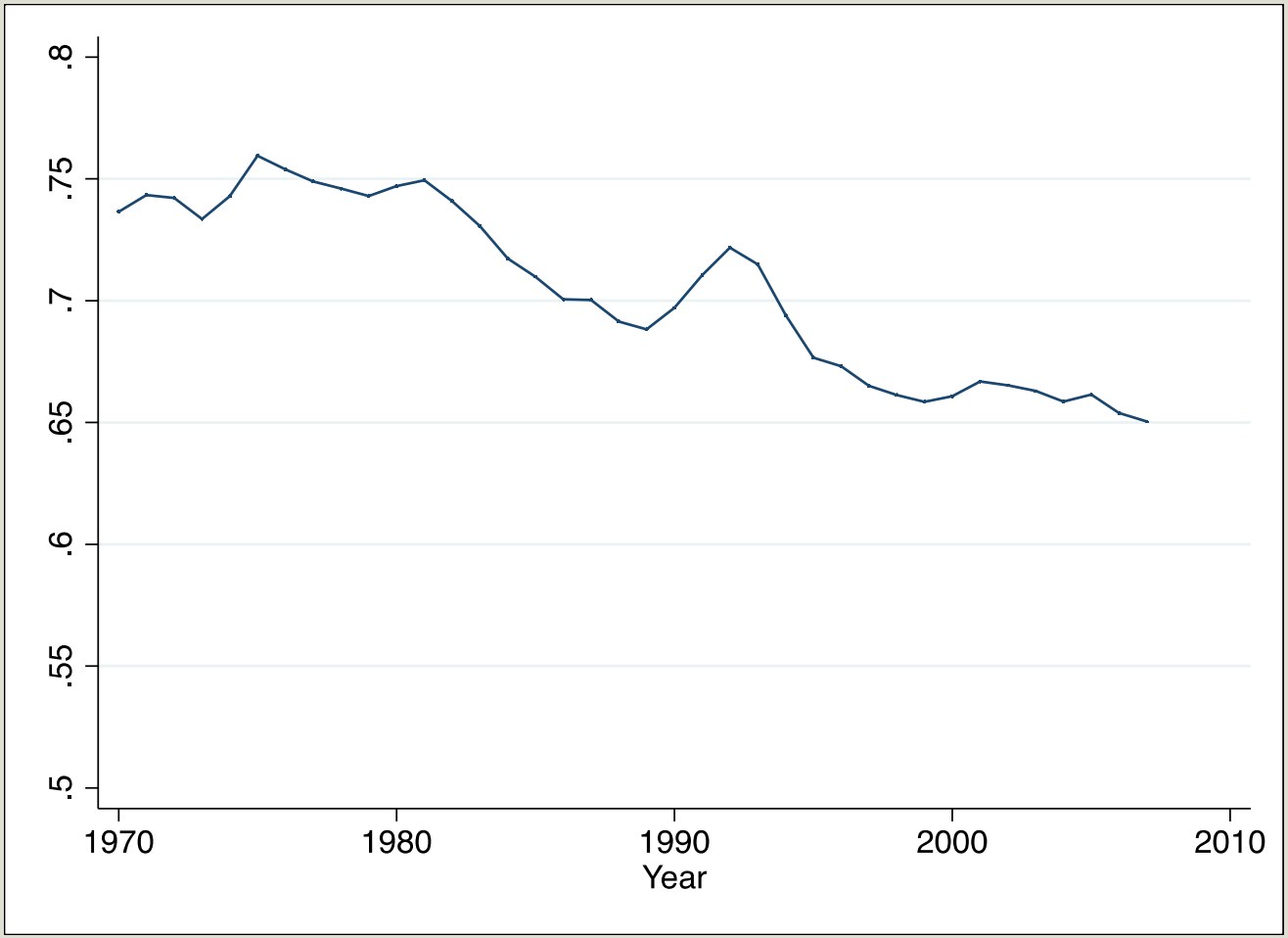
Labour share dynamics in OECD countries, (1970-2007)

Wage bill as a share of GDP, average across countries



What factors affect the movements of the labour shares?

- **Technological change**: new technologies/robotization (Bentolila & Saint Paul, 2003; Karabourbonis & Neiman, 2014; Acemoglu & Restrepo, 2017)

- **Market regulations** (Blanchard & Giavazzi 2003, Checchi and Penalosa, 2010, Bassanini and Manfredi 2012);

- **Globalization** (Elsby et al. 2013, Haskel et al. 2012)

What factors affect the movements of the labour shares?

- **Many previous papers focused on labour's share as payments to labour divided by GDP.**
- **Capital's share is therefore calculated as a residual.**
  – Recent focus on this residual
- **Profits and Market concentration:** (Barkai 2016; Autor et al. 2017)
- **Return to unmeasured intangible capital** (Timmer et al. 2018, this paper)

Capital Heterogeneity

Capital heterogeneity is at the centre of productivity analysis

Earlier focus on distinguishing ICT from other forms of capital (Jorgenson and Stiroh, 2000); Timmer et al., 2010)

More recent research measuring intangible assets (Corrado et al. 2005, 2009, Niebel et al. 2016).

Do these assets substitute for or complement labour? And what type of labour?

Objectives of the paper

Expand on the concept of ‘capital’

- Substitution/complementarity effects – better understanding of how different types of capital assets are driving the labour share

Technology: need to distinguish between long and short-run effects/trend and cyclical components

Address the time series properties of the data

Endogeneity

Analytical framework

Previous analysis (e.g. Bentolila and St Paul, 2003) was based on the specification of a CES production function, with two inputs Labour (L) and Capital (K):

$$Y = [\alpha(A_L L^{-\sigma} + (1-\alpha)(A_K K^{-\sigma}]^{-\frac{1}{\sigma}}$$

Where the elasticity of substitution equals:

$$\eta = \frac{1}{1+\sigma}$$

In that case labour's share can be written as:

$$S_L = 1 - S_K \quad = 1 - (1-\alpha)(A_K)^{-\sigma}\tilde{k}^{-\sigma}$$

Where $\tilde{k}$ is the capital output ratio and A_K is capital augmenting technical progress.

Analytical framework

Extending to 2K and 2L

$K = K_I^{\beta} K_N^{1-\beta} \qquad 0 < \beta < 1$

$L = L_S^{\gamma} L_U^{1-\gamma} \qquad 0 < \gamma < 1$

Using this setting we obtain that when the elasticity of substitution, η >1:

$\frac{\partial LS}{\partial \tilde{k}_I} < 0 \qquad \frac{\partial LS}{\partial \tilde{k}_N} < 0$ for a single labour type

$\frac{\partial LS_S}{\partial \tilde{k}_I} < 0 \qquad \frac{\partial LS_S}{\partial \tilde{k}_N} < 0$ for the shares by skill level

$\frac{\partial LS_U}{\partial \tilde{k}_I} < 0 \qquad \frac{\partial LS_U}{\partial \tilde{k}_N} < 0$

Alternative Analytical framework

Use a two sector model with each using different types of capital and labour. For example, a high tech sector could use knowledge capital and skilled labour and a traditional sector could use unskilled labour and tangible capital. Denote sectors by I and N. Aggregate output is given by:

$$Y = \left[\Phi_I Y_I^{-\varepsilon} + \Phi_N Y_N^{-\varepsilon}\right]^{-\frac{1}{\varepsilon}}$$

Where ε is the substitution parameter between goods.
Assuming perfect competition, the relative demand for good i is:

$$Y_i/Y = \Phi_i^{\lambda} (P_i / P)^{-\lambda}$$

Where λ = 1/(1+ε) and P is the price of aggregate output.
Each sector produces with a CES production function as before:

$$Y_i = \left[\alpha_i (A_L L_i^{-\sigma_i} + (1-\alpha_i)(A_K K_i^{-\sigma_i}\right]^{-\frac{1}{\sigma_i}}$$

And the derivative of LS_i w.r.t. its capital output ratio depends on the elasticity of substitution.

Alternative Analytical framework

At the aggregate level, the labour share is a weighted average of industry labour shares:

$$LS = LS_I\ \omega_I + LS_N\ \omega_N$$

Where ω_i is the share of the value of output of sector i relative to aggregate output.

$$\omega_i = P_i Y_i / PY$$

Then the impact of the capital output ratio in industry I on the aggregate labour share depends on its share of output.

$$\frac{\delta LS}{\delta \tilde{k}_I} = \frac{\delta LS_I}{\delta \tilde{k}_I}\omega_I + \frac{\delta \omega_I}{\delta \tilde{k}_I}\left(LS_I - LS_N\right)$$

within between

Alternative Analytical framework

The within effect depends on the elasticity of substitution in production. Using the relative demand condition above, it can be shown that:

$$\frac{\delta \omega_I}{\delta \tilde{k}_I} = -\varepsilon \Phi \frac{Y_I}{Y}^{-\varepsilon-1} \frac{1}{Y} \frac{\delta Y_I}{\delta \tilde{k}_I} \left(1 - \frac{Y_I}{Y} \frac{\delta Y}{\delta Y_I}\right)$$

If goods are substitutes or weak complements then this term is negative. However if they are strong complements the share of Y_I might decrease, depending on the movement of relative prices, and this term could be positive.

Within this alternative framework, we can have a positive or negative impact of the sector capital output ratios on aggregate labor shares, depending on the relative sizes of the within and between effects.

Structure of the empirical analysis

Part 1: data covering a long time period (1970-2007) & fully dynamic specification. We account for ICT and non-ICT capital, as well as knowledge intensive capital (R&D and patents)

Part 2: includes new data on a broader range of intangible assets, but estimation confined to 1995-2007 period.

In both the labor share is defined as the ratio of total compensation (including non-wage labor costs such as social insurance contributions) over gross value added.

And including an imputation for the self employed

Empirical specification

The static specification distinguishing two types of capital:

$$lnLS_{ijt} = \alpha_{0ij} + \alpha_1 lnA_{ijt} + \alpha_2 ln\tilde{k}_{N,ijt} + \alpha_3 ln\tilde{k}_{I,ijt} + \varepsilon_{ijt}$$

$$LS = \frac{wL}{Y} \quad \text{and} \quad \tilde{k} = \frac{K}{Y}$$

We also add knowledge capital

R&D stock in Part 1

And broader measures of intangibles in Part 2

Estimation method

The static model is affected by three main specifications issues (Eberhardt and Bond 2013):

- Variable non-stationarity
- Parameter heterogeneity
- Cross-sectional dependence (CSD)

ECM specification, with controls for cross-sectional dependence (AMG) – Eberhardt and Teal (2013):

$$\Delta \ln S_{Lijt} = \gamma_{0jt} + \gamma_1 \Delta \ln TFP_{ijt} + \gamma_2 \Delta \ln \tilde{k}_{ijt} + \gamma_3 \ln S_{Lijt-1} + \gamma_4 \ln TFP_{ijt-1} + \gamma_5 \ln \tilde{k}_{ijt-1} + \varepsilon_{ijt}$$

And similarly with different types of capital

Data

Part 1

14 EU countries + US + Japan, 20 industries per country. Time: 1970-2007

EUKLEMS: labour shares (total compensation/VA), including non wage labour costs and remuneration of self-employed, capital (ict and non-ict)

OECD ANBERD: R&D

Part 2

Similar EUKLEMS data for 1995-2007

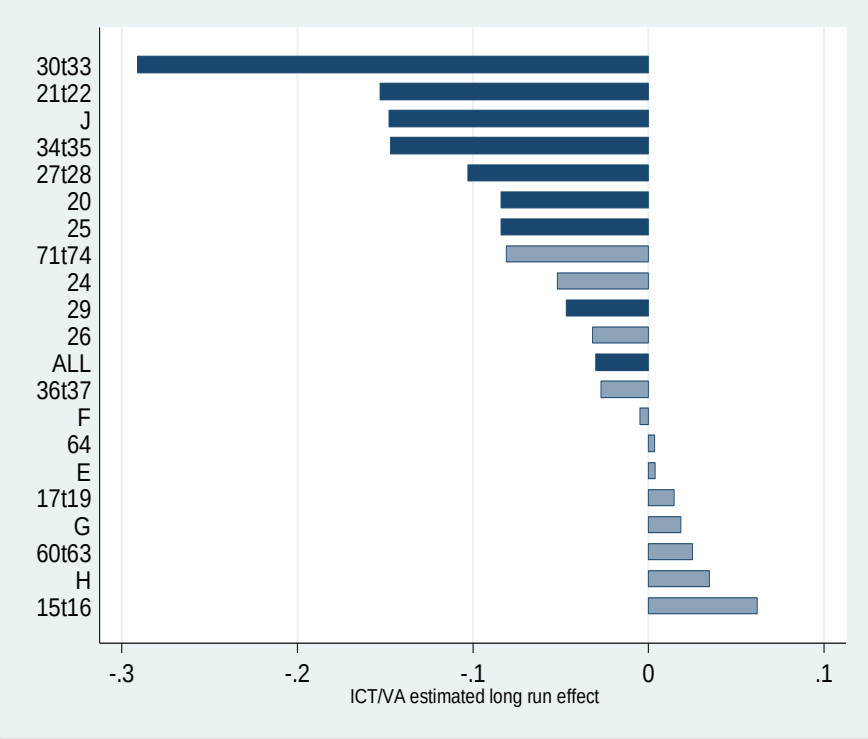
Add Intangible capital, based on estimates by Corrado, Haskel, Jona-Lasinio and Iommi

In both parts we also include a division of labour into skilled (university educated) and low/intermediate skilled

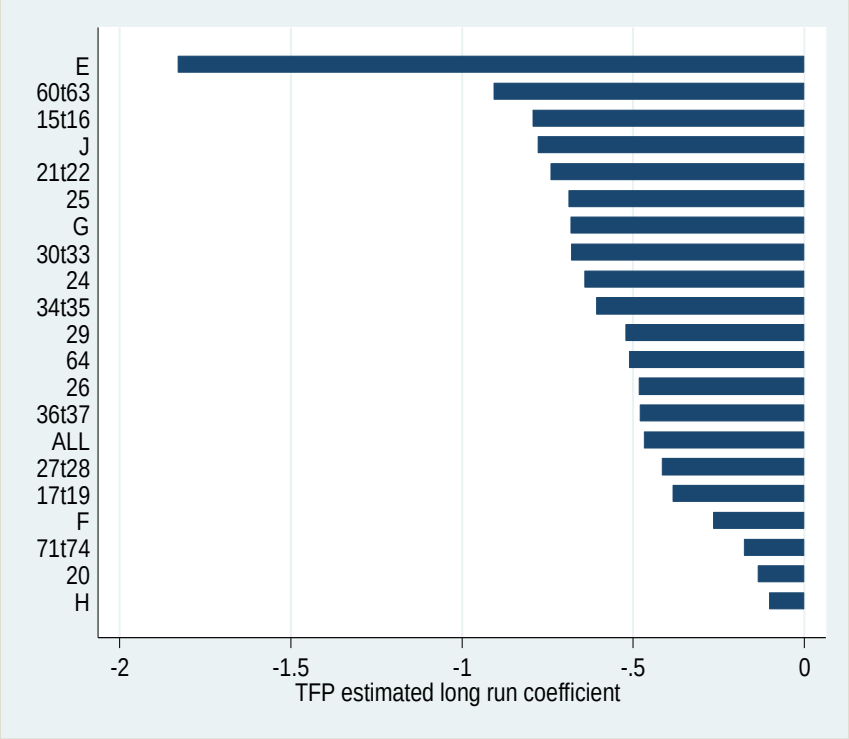
Long-run coefficients – baseline specification

Explanatory variables	Homogeneous coefficients	Heterogeneous Coefficients AMG	
	(1)	(2)	(3)
Total Factor Productivity (TFP)	-0.187***	-0.395***	-0.457***
	(0.000)	(0.000)	(0.000)
Total capital/ value added	-0.010	-0.070**	
	(0.666)	(0.016)	
Non-ICT capital/value added			-0.022
			(0.653)
ICT capital/ value added			-0.037***
			(0.000)
ECM	-0.134***	-0.515***	-0.632***
	(0.000)	(0.000)	(0.000)
Obs	8620	8620	8620
Groups	340	340	340

Baseline specification by Industry, ICT and TFP



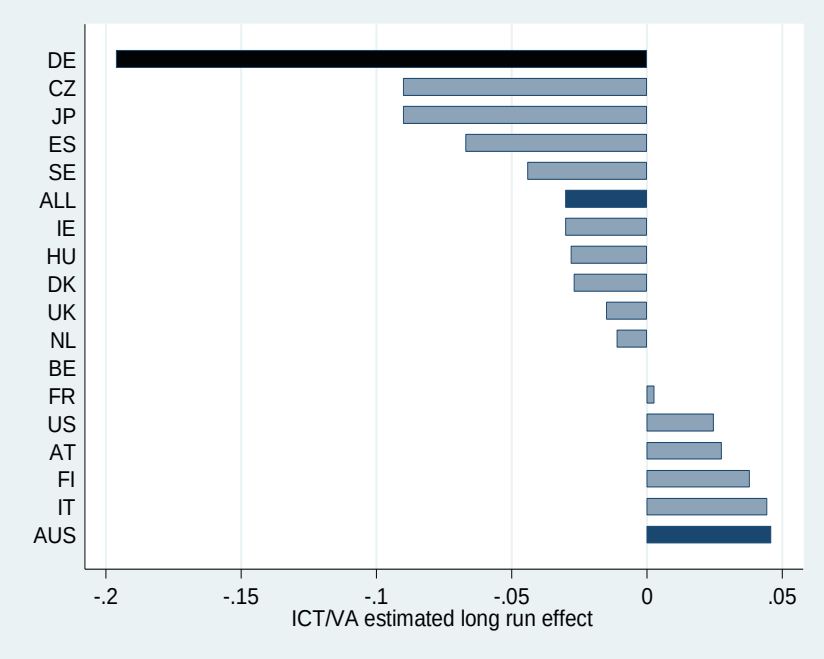
ICT/va



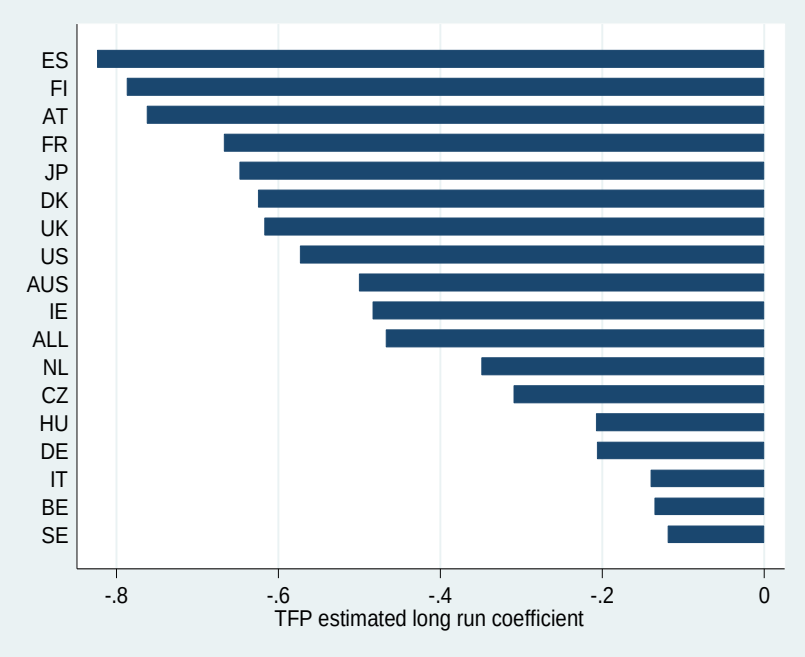
TFP

ICT negative in most industries – positive coefficients are not statistically significant (light bars). TFP is always negative and significant

Baseline specification by Country, ICT and TFP



ICT/va



TFP

Impacts of ICT not so apparent for countries. Lends some support to previous findings that industry variation is the more important source of variation, at least for ICT.

Introducing knowledge capital

THE IMPACT OF TANGIBLE AND KNOWLEDGE CAPITAL, (LONG RUN COEFFICIENTS)

	Total LS	Low/intermediate skilled LS	High skilled LS
	(1)	(2)	(3)
TFP	-0.372*** (0.000)	-0.345*** (0.000)	-0.474*** (0.000)
Non-ICT Cap. /VA	-0.003 (0.093)	-0.046 (0.523)	0.082 (0.529)
ICT Cap./VA	-0.045** (0.000)	-0.065*** (0.000)	-0.036 (0.230)
Knowledge Cap. /VA	0.052** (0.014)	0.035 (0.121)	0.005 (0.899)
ECM	-0.745*** (0.000)	-0.774*** (0.000)	-0.763*** (0.000)
Obs	4648	4018	4018
Groups	171	158	158

Empirical analysis part 2. Intangible capital assets

Second part of the paper: data developed by Corrado, Hulten and Sichel (2005-2009) and Niebel et al. (2016)

Computerized information (mainly software)

Innovative property (R&D, architectural and engineering design, mineral exploration, new products development costs in fin. Industry)

Economic competencies (spending on strategic planning, organizational changes, worker training, redesigning or reconfiguring existing products, brand development)

Also consider different skill levels

Econometric methods

Reduced time period in this sample (1995-2007) prevents the use of mean group estimators

Fixed effect estimator, with controls for first order serial correlation (Prais-Winsten estimator)

Distinguish between **trend** and **cyclical** TFP component – using Hodrick-Prescott filter

We also attempt to address endogeneity issues

THE IMPACT OF INTANGIBLE ASSETS ON LABOR SHARES

	Total LS		Low/intermediate skilled LS	Skilled LS
TFP - trend	**-0.209*** (0.027)**	**-0.185*** (0.027)**	**-0.271*** (0.031)**	**0.316*** (0.049)**
TFP - cycle	**-0.578*** (0.030)**	**-0.536*** (0.031)**	**-0.509*** (0.036)**	**-0.306*** (0.057)**
Non-ICT cap/VA	**0.000 (0.022)**	**-0.003 (0.022)**	**0.065** (0.026)**	**0.056* (0.033)**
ICT cap./VA	**-0.0125*** (0.004)**	**-0.0132*** (0.004)**	**-0.071*** (0.004)**	**0.166*** (0.008)**
Intangibles/VA	**-0.034*** (0.012)**			
Innovative properties/VA		**0.064*** (0.018)**	**0.093*** (0.021)**	**-0.023 (0.031)**
Econ. Competencies/VA		**-0.046*** (0.017)**	**-0.072*** (0.020)**	**0.095*** (0.031)**
Observations	**4,120**	**4,120**	**4,120**	**4,120**
R-squared	**0.902**	**0.900**	**0.982**	**0.912**

Addressing endogeneity

Labour share: enters the computation of TFP

Changes in factors' prices causes movements in both the labour and the capital share

Instruments: use information on the regulatory setting:

- Telecom services regulation (for ICT)
- Architectural and engineering services regulation (for innovative intangibles)
- Legal and accounting services regulation (for economic competencies)

We multiply the regulation indicator with the intensity of use of the respective service in each sector, using the 2000 share of intermediate service purchases over total intermediates expenditure from WIOD.

THE IMPACT OF INTANGIBLE ASSETS ON LABOR SHARES: IV ESTIMATES

	Total LS	Low/intermediate skilled LS	Skilled LS
TFP - trend	-0.3437***	-0.4651***	0.0463
	[0.0739]	[0.1338]	[0.1368]
TFP - cycle	-0.6611***	-0.7234***	-0.4735***
	[0.0792]	[0.1403]	[0.1439]
Non-ICT cap/VA	0.0256	0.1016*	0.1203***
	[0.0271]	[0.0530]	[0.0374]
ICT cap./VA	0.0171*	-0.0600***	0.2188***
	[0.0091]	[0.0159]	[0.0176]
Intangibles/VA			
Innovative properties/VA	0.0929	0.2356	-0.5889***
	[0.0943]	[0.1542]	[0.1556]
Econ. Competencies/VA	-0.3354***	-0.5320***	0.1976
	[0.0705]	[0.1211]	[0.1356]
Observations	3,580	3,580	3,580
Hansen J test	0.303	0.405	0.670
Hansen P value	0.582	0.525	0.413
Kleibergen-Paap LM statistic	102.205	49.567	103.372
Kleibergen-Paap P value	0.000	0.000	0.000

Conclusions

- Focusing on heterogeneous capital suggests the labor share depends on different types of capital in different directions
- ICT capital appears to dominate in terms of the long run decline
- Intangible capital is also important
- A back of the envelope calculation suggests that of the decline in average labor share from 0.63 in 1995 to 0.60 in 2007, about 20% is due to using more ICT capital and 10% from using more intangible capital
- Within intangibles, those complementary with ICT, economic competencies, are associated with a decline in labor's share whereas knowledge capital is associated with an increase
- These assets are all characterised by rapid depreciation


THANK YOU FOR
LISTENING