

The Trend in Labour Income Share: the Role of Technological Change in Imperfect Labour Markets

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Version: 25.08.2016
Preliminary draft - Do not circulate

Abstract

The non-constancy of factor shares is raising the attention of many researchers. We contribute to the literature by documenting an average drop of the labour share of 8 percentage points for eight European Countries and the US between 1980 and 2007. Speculating on the type of production function, we investigate theoretically and empirically two driving forces, the decline of Information Communication Technologies (ICT) investment price and the presence of frictions in the labour market. What we find is that cheaper ICT equipment represents the main channel for the labour share decline. Finally, we give interesting insights concerning the impact of labour market institutions and worker groups on the elasticity of substitution between labour and ICT.

1 Introduction

The labour income share (LS) is used in many empirical studies as well as in several theoretical frameworks. Its constancy is one of the so called Kaldor's facts and a value of $2/3$ is usually adopted in several calibrations. However, recent studies reveal that it is declining for most of the OECD countries since the 1990's [OECD (2012), Raurich et al. (2012), Arpaia et al. (2009)]. This trend likely arises from technological progress, as argued by Karabarbounis and Neiman (2014), as well as change in institutional factors and international trade competition, as suggested by Elsbey et al. (2013a). It might be the case that this decreasing trend is part of a longer path at the end of which

the LS fluctuates without showing a clear positive or negative path. However, the LS decline shows up at the same time when new technologies become more and more substitute to labour, namely Information Communication Technologies (ICT).

The motivation behind this paper is to assess theoretically and empirically the impact of ICT equipment on the labour share. In particular, building on Karabarbounis and Neiman (2014) and on the job-polarization literature, we focus on the degree of substitution between ICT and labour, by modelling it together with labour market imperfections, as well as with institutional and compositional variables. To the best of our knowledge, there is no literature on that and in general there are few studies aimed at explaining the role of the new technologies for factor shares. The results we get are useful not only to understand what happened to capital and labour so far, but also to have an idea of the future trajectory of factor shares. Finally, by considering search frictions in the labour market, we take up the hint of Acemoglu and Autor (2011) of studying job-polarization under labour market imperfections.

We firstly compute the labour share from Euklems for Austria, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain and the US. The average LS dropped from 71% to 63% between 1980 to 2007. Concerning the sectoral differences, there is ambiguous evidence on whether this phenomenon is more within or between industries. The data we have have been used in previous studies to get indication of a stronger within industry component. From the same dataset we collect data on investment price of ICT and Non-ICT capital. Using the relative price index measure, as in Karabarbounis and Neiman (2014), we show how the decline of capital investment price is mainly connected to the ICT equipment price. Building on that, we set a theoretical framework to give a rationale to the relationship between ICT price and the labour share. The prediction is that a decline of the labour share is modelled either with a CES production function and an elasticity larger than one or with a Cobb-Douglas production function and labour market imperfections, job frictions here. When we assess the model quantitatively, the elasticity between labour and ICT equipment without search costs lies close to 1.17 and significantly different from one. However, in case of job frictions, the elasticity is still higher the one and about 1.12. This is generated by a low outflow-inflow employment ratio and gives support for the cheaper ICT explanation. In line with the theory, the estimates provide an interesting insight for factor shares modelling.

The last part of the empirical investigation is addressed to verify to what extent the impact of ICT on the LS is affected by country-specific labour market variables. Indeed it is reasonable to expect that the intensity of the substitution between labour and ICT might vary depending on the rules to hire and fire the labour input as well as on the level of human capital or type of tasks. Therefore, we collect data on institutional variables, namely employment protection legislation and degree of wage coordination,

and compositional variables, namely high-skill share and routine occupation share. The way we test for this effect is by modelling the elasticity parameter in a linear combination with the above variables. The main result is that a reduction of routine share is associated to a higher elasticity of substitution. This is an unconventional way to show the job polarization phenomenon, being in this view the potential mechanism behind the ICT-labour substitution.

The rest of the paper proceeds as follows. Section 2 documents the decline of the labour share and of the capital price index, at aggregate and country level. Here we provide evidence of the different evolutions of ICT and Non-ICT capital. Section 3 goes through the most recent facts concerning the impact of technological change on the labour market. In particular, we review the job-polarization theory and the role of ICT for routine tasks. This allows me in Section 4 to derive a theoretical setting that links the labour share to the ICT price index and to account for search costs. The prediction is that changes of the labour share are obtained under a CES function and an elasticity higher than 1 or under a Cobb-Douglas function and job frictions. Section 5 describes the data sources and the variables we use for the empirical analysis. Finally in Section 6 we assess the theoretical prediction and model the elasticity parameter on a set of country-specific labour market variables. The quantitative estimates reveal an elasticity higher than and provide interesting insights on how it reacts to different labour market conditions.

2 Labour Share and ICT Facts

The shares of national income that goes to labour and capital have been considered constant for many years. Kaldor in 1956 writes that there has been a

relative stability of these shares in the advanced capitalist economies over the last 100 years or so, despite the phenomenal changes in the techniques of production, in the accumulation of capital relative to labor and in real income per head.

This fact has been well described with the use of a Cobb-Douglas form of production function, that implies a constant elasticity of substitution between labour and capital of value one. However in the last decades several studies highlighted a decline of the LS for many developed countries. OECD (2012) reveals that the LS dropped in average by 5 percentage point between early 1990s and late 2000s, with significant differences among countries. The main conclusion is that new technologies, mainly ICTs, are probably the driving force of this decline and that increasing the matching quality could help to reverse the trend. A similar drop is computed by Karabarbounis and Neiman (2014) that analyses 59 countries at industry level and claims that the decline of the

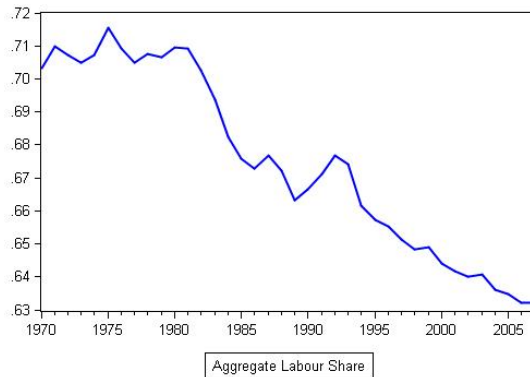


Figure 1: Labour Share, year fixed effects of country fixed effect regression (source Euklems)

price of investment goods is bringing down the LS given an elasticity of substitution of about 1.25. A detailed research for the US comes from Elsby et al. (2013a) and argues that the main LS decline is experienced by the manufacturing sector, potentially due to offshoring of labour-intensive productions, and that changes in institutional setting are negligible.

Using Euklems dataset we compute the labour share as labour compensation over value added at current basic prices between 1970 and 2007. Figure 1 shows the year fixed effects of a regression of LS on country and year fixed effects. A clear drop is visible starting from 1980 until the end of the time series. There are of course differences among countries, both in the timing and in the intensity of the decline, as shown in Figure 2. In particular, Denmark seems to not experience the same phenomenon as the LS is actually constant. Looking to the sectoral differences, in the literature there is ambiguous evidence concerning the degree of within-industry component of the LS decline¹. We don't go through the decomposition analysis, because we use the same dataset of Karabarbounis and Neiman (2014) and they already showed that the within component prevails.

As discussed above, Karabarbounis and Neiman (2014) is the closest paper to ours as they assess the impact of capital price index on the labour share. However we addressed our research on a specific capital asset, namely Information Communication

¹Karabarbounis and Neiman (2014), Elsby et al. (2013a) and OECD (2012)

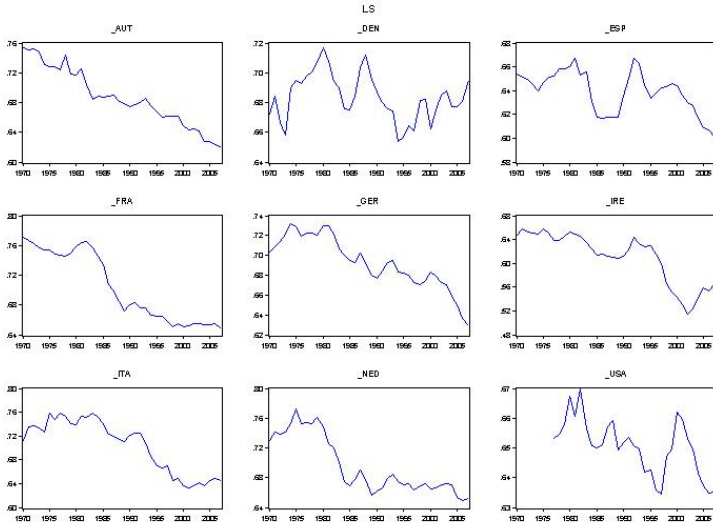


Figure 2: Labour Share for the countries in our sample (source Euklems)

Technology. The motivation is double: firstly, among all capital assets, ICT is the one that experienced the most significant price fall; secondly, ICT is the main candidate to substitute labour into the production. To this purpose, Figure 3 shows the price index for total, ICT and Non-ICT assets. The measure is the one used in Karabarbounis and Neiman (2014), namely gross fixed capital formation price index divided by price index of gross value added. Looking to the evolution of the time series, it is clear how the decline of the total assets price index is mainly related to Non-ICT equipment.

As far as the research on ICT asset is concerned, several studies emerged after year 2000, when new data on new technologies became available and allowed to investigate their contribution to output and productivity. The figures that emerged are the following. A high productivity growth rate for ICT-producing industries, especially in manufacturing, between 1979 and 2001. Secondly, a similar labour productivity in ICT producing sectors between US and EU as well as within Europe. In particular, ICT-producing industries play a significant role in the high labour productivity correlation among EU countries ². Lastly, connected with these facts is the trend of the price for investment in ICT. We computed it by making use of the nominal and real

²O'Mahony and Van Ark (2003)

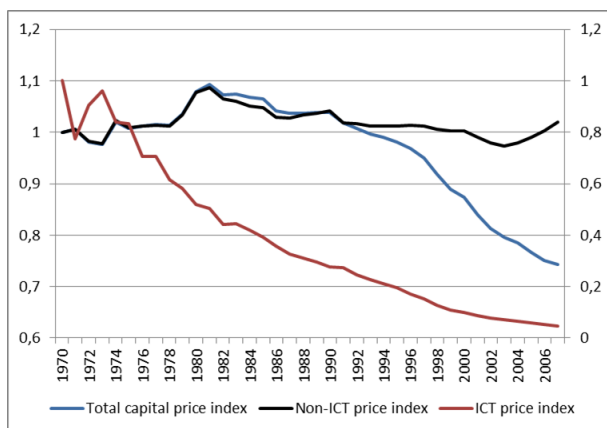


Figure 3: Price index per type of capital and total (source Euklems)

gross fixed capital formation index given by EUKLEMS dataset. Using this data a downward trend shows up, starting roughly around 1990 with an acceleration in the late 1990s. The main contributions on such decline come from Bosworth and Triplett (2000) and Jorgenson (2001), according to which it has been driven by the gain in capacity of microprocessors and storage devices. Table 1 shows the average investment price in ICT capital for three time spells between 1976 and 2005. In the period 1976-1985, almost all the countries experience a substantial increase, with the exception of Denmark (that reveals a positive growth rate in the early 1970s). In the late 1980s and early 1990s the decline of the ICT investment price begins for 6 European countries and the US and it becomes a clear common path from 1996 onwards. The acceleration post-1995 corresponds to the acceleration of the price decline for semiconductors³ revealed by Jorgenson (2001).

3 ICT Adoption and Labour Markets

The impressive adoption of ICT has obviously raised several questions and pushed the research to investigate its impact on labour markets. The common framework for long time has been the capital-skill complementarity, argued by Krusell et al. (2000) according to which the technological change has been skill-biased and has pushed the demand for high-skill workers, resulting in an increase of the skill premium. Acemoglu (2002)

³They are employed in microprocessors for encoding information in binary form

Table 1: Growth rate of ICT investment price (percent)

Countries/Average	1976-1985	1986-1995	1996-2005
Austria	2.2	-3.3	-11.0
Denmark	-3.5	-9.2	-12.1
Spain	10.0	0.1	-4.7
France	9.5	-0.6	-0.9
Germany	0.5	0.0	-10.1
Ireland	8.8	-2.8	-10.9
Italy	11.1	-0.1	-8.4
Netherlands	2.5	-4.2	-9.1
US	3.4	-4.1	-8.7

further develops this view by arguing that the abundance of an input (namely, high skill workers) into the production function can induce a biased technological change irrespective of the elasticity of substitution, the latter playing a role mainly in determining the reward of the factor.

However, the recent literature dealing with the spillover effects of technology highlights how the high substitutability of capital with labour is likely biased towards middle skill workers. Autor et al. (2003), Autor et al. (2006) and Acemoglu and Autor (2011) claim indeed that in the US labour market a job-polarization emerged around the 1990s, with wage growth and employment opportunities of middle-skill workers revealing a contracting path together with a substantial improvement for low and high skill occupations. The aim here is to interpret the decline of the labour share consistently with the job-polarization. Figure 4 reports the time series for ICT capital formation price index, total labour share and manufacturing labour share (given that Elsby et al. (2013a) argues that most of the LS decline is in manufacturing). Even if the paths are different among countries, there is an interesting overlapping of the labour share decline and the ICT price index decline. Moreover, Spain, Italy, Germany and Ireland don't show significant fluctuations of the labour share until the dramatic declining trend for ICT price.

The question is: how can the two trends be related to each other? What we know from job-polarization theory is that there are routine tasks in the labour market that are negatively affected by technological developments. To be precise, following Acemoglu and Autor (2012), "a task is a unit of work activity that produces output. A skill is a worker's stock of capabilities for performing various tasks". Then workers perform

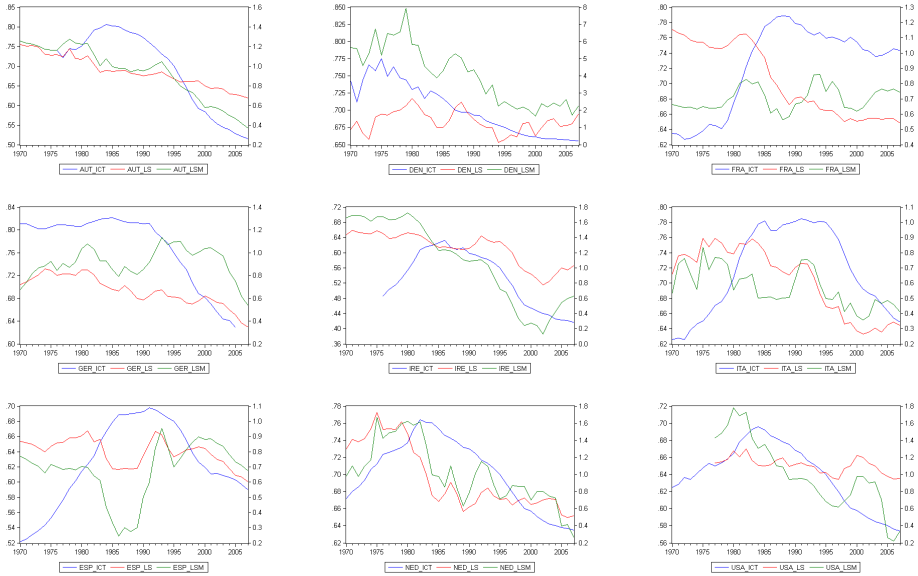


Figure 4: ICT index price (1995 price), Labour Share and Manufacturing Labour Share (source Euklems)

tasks in exchange for wages. The main intuition is that, if the assignment of skill to task is not one-to-one but a given skill can carry out a set of tasks, workers (and related wages) might react to changes in labour market or technological conditions. Accordingly, the known figure is that ICT capital has been more and more adopted for routine and "codifiable" tasks, previously carried out by middle skill workers, with a consequent drop of their wage growth and their employment opportunities. Consequently, depending on the employment share of middle skill workers and how the replacement within the labour market works, we might expect an effect on the labour share.

There is a discrete consensus on the presence of job-polarization in Europe. Goos et al. (2014) focuses on 16 Western European countries and shows a pervasive job polarization between 1993 and 2010. Consoli and Roy (2015) finds evidence for Germany of routine job displacement following ICT adoption, even though it seems that mainly high rank occupations profit from this phenomenon. In order to support our argument we integrate it with an analysis of the changes in occupational employment shares in Europe. We make use of Eurostat dataset that relies on the International Stan-

standard Classification of Occupations and we focus on 9 major classes⁴. Figure 5 reports the percentage change of occupational employment shares for 4 time spells between 1993 in the aggregate EU15⁵. The familiar U-shaped distribution is visible in all spells and we keep it as a tentative confirmation of employment polarization in Europe.

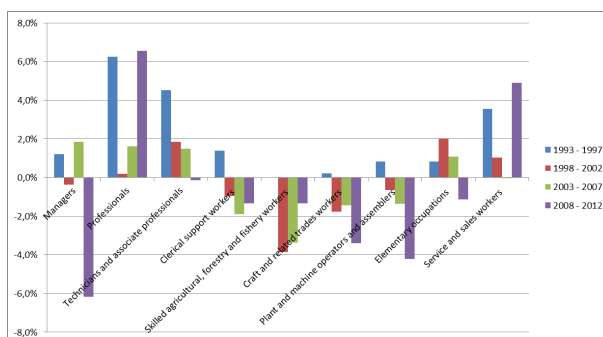


Figure 5: Percentage Changes in Employment by Occupational Classes. EU15 countries between 1993 and 2012 (source Eurostat)

4 Model

The aim of this section is to develop a theoretical setting able to explain the decline of the labour share with technological progress and labour market imperfections. We will make use of two assumptions: that only labour is affected by frictions in its hiring process and that the production function has an unitary elasticity of substitution between the combined production of ICT-capital with labour and and NonICT-capital. It is reasonable to expect, indeed, that the characteristics of capital equipment are less volatile than those of a worker and that both ICT-capital and labour need a basic level of non-ICT capital, like machines and plants. Moreover, NonICT-capital is experiencing no striking change in the price index and in the capital formation. Hence, output is obtained with the combination of labour force N , ICT capital K_{ICT} and non-ICT capital

⁴We neglect Armed forces as the cited studies above do.

⁵Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom, Austria, Finland and Sweden. EU aggregate is calculated aggregating totals from Member States

K_{NICT} in a nested production function of the type

$$Y = \left[\left(\alpha (K_{ICT})^{\frac{\varepsilon-1}{\varepsilon}} + (1-\alpha) N^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \right]^{\sigma} (K_{NICT})^{1-\sigma} \quad (1)$$

where α is a distribution parameter and $\varepsilon \in (0, \infty)$ is the elasticity of substitution between capital and labour. Moreover, we consider job creation subjected to search costs c , namely the aggregate flow into employment in each period is given by a costly vacancy posting process and equals $v \cdot i$, where v is the number of vacancies and i is the inflow probability. Given an exogenous separation rate s , the outflow of worker from employment to unemployment is $s \cdot N$. This implies that the law of motion of employment follows

$$N_{t+1} = (1-s_t)N_t + v_t i_t \quad (2)$$

from which we get the steady state number of employees

$$N = \frac{vi}{s} \quad (3)$$

Moving to capital, capital input is "hired" smoothly at the cost r that represents the overall investment price. the law of motion for type j of capital is given by

$$K_{j,t+1} = K_{j,t} + I_{j,t+1} - \delta_{j,t} K_{j,t} \quad (4)$$

where K_j is the stock of capital j , I_j is the flow of new capital and $\delta_{j,t}$ the depreciation rate. In steady state $K_{j,t+1} = K_{j,t}$, that implies trivially that capital formation must be equal to consumed capital.

We now derive the lagrangean to maximise the real profit, subject to the equilibrium employment in (3) and the equilibrium condition for capital formation implied by (4)

$$L = Y - wN - cv - (r_I + \delta_I)K_I - (r_{NI} + \delta_{NI})K_{NI} \quad (5)$$

From that, we compute the first-order conditions:

$$\begin{aligned}
\partial N : \lambda_1 &= \sigma(1 - \alpha) \frac{Y}{Y^*} N^{-\frac{1}{\varepsilon}} - w \\
\partial v : \lambda_1 &= \frac{cs}{i} \\
\partial K_I : \lambda_2 &= \sigma \alpha \frac{Y}{Y^*} K_I^{-\frac{1}{\varepsilon}} - r_I - \delta_I \\
\partial \delta_I : \lambda_2 &= \frac{K_I \delta_I^2}{I_I} \\
\partial K_{NI} : \lambda_3 &= (1 - \sigma) \frac{Y}{K_{NI}} - r_{NI} - \delta_{NI} \\
\partial \delta_{NI} : \lambda_2 &= \frac{K_{NI} \delta_{NI}^2}{I_{NI}}
\end{aligned}$$

where $Y^* = \left(\alpha (K_{ICT})^{\frac{\varepsilon-1}{\varepsilon}} + (1 - \alpha) N^{\frac{\varepsilon-1}{\varepsilon}} \right)$. By substituting the second condition into the first, we get the labour demand

$$N = \frac{[\sigma(1 - \alpha)Y]^\varepsilon}{\left[\frac{cs}{i} + w\right]^\varepsilon (Y^*)^\varepsilon} \quad (6)$$

Equation (6) tells us that labour demand is a derived demand and depends negatively on the wage, as the classical framework states. But interestingly, it gives also the intuition on how the labour input is affected by search frictions and the substitutability with capital. In a context of high-substitutability between labour and capital, namely with $\varepsilon > 1$, higher search costs or higher wage reduce the amount of labour demanded because it is more convenient to run the same production with capital.

Condition three and four give the demand for ICT-capital

$$K_I = \frac{[\sigma \alpha Y]^\varepsilon}{P_I^\varepsilon (Y^*)^\varepsilon}$$

where $P_I = r_I + \delta_I - \frac{K_I \delta_I^2}{I_I}$ and we use this expression to substitute $(Y^*)^\varepsilon$ into N, to get

$$N = \left[\frac{1 - \alpha}{\alpha} \right]^\varepsilon \frac{P_I^\varepsilon K_I}{\left[\frac{cs}{i} + w\right]^\varepsilon} \quad (7)$$

From this expression, we compute the labour income share

$$LS = \frac{w}{Y} \left[\frac{1 - \alpha}{\alpha} \right]^\varepsilon \frac{P_I^\varepsilon K_I}{\left[\frac{cs}{i} + w\right]^\varepsilon} \quad (8)$$

To conclude the theoretical setting we substitute condition five and six into equation (8), to get the final expression for the labour income share

$$LS = \frac{w(1-\sigma)}{C^\varepsilon} \left[\frac{1-\alpha}{\alpha} \right]^\varepsilon \frac{P_I^\varepsilon}{P_{NI}} k \quad (9)$$

where P_{NI} has the same formulation as P_I above and k is the ratio between ICT and Non-ICT stocks. The economic prediction of the model comes from the combination of the elasticity parameter ε , the costs and the quantities of the inputs:

- when $\varepsilon < 1$, labour and ICT are used as complement into the production and changes in the ICT price as well as vacancy cost have low impact on changes in the labour share. The latter depends positively on wage and capital ratio and negatively on investment price for NonICT capital. In this case, technological progress would barely predict the decline of the LS as k is increasing at a higher speed than P_{NI} ;
- when $\varepsilon = 1$ the production function of labour and ICT is Cobb-Douglas. Interestingly, if we assume no labour market frictions, we would end up with a LS affected only by the investment price ratio and the stock ratio of ICT and Non-ICT. Since we assumed an elasticity between ICT and NonICT capital equal to one, both price and stock ratios cannot provoke a decline of the labour share. This suggests that, in order to describe the impact of technological change on factor shares in a Cobb-Douglas setting, one should likely embed some degree of imperfections in the labour market⁶;
- when $\varepsilon > 1$ the income share of labour is affected by both the labour cost and the price of capital investment. In particular, given that k is trending upward as well as P_{NI} , the investment price of ICT is, according to the model, the key driving force for the decline of the LS.

This simple framework could describe what is happening to the factor income shares. Looking again to Figure (1), from 1995 onwards ICT price and labour share appear to move according to the prediction of the model above, if we consider an elasticity higher than 1. Before that date, there are different fluctuations of the labour share and a common upward trajectory of the ICT price, such that one may assume that before 1995 the elasticity of substitution between labour and ICT capital was low or institutional factors played a role on the effect of technological change on the labour share. Furthermore, for Spain, Denmark and Germany the decline of the labour share

⁶As well as in capital markets, that we don't treat here.

lags the decline of ICT investment price. A further point, as it is clear from Section 2, the improvement of ICT has been primarily a supply shock that might have affected price and stock similarly, generating an elasticity of substitution equal to one. The use of ICT in workers' tasks, a demand side phenomenon sighted around the beginning of the 1990s, might have pushed the elasticity and have affected the labour share with some delay. We check all these hypotheses in the empirical section.

5 Data

Given the recent categorization of the ICT-capital, there are not a lot of dataset useful for international comparison. EUKLEMS is one of that, indeed it provides data at sectoral level for most of the European and other developed countries, like US, Canada, Australia. The data come mostly from national statistical offices and the comparability is guaranteed by the same variables construction. For the majority of the countries the time series goes back to 1970, and in some case we recomputed the series (as for France and for Germany) to generate homogeneous unit of measures for capital inputs. From the EUKLEMS project we make use of the labour share⁷, the price index of capital formation, the nominal and real value of capital formation, the real value of capital stock, the capital consumption and the employment share per skill group of workers. For the matching variables, we use the inflows into and outflows from unemployment estimated according to Elsby et al. (2013b), collected by ILO. Concerning the vacancy cost c , we make use of a result from Carbonero and Gartner (2016) based on the IAB Job Vacancy Survey, where we compute a vacancy cost of about 1400 euro⁸; we compute the ratio between this vacancy cost and the annual wage for Germany and we apply this ratio (0,03) to all countries in our sample. In order to assess the degree of job polarization, we use the Eurostat dataset on employment per occupation. This dataset covers all the European countries we selected, while for the US we rely on the Laborsta dataset from ILO. Finally, concerning the labour market institutions, the EPL index comes from the OECD and the degree of wage coordination from the ICTWSS⁹.

⁷Computed as labour compensation over gross value added at current basic prices

⁸Close to Muehleemann and Pfeifer (2013) estimates

⁹Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts from 1960 to 2010

6 Model Estimation

The estimation of the impact of ICT investment price on the labour share is closely related to the elasticity of substitution between labour and ICT-capital, as we have seen in Section 4. In order to do that, we take the log of equation (9) and we provide two models, one without and one with search costs

$$\ln LS = a + \varepsilon \ln P_I - \varepsilon \ln w + \ln \frac{wk}{P_{NI}} \quad (10)$$

$$\ln LS = a + \varepsilon \ln P_I - \varepsilon \ln C + \ln \frac{wk}{P_{NI}} \quad (11)$$

Equation (10) and (11) represent the two empirical models we use to check the theoretical prediction and we estimate them with country fixed effects and cross-section weights. As it is implied in both equations, the coefficient of the last member is restricted to one, so the estimate will concern only the elasticity parameter ε . Moreover, we propose the latter split into two coefficients as well as in a version where it results from the difference of P_I and C and P_I and w .

Table 2 reports the estimate of P_I and w in equation (10). The elasticity of substitution lies between 1.11 and 1.24, significantly different from one. The Wald test rejects the hypothesis of equal coefficients¹⁰, however, since they are both larger than one and close to each other, we compute a unique estimate for ε by running equation (10) with $P_I - w$ as regressor. We get an elasticity of about 1.17, significantly different from one¹¹. As it results from the theory, an elasticity higher than one associated to a fall of ICT price produces a decline of the labour share. This means that cheaper ICT index price is a good channel to explain the decline of the labour share and that the CES function is a candidate to model it.

We turn now to the model with job frictions. The results of the estimation of equation (11) are shown in Table 3. We replicate the above steps and we provide separate estimates for P_I and C and one estimation with the restriction implied by the theory. What we get is that, adding job frictions to the model slightly reduces the size of the elasticity of substitution between labour and ICT. In the separate coefficient version, the elasticity lies into a larger interval, namely 0.88 and 1.59, while the unique estimate is 1.12. However this is due to the different number of observations between model (10) and model (11), because job flow data are available for a shorter time spell. Thus, when we estimate model (10) with the same time dimension of model (11) we

¹⁰Explanations for that would involve a detailed digression on the estimation of the production function, while the aim here is to check the size of the elasticity

¹¹The number of observations are higher than in the model with search costs, but when we estimate equation (10) with the same observations we get an elasticity of 1.12, significantly different from one

Table 2: Estimation of equation 10 with country FE and robust SE. Dependent variable: logarithm of LS

Covariates	ϵ	SE
$\log(P_I)$	1.11***	0.021
$\log(w)$	-1.24***	0.019
$\log(P_I) - \log(w)$	1.17***	0.010

Table 3: Estimation of equation 11 with country FE and robust SE. Dependent variable: logarithm of LS

Covariates	ϵ	SE
$\log(P_I)$	0.88***	0.025
$\log(C)$	-1.59***	0.046
$\log(P_I) - \log(C)$	1.12***	0.011

obtain an identical estimate of 1.12. Economically, job frictions does not seem to be a further potential channel to explain the decline of the labour share. Looking at the job flows of the countries in our sample, outflow rates from unemployment are generally much larger than the inflow rates. This fact, together with a small size of the relative vacancy costs, explains the low importance of job frictions compared to ICT price index in modeling the evolution of the labour share. Finally, the results shown so far give support to the CES function and an elasticity higher than one to model labour and ICT capital.

The second aim of this section is to assess how the elasticity of substitution between ICT and labour is affected by country-specific labour market variables. Contributions concerning the impact of technological change on labour markets revealed, on one hand, different compositional outcomes, depending on the skill and occupational group of the workers. On the other hand, the same attention has been addressed to the influence played by labour market institutions. In particular, the adoption of ICT has been associated to a higher demand for highskill workers (the skill-biased view) and more recently to the shrink of routine occupations (job-polarization view). Furthermore, changes in employment protection legislation and wage coordination have been analyzed in their attempt to govern the technological progress or correct its undesired consequences (OECD (2012)). For this reason, we interact our elasticity parameter

Table 4: Modification of equation (10) with interactions, country FE, robust SE. Dependent variable: logarithm of LS

Covariates	ε	SE	ε	SE
ε x <i>epl</i>	0.002	0.003	—	—
ε x <i>routine</i>	0.059	0.053	−0.237***	0.067
ε x <i>highskill</i>	−0.001**	0.000	0.002**	0.000
ε x <i>coordination</i>	−0.002	0.001	−0.008***	0.002

from equation (10) with four labour market variables, as it follows

$$\varepsilon = \beta_0 + \beta_1 epl + \beta_2 routine + \beta_3 highskill + \beta_4 coord \quad (12)$$

where *epl* is the Employment Protection Legislation index, *routine* is the share of routine occupation, *highskill* is the share of highskill workers and *coord* is the wage coordination index¹². Results are reported in Table (4). The estimates of the interaction terms have almost no statistical significance, mainly due to the *epl* index. After having taken it out, we get some interesting results. In particular, a lower employment share of routine occupations is associated with a higher elasticity of substitution between labour and ICT equipment. This is another proof of the job polarization, namely the substitution between capital and labour is mostly concentrated among the routine occupations.

¹²The scale is from 5 (centralized bargaining) to 1 (firm level bargaining)

7 Conclusion

The decline of the labour share, and the consequent increase of the capital share, is taking more and more space on the stage of the economic research. This is because of its implications on income distribution as well as on the role of labour input in the future. We try to give an explanation to this trend connected to the most recent technological progress and labour market facts. As a consequence we analyse the effect of ICT adoption and above all the evolution of its index price. Building on the job-polarization hypothesis, we check if the substitution between ICT and the labour force is a potential mechanism for the evolution of the labour share. Moreover, we embed job frictions to explore an another discriminating factor between labour and capital. After having showed the common negative trends of the labour share and ICT-capital price, we develop a simple theoretical framework to model this comovement. The prediction is that negative changes of the labour share are generated by a fall of ICT price and an elasticity of substitution higher than one between labour and ICT-capital, as well as by an increase of search frictions in a Cobb-Douglas setting. Thus, we collect data for 8 European countries and the US and we assess quantitatively our structural model in a panel analysis. What we get is an elasticity of substitution that lies between 1.12 and 1.17, establishing a link between the decline of the LS and the downward trend of ICT capital price. Interestingly, if we consider labour market affected by search frictions, the elasticity does not differ at all.

8 Appendix

Table 5: Employment share of occupations per task group, percent average between 1993 and 2000

Countries/Average	Abstract	Routine	Manual
Austria	31	46	22
Denmark	37	35	28
Spain	26	45	29
France	35	43	22
Germany	37	42	22
Ireland	32	42	26
Italy	27	47	26
Netherlands	45	31	24
EU	34	40	24

Table 6: Labour share, Labour share in Manufacturing and ICT investment price Correlations.

	ICT price	LS		ICT price	LS		ICT price	LS
LS	0.79	1	LS	0.34	1	LS	-0.17	1
LS M	0.87	0.97	LS M	0.87	0.59	LS M	-0.39	0.44
Austria			Denmark			Spain		
	ICT price	LS		ICT price	LS		ICT price	LS
LS	-0.73	1	LS	0.73	1	LS	0.74	1
LS M	0.22	-0.09	LS M	-0.21	-0.06	LS M	0.64	0.90
France			Germany			Ireland		
	ICT price	LS		ICT price	LS		ICT price	LS
LS	0.08	1	LS	0.36	1	LS	0.51	1
LS M	-0.10	0.77	LS M	0.66	0.83	LS M	0.72	0.84
Italy			Netherlands			US		

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