Technological Advance and the Labour Share of National Income in the European Union

Lino Briguglio
Department of Economics, University of Malta*
Melchior Vella
Department of Economics, University of Malta†

This article tests the hypothesis that member states of the EU have been experiencing a declining share of labour income due to technological advance. It discusses factors that lead to the fall in the labour share, including technological advance, which is a tendency found in the capitalist system. We also identify the undesirable effects of a fall in the labour shares. The results of an econometric test conducted in our study, based on a labour demand equation that was derived from the CES production function, confirm the hypothesis that technological progress negatively affected the labour share of income, everything else remaining constant. This finding has important implications for EU Member States, namely that some form of policy intervention would seem to be necessary, as technological progress could lead to a continuing fall in the share of labour income if left to its own devices.

Keywords: share of labour income, inequality, technological advance, globalisation, CES production function, labour demand
JEL Classifications: E25, J30, L51

Introduction

During the past decade there has been a growing body of literature on technological advance and labour share of national income. It has been observed that in many countries the share of national income that is earned by labour, termed as the labour share, has been declining over time, though the pace of the decline differs (Bassanini and Manfredi, 2012; Stockhammer, 2012). This implies that the share of capital income has become more prominent in the functional distribution of national income. The labour compensation in national income has fallen in most developed countries (OECD, 2012), while this decline is also observable in developing countries (ILO, 2012).

*Address for Correspondence: Faculty of Economics, Management & Accountancy, Msida MSD 2080, Malta. Email: lino.briguglio@um.edu.mt
†Address for Correspondence: Faculty of Economics, Management & Accountancy, Msida MSD 2080, Malta. Email: melchior.vella.09@um.edu.mt

In Europe, the decline in wage share is associated with technological advances[1] that have contributed to lower labour demand (Jaumotte *et al*., 2013; Lawless and Whelan, 2011), as we shall test in this article. This suggests that technological improvements have been capital augmenting, which increases demand for capital inputs and reduces demand for labour (Raurich *et al*. 2012; Checchi and Garcia-Penalosa, 2010; European Commission, 2007; IMF, 2007; Bentolila and Saint-Paul, 2003), and particularly low-skilled workers (Arpaia *et al*., 2009); such a change leads to fewer workers producing a given output, and this in turn leads to higher returns to capital owners, who generally have a stronger say than workers in how to distribute income from increased productivity. Several studies explain why and how technological change can be directed towards labour saving.[2] Acemoglu (2003*a*, 2003*b*, 2002) shows that technology is capital-augmented, because increases in wage rates invoke labour-saving technological change, which therefore reduces the labour share. Acemoglu *et al*. (2014) and Elsby *et al*. (2013) also propose that decline in the labour share could be attributed to offshoring that is mostly concentrated in the labour-intensive component of the supply chain. The asymmetrical power over the income distribution is another possible cause why the fruits of technological advance are not shared equally between employees and employers.

The globalisation process is considered as another reason why the share of labour has decreased. Athreye and Cantwell (2007) argue that technological advance has spread due to the emergence of new countries as contributors[3] to technology generation in the world economy, and has deteriorated the bargaining power of hired employees in most developed countries. Globalisation has opened trade in most countries and this has been considered as an important factor affecting the labour share of income, particularly if the competition by imports lowers the relative income of workers (Helpman *et al*., 2010; Egger and Kreickemeier, 2009).

Another factor associated with globalisation is migration. Reed and Latorre (2009) found that immigration tends to decrease wage rates, and according to Dustmann *et al*. (2013), and Nickell and Salaheen (2008), lower-paid workers are more likely to experience this. In this regard, Jaumotte and Tytell (2007) note, however, that a fall in average wage rates need not result in a falling share of labour, since the latter depends on the labour demand wage elasticity.

Furthermore, the increasingly powerful forces of globalisation — namely, the combination of intensified cross-border competition and global labour arbitrage — have given rise to an increase in productivity (Roach, 2009). The globalisation process may have led to various changes favouring capital owners, given that this process may have been driven by powerful corporations. In addition, laws and policies favouring the supply side of the economy, which lead to the erosion of the power of labour unions, may also have led to a lower labour share (Lavoie and Stockhammer, 2012; OECD, 2012; Storm and Naastepad, 2009; Atkinson *et al*., 2009).

Yet, another factor associated with globalisation is the greater influence of financial institutions (Palley, 2011). Lawless and Whelan (2011) estimated the impact of changes in the structure of European economies from high to low labour share sectors, and found that the share-shift fails to explain most of the decline in labour share. This suggests that technological improvements have been the underlying factor behind the general decline in labour share.

Some authors, taking an ideological stance, also argue that technological change is associated with capitalism and may even strengthen the tendencies of a capitalist system to reduce the overall labour share income. For example, Bengtsson and Ryner (2014) relate the falling wage share with the neoliberal transnational class rule that has restricted the power of trade unions, rendering increasingly relational power resources ineffective.

Several undesirable effects of the decline in the labour share have been identified in the literature. The main implication of the falling labour share relates to income inequality between those who offer the services in the form of labour and those whose contribution relates mostly to ownership (Karanassou and Sala, 2013; Checchi and Garcia-Penalosa, 2010). This need not translate into a situation where all workers become relatively poorer and all capitalists become richer. Some highly skilled and highly educated workers may actually have enjoyed an increasing income share (IMF, 2007; Autor *et al.*, 2006). In addition, self-employed persons are themselves owners of enterprises, so that while their income share as labour providers of labour may have declined, their income share as owners may have increased. If wage earners are taken collectively, however, as previously indicated, their share has been observed to have decreased over time in many countries.[4]

It needs to be emphasised, however, that inequality depends on other factors, such as the distribution of capital income and the degree of tax progression, keeping the labour share constant. For example, a concentrated distribution of capital income and progressive taxation are anticipated to keep a relatively flat income distribution. Further, faced with an aging population, capital shares are expected to increase to insure retirees to be equally well-off (Thøgersen, 2015). Consequently, as capital share of income rises, so should productivity and wages that should at least partially compensate for the decline in labour share. On the other hand, Piketty and Zucman (2014) foresee an increase in the share of wealth going to the top of the distribution, due to international competition of capital and slower population and productivity growth. The overall effects will remain unclear and we cannot draw any hard and fast conclusions on this subject.

The falling labour share may also lead to a decrease in aggregate demand due to, among other things, the possibility that high income households have a lower propensity to consume than lower income households.[5] Its impact on economic growth, however, is not so straightforward. Whether a decrease in labour share creates shortfalls in aggregate demand depends on whether aggregate demand is

wage-led or profit-led. Onaran and Galanis (2012) examine this issue and conclude that there are two opposing forces involved, namely: (i) as labour share decreases, propensity to consume declines; (ii) but as the labour costs decrease, this is counterbalanced by an increase in profit rates that could possibly increase investment and improve competitiveness. On the other hand, the falling labour share could result in weaker purchasing power of a large proportion of the population.[6] Nevertheless, the decline in consumption is ambiguous depending on the set of assumptions adopted and the groups of households considered.

The declining share of labour income may also possibly lead to social unrest (Curci *et al*., 2011). It should be recalled that the effect of incomes on satisfaction does not generally depend on their absolute value but on their relative value, so even if labour income increases in absolute terms, a fall in the labour share may lead to social dissatisfaction.[7]

The purpose of this article is to test the hypothesis that the labour share may have been secularly declining mostly due to technological advance, and that owners, rather than employees, appropriated the resulting returns. Thus, the focus of the article will be on the EU Member States.

The article is organised as follows. Following the introduction, the first section shows that wages rose at a slower rate than labour productivity in the EU, a tendency that contributed to the falling income share and which may have been caused by technological progress. The second section econometrically tests the premise that technological change influences labour demand in the EU Member States, and it also negatively affects the labour share income. For this purpose, we use a labour demand equation derived from the CES production function. The final section concludes the paper with a number of implications relating to the econometric results.

The Falling Labour Share on the EU Over Time

The measurement debate

Simply defined, the labour income share in a given country is the compensation to those offering labour services divided by the total value added in that country. Measuring the labour income share, however, is not straightforwardly done by multiplying the number of employees by the average wage rates and dividing by GDP. Sweeny (2013), Stockhammer (2012) and Gomme and Rupert (2004) discuss a number of problems encountered when measuring the labour income share, which include the well-known difficulties of correctly measuring gross value added, including understatement of incomes for tax evasion and tax avoidance purposes. There are additional problems relating to such issues as to whether depreciation and pension income should be included.

Another issue creating measurement problems is that the labour share ought

to include the labour services offered by self-employed persons. In many studies it is assumed that self-employed persons earn the same average earnings as hired employees. This assumption would not be correct if the distribution of the self-employed is different from that of the hired employees. For example, if there are proportionately more self-employed professionals (lawyers, doctors, *etc.*) and traders than is the case with hired employment, then income per person could conceptually be higher on average among the self-employed persons when compared to hired employees. On the other hand, if the self-employed persons include a larger proportion of small farmers, the share of the self-employed could conceptually be lower when compared to that of hired employees. Some authors try to correct for such distributional differences by imputing it from wage and salary data at the sectoral level (Askenazy, 2003) or from survey data (Freeman, 2011*a,b*).

Labour income share for self-occupied persons cannot be easily inferred, and national accounts record self-employed labour and capital income together. Krueger (1999) explains that isolating the component of self-employment income that accrues to labour is ambivalent. Pugsely (2012) argues that there is substantial under-reporting of self-employment income in surveys, while Elsby *et al.* (2013) discuss practical caveats to capture the mixture of labour and capital income of the self-employed. Refining the assumption to impute the self-employment income that accrues to labour, however, does not change the evaluation of the labour share (Freeman, 2011), nor does the under-reporting of self-employment income (Hurst, Li and Pugsley, 2012). This study takes the usual approach, as adopted by the OECD, the US Bureau of Labour Statistics and the EU AMECO, assuming that wage rates of employees and the self-employed are the same, and adjusts the wage share accordingly.[89]

The labour share in the EU since 1995

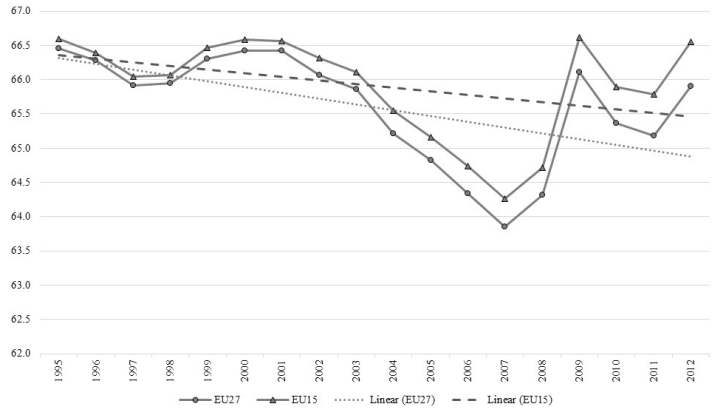
The labour income share differs between the EU Member States, but there is a common feature in this regard, namely that their labour share has been generally declining over time, as can be seen in Table 1, which presents relevant data for EU Member States for the 18-year period between 1995 and 2012. Between 1995 and 2007, labour share has decreased for 18 countries, increased for 8 countries and stayed equal for 1 country. We observed the largest declines in Poland, Slovenia, Bulgaria, and Austria, while we observed noticeable improvements in Lithuania, Czech Republic, Denmark, and Sweden.

Looking at the EU as a whole, in recent years there were short term upswings in the labour share during the economic showdown of the early 2000s and during the post-2008 economic crisis period, as illustrated in Figure 1.[10] One possible explanation is that a counter-cyclical change in the labour share has been observed (European Commission, 2007; Hansen and Prescott, 2005). Indeed, employers

tend to maintain employment when there is a reduction in output due to the costs of hiring-and-firing. As a result, the labour share increases at the expense of the capital share. The opposite happens during a recovery, such that employment would increase less-than-proportionately relative to output.

Nevertheless, the secular trend shows a clear decline. This is demonstrated by estimating a linear time trend of labour share levels across time via using the Ordinary Least Squares (OLS) method. The estimates show that the labour share in the majority of member states of the EU has a negative time trend. Some countries — Cyprus, Finland, France, Italy, Malta, Sweden, and the United Kingdom — registered inconclusive trends when taking into consideration both pre- and post-crisis periods. Overall, in the EU as a whole, declining labour share trends were found in both EU27 and EU15.

Figure 1
The share of labour income in the EU27 and EU15 since 1995



Source: AMECO

Compensation of employees, productivity, and the labour income share

If it is assumed that the labour share is measured by WL/Y, where W is the wage rate, L stands for persons employed and Y for GDP, then the labour share would remain constant if W increases by the same proportion as the output/labour ratio, Y/L. If W increases at a slower rate than the ratio Y/L (or faster than the L/Y ratio), then the end result will be a decrease in the labour share, and vice-versa.

The growth rate for W and Y/L was calculated through the equation $X_t = X_o e^{rt}$, where X denotes the dependent variable (W or Y/L) and e^{rt} is a time trend, which takes values of 1, 2, 3, $\ldots T$. The equation becomes linear if transformed into natural logs and, using OLS, an estimate of r (the growth rate) can be obtained.

Table 1
The share of labour income in the EU member states since 1995

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	CH 07-95	CH 12-95	Trend 95-12	Trend 95-07
Austria	69.9	69.2	68.7	68	67.9	66.8	66.1	65.4	65.3	63.9	63.2	62.5	62	63.2	65.6	64.8	64	64.9	-7.9	-5	-0.35	-0.67
Belgium	70.2	70.7	70.5	70	70.9	69.8	70.9	71.2	70.4	68.8	67.9	67.6	67.1	68.3	70	68.3	68.6	70.2	-3.1	0	-0.13	-0.26
Bulgaria	63.1	62.1	52.8	62.6	60.1	58	58.8	56.5	57.3	57.4	56.7	55.2	54.5	56.9	59.5	60.7	59.1	60	-8.6	-3.1	-0.10*	-0.51
Cyprus	64.6	64.9	65.4	63.2	62.5	62.8	61.9	64.5	69.5	69.4	68.8	67.6	67	64.6	65.5	64.8	64.5	61.9	2.4	-2.7	0.06*	0.42
Czech Republic	50.8	52.2	53	51.4	51.5	52.1	52	54	55.2	55.2	54.9	54.6	54.4	55.1	55	55.8	56.7	57.9	3.6	7.1	0.34	0.34
Denmark	65.2	65.7	65.6	67.7	67.9	65.7	67.1	67.8	68.2	67.1	67	67.2	68.8	69.5	72.4	69.1	68.7	68.1	3.6	2.9	0.23	0.2
Estonia	64	61.3	60.1	58.4	56.5	55.9	54.6	54.4	54.7	55.5	54.3	54.9	57.6	61.7	64.1	60	57.2	57.9	-6.4	-6.1	-0.04*	-0.59
Finland	64.3	65.4	64.1	62.6	62.6	60.9	61	61	62.3	61.8	62.9	62.5	60.7	62.7	67.7	66.3	66.5	67.7	-3.6	3.4	0.18	-0.24
France	67.3	67.6	67.1	66.3	66.8	66.3	66.2	66.7	66.7	66.5	66.7	66.4	65.6	65.9	67.8	67.5	67.9	68.5	-1.7	1.2	0.03	-0.1
Germany	66.7	66.3	65.5	65.3	65.9	66.8	66.3	65.8	65.9	64.7	63.7	62.2	61.2	62.1	65.1	63.4	63.5	64.6	-5.5	-2.1	-0.21*	-0.35
Greece	63.2	62.8	64.6	64.5	65.5	63.2	61.3	64.6	62.6	61.9	62.2	60.7	60.4	60.4	61.9	61.9	60.3	57.1	-2.8	-6.1	-0.29	-0.27
Hungary	65.9	64.9	63.2	62.3	61.6	63	61.9	61.6	62.6	62.1	61.8	60.4	61.5	61	61	59.5	58.9	59.3	-4.4	-6.6	-0.3	-0.3
Ireland	62.5	61.3	59.2	57.6	56	54.3	53.6	51.7	52.2	53.7	55	55.7	57.1	62	61.9	58.8	55.9	55.6	-5.4	-6.9	-0.06*	-0.54
Italy	63.2	63.2	63.8	63	62.5	61.6	61.2	61.3	61.7	61.5	62	62.7	62.1	62.7	63.5	63.6	63.5	64.5	-1.1	1.3	0.05*	-0.12
Latvia	59.1	61.7	62.6	59.7	59.1	55.4	53.3	50.7	51.8	51.4	54	56.7	59.7	62.4	57.9	52.9	50.8	50.8	0.6	-8.3	-0.38	-0.55
Lithuania	51.4	54.8	57.9	59.8	61.5	55.3	53.4	54.4	54.9	54.7	54.2	56.1	55.4	56	56.8	51.8	49.5	48.9	4	-2.5	-0.28	-0.08*
Luxembourg	57.1	56.9	58.5	58.4	56.2	56.9	60.1	59.9	57	57.2	55.8	52.6	51.5	56	60.5	56.9	56.6	57.8	-5.6	0.7	-0.08*	-0.35
Malta	59.9	59	58	57.2	57	55.1	57.9	57.3	58.2	60.2	58.8	59.2	58.3	57.8	60	56.9	57.8	58.7	-1.6	-1.2	0.02*	0.04
Netherlands	67.6	67.2	66.4	66.9	66.8	65.9	66.2	66.6	66.9	66.7	65	64.5	64.3	64.7	67.4	66.6	66.3	67.3	-3.3	-0.3	-0.06*	-0.21
Poland	65.3	67.2	67.1	65.9	65.4	63.1	64.9	62.6	60.3	56.1	55.3	54.3	53.6	55.7	54.2	54.7	53.8	52.9	-11.7	-12.4	-0.97	-1.22
Portugal	65.9	66.9	66.9	66.8	66.2	67	67.1	67.1	68	66.7	68	67.2	65.9	66.9	67.2	66.2	65.7	63.9	0	-2	-0.06*	0.05*
Romania	62.7	64	58.4	72.3	70.1	80.4	84.4	68.6	67.9	60.2	66.4	62.7	63.8	67.7	66	61.9	56.1	56.3	1.1	-6.4	-0.53*	-0.11*
Slovakia	48	49.9	51.4	51.9	50.1	50.3	48.7	49.2	48.8	47.2	48.3	47.1	46.8	47	50.3	49.5	49.4	48.9	-1.2	0.9	-0.10*	-0.28
Slovenia	79	76.6	73.9	72.9	72.1	72.9	73	72.1	71.3	71.5	71.2	70	68.6	69.7	72.6	73.8	73.1	73.8	-10.4	-5.2	-0.22	-0.62
Spain	65.9	66	66	65.8	65.7	65.4	64.6	63.8	63.1	62.5	62.3	61.8	61.6	62.4	62.5	62.4	61.5	60.1	-4.3	-5.8	-0.34	-0.43
Sweden	63.9	67	67	67.6	67.2	68.4	70.3	69.8	68.8	67.9	67.4	65.9	66.9	68	70.1	67.3	67.1	68.3	3	4.4	0.08*	0.11
United Kingdom	68.2	66.6	66.7	68.2	69.3	70.4	71.1	70.2	69.7	69.4	68.7	69	68.8	68.5	70.8	70.7	70.6	71.8	0.6	3.6	0.17	0.15*
EU-27	66.5	66.3	65.9	65.9	66.3	66.4	66.4	66.1	65.9	65.2	64.8	64.3	63.9	64.3	66.1	65.4	65.2	65.9	-2.6	-0.6	-0.08	-0.18
EU-15	66.6	66.4	66	66.1	66.5	66.6	66.6	66.3	66.1	65.5	65.2	64.7	64.3	64.7	66.6	65.9	65.8	66.5	-2.3	-0.1	-0.05*	-0.16

Source: AMECO
* Estimates are not statistically different from zero at 10% level.

An estimate of the growth in the wage rates (W) compared to the growth in the output/labour ratio (Y/L) for the period 1995 to 2012, shown in Table 2, indicates that in most of the EU-27 Members States, W rose at a slower rate than the Y/L ratio, explaining, albeit mathematically, the fall in the labour share during this period. This could possibly indicate, but does not prove, that the effect of technology may have increased output faster than labour, leading to a wage/productivity gap and therefore to a decrease in the labour share.

Table 2
Average Annual Growth in Compensation per Employee, and GDP per Person Employed, 1995–2012

	(a) GDP	(b) Capital Income	(c) Compensation per Employee	(d) GDP per Person Employed
Austria	3.42%	4.13%	1.94%	2.47%
Belgium	3.68%	3.73%	2.48%	2.67%
Bulgaria	9.88%	10.10%	9.35%	9.51%
Cyprus	5.55%	4.84%	3.65%	3.57%*
Czech Republic	8.07%	7.83%	8.60%	7.97%*
Denmark	3.46%	2.67%	3.43%	3.09%*
Estonia	10.33%	10.49%	10.39%	10.47%
Finland	3.94%	3.44%	3.01%	2.74%*
France	3.36%	3.18%	2.60%	2.55%*
Germany	1.89%	2.45%	1.06%	1.39%
Greece	5.03%	4.81%	3.83%	4.30%
Hungary	6.92%	6.79%	6.39%	6.87%
Ireland	6.86%	6.71%	4.40%	4.51%
Italy	3.14%	2.76%	2.32%	2.25%*
Latvia	10.68%	10.87%	10.45%	11.12%
Lithuania	10.48%	10.17%	10.64%	11.15%
Luxembourg	6.45%	6.42%	2.89%	3.03%
Malta	4.73%	4.75%	3.86%	3.83%*
Netherlands	4.01%	4.00%	2.87%	2.96%
Poland	7.35%	8.13%	5.44%	7.06%
Portugal	3.77%	3.47%	3.40%	3.49%
Romania	10.54%	10.35%	11.57%	12.37%
Slovakia	10.24%	10.90%	9.68%	9.89%
Slovenia	5.40%	5.71%	4.61%	4.91%
Spain	5.58%	5.75%	2.89%	3.42%
Sweden	3.44%	3.06%	2.83%	2.71%*
United Kingdom	3.51%	3.20%	2.99%	2.74%*
EU-27	3.59%	3.70%	2.65%	2.93%
EU-15	3.31%	3.33%	2.29%	2.41%

There are other factors that could possibly influence the labour share of EU-27. Indeed, the direction of labour share also depends on the magnitude of the elasticity of substitution between labour and capital, which measures the responsiveness of a percentage change in factor proportions brought about by a proportionate

change in their relative prices, holding total output constant. Indeed, if the elasticity of substitution is larger than unity, an increase in wage rate is likely to induce firms to substitute labour for capital more-than-proportionately and consequently reduce the labour income share. Globalisation could also be another force that exerts downward pressures on the labour share income for capital-abundant countries, provided that the elasticity of substitution between labour and capital is less than unity. Another factor that should be mentioned is labour market institutions, such as industrial and employment relations legislations, which may determine the bargaining power of labour. For example, flexible regulations may act as a disincentive to work, make informal work more attractive, and hence mitigate the bargaining power of labour. In the next section we shall use cross-section data pertaining to EU Member States to test whether the labour share has been influenced by technological change.

Technological Advance and the Labour Share

This section tests the hypothesis that technological change has negatively affected the falling labour share in the EU. The approach adopted in this section is to estimate a labour demand equation, derived from a production function. The result could shed light on the effect of technology on labour demand, everything else remaining constant, and in turn this would have implications on the labour income share, as explained below.

The Production Function

The basic assumption underlying a production function is that output depends on labour and capital, given the state of technology. The variable representing capital is often difficult to measure, and data on this variable are generally not readily available (Dean, 1964). In addition, there is the problem of measuring capital utilisation. One way of circumventing this problem is by deriving and using the marginal productivity condition derived from the production function, which is the approach adopted in this study. The underlying production function that will be utilised is of the CES type introduced by Arrow *et al.*, (1961),[11] allowing for the possibility of efficiency changes and non-constant returns to scale as shown in Equation 1:

$$Y_{it} = A_{it}^{\chi}\left[bL_{it}^{-\rho} + (1-b)K_{it}^{-\rho}\right]^{-\nu/\rho} \tag{1}$$

where Y_{it} represents value-added produced by the inputs, namely labour (L_{it}) and capital (K_{it}) for each of the 26 countries over 5 years. The subscript i, takes a value of 1, 2, ...26 and the subscript refers to the t takes a value of 1, 2, ...5. The expression A_{it}^{χ} captures shifts in the production function, due to technological

differences between countries,[12] which could influence employment even if wage rates and output do not vary between the countries concerned. When the function is based on time series data, the expression is often represented by a time trend e^{rt} where r is the rate of growth of Y_i as a result of technological advance, with wage rate and output remaining constant, and t is time, taking the value of 1, 2, ... T. In the present specification shown as Equation 1, the change is across countries so the exponent χ captures the effect of technological differences across countries.[13]

The coefficients of Equation 1 can be interpreted as follows:

- b is related to the distribution of income;
- ρ is related to the elasticity of substitution (σ) which is equal to $1/(1+\rho)$. In the Cobb-Douglas production function, the value of σ is restricted to unity, implying that ρ takes a value of zero. By using the CES production function, we are implicitly allowing for the possibility that a certain percentage decrease in factor prices need not generate a corresponding percentage increase in factor demand;
- ν is the homogeneity parameter, which measures the degree of returns to scale. It would indicate constant returns if its value is unity, decreasing returns if its value is a positive fraction and increasing returns if its value is higher than unity.
- χ captures the effect of technological differences between countries on output.

Deriving a labour demand equation

The labour demand equation can be derived by first specifying the marginal productivity condition, and assuming, as is the standard done in economic theory, that the marginal product of labour is equal to the wage rate (W) as shown in Equation 2:

$$MP_L = \partial Y_{it}/\partial L_{it} = W \tag{2}$$

Applying this condition to Equation 1, we obtain:

$$\partial Y_{it}/\partial L_{it} = \nu b A_{it}^{\chi(-\rho/\nu)} L_{it}^{-(1+\rho)} Y_{it}^{(1+\rho/\nu)} \tag{3}$$

Combining Equations 2 and 3, re-arranging, and expressing the resultant equation in log form, we obtain the following equation:

$$\ln L_{it} = \sigma \cdot \ln(\nu b) - \sigma \cdot \ln W_{it} + [1+\sigma(\nu-1)]/\nu \cdot \ln Y_{it} - (1-\sigma)/\nu \cdot \chi \ln A_{it} \tag{4}$$

where $\sigma = 1/(1+\rho)$, which can be interpreted as representing the elasticity of substitution between labour and capital. Equation 4 can therefore be expressed as follows for estimation purposes:

$$\ln L_{it} = \alpha_0 + \alpha_1 \ln W_{it} + \alpha_2 \ln Y_{it} + \alpha_3 \ln A_{it} \tag{5}$$

where the coefficients have a number of interesting properties, namely:

- α_1 takes a value of $-\sigma$, that is, the elasticity of substitution with a negative sign, indicating the extent to which labour responds to a change in wage rates.

- α_2 represents the elasticity of employment with respect to output. This coefficient will, under certain conditions, take a value of a positive fraction if increasing returns to scale are assumed.

- α_3 captures the effect of technological differences on labour demand. It is expected to have a negative sign, indicating that with technological advance, the number of employees per unit of output would decrease.

It should be noted that the coefficient on $\ln Y_i$

$$\alpha_2 = [1 + \sigma(\nu - 1)]/\nu \tag{6}$$

which means that the labour demand elasticity with respect to output is not uniquely related to ν but also to σ. It can be shown that $\nu = (1-\sigma)/(\alpha_2 - \sigma)$, so that if α_2 is a positive fraction ($0 < \alpha_2 < 1$), ν would be higher than unity, implying increasing returns to scale.

It should also be noted that the coefficient on $\ln A_{it}$

$$\alpha_3 = (1-\sigma)/\nu \cdot \chi \tag{7}$$

which means that effect of technological change on labour demand is influenced by the elasticity of substitution and by returns to scale.

Notice also that technology's effect is unbiased in that it affects labour and capital equally. There is considerable debate on the matter relating to biased and unbiased technological progress, but allowing for this would have introduced unnecessary complications in the estimation procedure. The question arises therefore as to whether technology also affects the share of capital. Given the stronger decision power of capital owners, when compared to labour, it is likely that capital will enjoy most of the gains from technology.

Estimating the labour demand equation

With reference to Equation 5, a priori, one expects that α_2 takes a negative sign, α_3 a positive sign, and α_4 a negative sign, given that the labour demand function is assumed to be derived from the production function.

We investigate labour demand in the private sector[14] for a cross-section of EU-27 countries utilising annual data on total hours worked (L), wage rates (W), and gross value added (Y) with data over the period of five years (2008 to 2012). The data is mostly sourced from the EUROSTAT database (see data appendix). Technology (A) is sourced from Pillar 9a of the Global Competitiveness Report (Technological Adoption) and defined as (i) the availability of latest technologies (component index 9.01) and (ii) FDI and technology transfer (component index 9.03). All variables are measured in natural logs as indicated in Equation 5.

The choice of 26 countries was conditioned by EU Membership up to 2012, which enjoys the benefit of availability, reliability, and comparability of data.[15]

Estimation Results

Equation 5 was estimated using the panel data approach and the random effects method. This estimation technique was taken into consideration to control for time-specific effects. Alternative specifications are provided in the Appendix.

It was estimated first by assuming that all observations of employment indicate labour demand, which means that the labour market in all countries was characterised by equilibrium or excess labour supply. From the available data, the estimation results are as follows:

$$\begin{array}{lcccc} \ln L_{it} = & 3.349 & - 0.770 \ln W_{it} & + 0.968 \ln Y_{it} & - 0.668 \ln A_{it} \\ & (16.317) & (-37.679) & (128.275) & (-5.481) \\ \text{N} = 130 & & R^2 = 0.993 & & \text{Adj } R^2 = 0.993 \end{array} \quad (8)$$

The estimated parameters are in line with a priori expectations and have plausible magnitudes. The numbers in parentheses are the estimated t-values and indicate that the estimates are statistically different from zero at the 95 percent level, whereas the correlation coefficient is on the high side.

The estimated equation shows that the coefficient of W takes a value of -0.770, indicating that a 10% increase in wage rate generates a decrease in employment of 7.70%, everything else remaining constant. As alluded to earlier, this is an estimate of the elasticity of substitution which is less than unity, justifying the use of the CES production function rather than the Cobb-Douglas one. This parameter has important implications, since its magnitude provides an insight into the labour/output ratio changes as the countries' wage rates change.

The estimated parameter α_2, that is, the coefficient on output, takes a value of 0.968. This would seem to suggest that as the private sector expands, the cost per

unit of output decreases, since the coefficient on Y implies that there are increasing returns to scale, as indicated by the parameter ν in the underlying CES production, which as a result takes a value of value of 1.16. In other words, the value of ν shows increasing returns to scale, meaning that a given increases in inputs generate a more-than-proportionate increases in output. A t-statistic test on the coefficient of Y indicates that it is statistically lower than unity at the 95 percent level of significance.[16] The returns to scale parameter has important implications for the size of countries. It confirms that larger countries, which employ more labour and capital, are able to enjoy increasing returns to scale. This is in line with the hypothesis that larger countries have a cost advantage over smaller size economies.[17]

The estimated coefficient for technological change is in line with theoretical expectations. The result shown would seem to suggest that, as expected, technological progress across countries leads to a reduction in labour demand, other things remaining constant. The way the index is constructed implies that the percentage difference between the highest and lowest is 1.45% so, keeping everything else constant, a 1% improvement in technology between the technological leader and technological laggards would give rise to less than 1% decrease in labour demand.

Equation 8 can be rearranged so as to have the labour income share ($LS = LW/Y$) as the dependent variable by multiplying both sides of the equation by W and dividing both sides by Y as follows:

$$\begin{array}{lcccc} \ln L_{it} = & 3.349 & + 0.230 \ln W_{it} & - 0.032 \ln Y_{it} & - 0.668 \ln A_{it} \\ & (16.317) & (11.274) & (-4.290) & (-5.481) \\ \text{N} = 130 & & R^2 = 0.523 & & \text{Adj } R^2 = 0.511 \end{array} \quad (9)$$

The estimated parameters confirm that the labour income share (LS) is negatively affected by technological change across European countries, as indicated by the coefficient on A. In addition, the estimated coefficient on W confirms that the elasticity of substitution between labour and capital is relatively inelastic, implying that an increase in wage rates is unlikely to induce firms to substitute labour for capital more-than-proportionately and therefore increases the labour share, everything else remaining constant. The parameter on output is, as expected, negative. This means that an increase in output implies a decrease in the labour share, everything else left unchanged.[18]

Existence of excess demand and segmenting the sample

In the real world, wage rates may not clear the market in all periods. If excess demand for labour exist, employment would not measure labour demand, given that in such a case, unfilled job vacancies, which are part of labour demand, would not be included.

An approach to take into account labour market disequilibrium is by assuming

that employment represents labour demand only when excess demand is absent, that is when the rate of unemployment is equal or higher than what is known as the Non-Accelerating Inflation Rate of Unemployment (NAIRU) or natural rate of unemployment (NRU)[19] during the 2008–2012 period.

For this purpose the labour demand equation was re-estimated by excluding those countries characterised by excess labour demand, assuming that those countries with an unemployment rate lower than NAIRU were characterised by excess labour demand. Based on the data on NAIRU[20] four countries were found to be characterised by excess demand, and were therefore excluded from the sample.[21] The estimation results of this approach are as follows:

$$\begin{array}{lcccc} \ln L_{it} = & 3.143 & - 0.789 \ln W_{it} & + 0.965 \ln Y_{it} & - 0.507 \ln A_{it} \\ & (14.806) & (-35.701) & (113.164) & (-4.112) \\ \text{N} = 110 & & R^2 = 0.993 & \text{Adj } R^2 = 0.993 & \end{array} \quad (10)$$

where L, W, Y, and A have the same meaning as before.

In Equation 10 all estimates agree with a priori expectations in terms of signs and have plausible magnitudes. Again, the t-statistics pertaining to W, Y, and A indicate that the parameters are statistically different from zero, and the coefficient on Y is statistically different from unity, at the 95 percent level.[22]

Repeating the procedure for Equation 9 the results again indicate that technological advance negatively affects the labour income share, after controlling for W and Y:[23]

$$\begin{array}{lcccc} \ln L_{it} = & 3.143 & - 0.211 \ln W_{it} & + 0.035 \ln Y_{it} & - 0.507 \ln A_{it} \\ & (14.806) & (9.537) & (-4.062) & (-4.112) \\ \text{N} = 110 & & R^2 = 0.501 & \text{Adj } R^2 = 0.487 & \end{array} \quad (11)$$

Residual diagnostic tests

It should be noted that both equations performed satisfactorily in terms of residual diagnostic tests, for which we used the Jarque-Bera tests, which showed that the residuals are normally distributed, at 95 percentconfidence interval respectively. Furthermore, to control for heteroscedasticity, the parameters were also estimated using the Huber-White sandwich estimators, showing that the standard errors remained practically unchanged. Regarding multicollinearity, the correlation between W, Y and A across countries was not found to be unduly high.[24] Two diagnostic tests were also conducted to test for the random effects method. The results of the Hausman test decisively favours the use of the RE estimator over fixed-effects in this analysis, while the Breusch-Pagan Lagrange multiplier test prefers RE over the simple OLS regression.

Conclusion

This article argued that technological advance has a negative effect on the labour income share, mainly due to its capital augmenting effects, and the asymmetric power over the distribution of income. In turn, this reduces the labour share income. This hypothesis was tested using a production function approach, utilising the marginal productivity condition for labour derived from the CES production function. The results indicate, among other things, that technological progress negatively affects labour demand, everything else remaining constant. This conclusion was extended to explain why technological advance also negatively affects the labour share. Therefore, as countries experience improvements in technology, lower labour share income is experienced when compared to countries with lower levels of technology.

This finding has important implications for EU member states, namely that countries with higher levels of technology would tend to experience higher income inequalities and the consequent negative effects, discussed above, when compared to countries with a lower level of technology, everything else remaining constant.

The article also argued that the adverse effects of a declining labour income share are generally not blamed on the workers themselves but on factors outside their control, including technological advance and a higher degree of decision making enjoyed by the owners of capital when compared to hired labour. This suggests that some form of policy intervention would seem to be necessary as left to its own devices, the capitalist system — which has often led to asymmetrical power over the income share between owners and employees and has ushered in the globalisation process — has generated technological advance that could result in a continuing secular falling labour share income.

One should not imply from this finding that policies aimed at dismantling technological advance and banning labour-saving devices would solve the problem, as this will result in a loss of competitiveness and productivity, and will be counterproductive. As Bernanke (2007) argues, policy approaches that would inhibit the dynamism and flexibility of the labour market would do more harm than good as technological advance is a critical source of overall economic growth and of improvements in the overall standard of living. It should be noted however, that the effect of technology will depend on the workings of the labour market. If, for example, labour-saving technology leads to loss of job in one industry, job mobility could mitigate this problem as those who lose their jobs could relocate into other industries

One form of policy intervention is progressive income tax to redress this problem. Atkinson *et al.* (2009), for example, make a case for progressive income tax to redistribute income to labour earnings and from capital earnings which have grown at an unprecedented rate since the 1970s.[25] Progressivity of income tax

could be strengthened by cutting back tax relief that benefit mainly high-income groups (OECD, 2012), such as reduced taxation on capital gains. Income tax progressivity, however has various downsides in that it could discourage effort, as well as research and innovation, which are the drivers of technological advance, and could stimulate outflow of capital in search of lower rates of taxation.

One of the factors leading to lower earnings relate to skill mismatches which arise with the changing structure of the economy, often driven by technological advance. In this regard, another form of policy intervention in mitigating the adverse effects of a declining labour share is the activation of active labour market policies (OECD, 2012; Bernanke, 2007), which tend to reduce market frictions. Improving skills and labour mobility are vital to counteract the effect of technological advance (Baumol and Wolff, 1998). Indeed, skilled workers and those with a good level of education are better able to respond to changing circumstances in the labour market (Acemoglu and Angrist, 2001)

As explained above, labour replacing technology could lead to GDP growing faster than wage rates, and this could in turn lead to chronically high unemployment rates. Brynjolfsson and Mcafee (2012) consider the rapid technological advance as destabilising, as the jobs that being displaced by technology may be lost for good, leading to long term unemployment.[26] This would be harmful to society given that gainful employment has dignity associated with it and that unemployment leads to a number of social ills.

Some economists (*e.g.* Coote and Franklin, 2013) consider that a shorter working week, without a reduction in pay, could reduce this tendency. In addition, according to the same authors, a shorter working week would lead to a healthier, more fulfilling and sustainable way of life.[27] A similar argument is also put forward by Kallis *et al* (2013) who conclude that while the results of reducing working hours are uncertain, this may be a risk worth taking, especially as an interim measure that may relieve unemployment while other necessary structural changes are instituted. Such a measure would of course lead to higher costs for firms, who would have to employ more persons to produce the same level of output, everything else remaining constant. On the other hand, if the reduced man-hours do not produce a lower level of output[28] this measure would be counter-productive in that it will not increase labour demand.

In summary, the finding of negative effect of technology advance on labour share, as evidenced by the results of the labour demand equation, is plausible, and confirms the tested hypothesis. It should be noted, however, that other factors are likely to affect the labour income share, such as globalisation process and structural shifts. These could also have had some effects on the labour share, however, they might have been captured in the technology variable, given that exposure to the globalisation process and structural shifts may have themselves conditioned technological changes.

Appendix A

Table A1
Total Hours Worked and Gross Value Added

	Total Hours Worked					Gross Value Added				
	2008	**2009**	**2010**	**2011**	**2012**	**2008**	**2009**	**2010**	**2011**	**2012**
Belgium	139,366	137,676	141,604	141,723	141,241	286,926	281,204	293,440	305,040	309,260
Bulgaria	127,512	120,740	113,629	109,644	107,603	27,654	28,049	29,149	31,401	32,254
Czech Republic	187,424	181,752	179,047	178,670	178,799	130,315	119,230	125,847	130,831	128,252
Denmark	91,477	86,653	85,881	86,499	85,399	188,538	179,025	189,858	193,193	197,424
Germany	1,252,286	1,220,916	1,239,585	1,278,508	1,289,663	2,084,920	1,979,910	2,095,440	2,192,340	2,241,120
Estonia	24,415	21,022	20,424	21,956	22,282	13,515	11,172	11,623	13,220	14,167
Ireland	69,692	62,143	59,369	58,377	58,260	153,414	138,774	137,806	142,499	141,408
Greece	163,094	159,136	155,045	144,009	131,647	187,593	185,942	176,678	165,001	151,266
Spain	707,995	641,258	620,627	605,909	571,880	936,637	908,823	889,364	894,742	882,227
France	812,543	803,482	812,972	819,991	817,844	1,604,812	1,566,661	1,604,886	1,654,519	1,678,898
Italy	797,250	771,263	768,383	766,418	753,575	1,325,583	1,274,976	1,295,303	1,319,872	1,308,890
Cyprus	13,458	13,495	14,124	14,297	14,108	13,646	13,473	13,998	14,441	14,391
Latvia	42,031	35,547	33,818	30,885	31,443	18,863	15,308	14,953	16,845	18,580
Lithuania	52,345	47,775	45,076	45,117	45,819	27,138	22,231	23,208	26,105	28,009
Luxembourg	6,501	7,219	7,324	7,436	7,893	31,868	30,029	33,561	35,484	36,258
Hungary	142,687	137,200	136,974	136,667	136,677	82,028	70,149	73,926	76,672	74,421
Malta	5,577	5,600	5,621	5,718	5,828	4,887	4,828	5,284	5,443	5,604
Netherlands	245,684	244,076	237,197	238,681	237,646	492,023	472,822	485,097	497,787	498,843
Austria	139,541	134,925	135,535	136,984	137,974	241,727	234,587	242,258	255,083	261,581
Poland	589,653	582,010	568,431	568,670	567,505	300,949	261,019	295,675	309,431	321,034
Portugal	184,528	179,337	179,132	173,311	166,260	136,571	135,248	138,162	136,911	130,919
Romania	371,280	360,648	361,258	357,274	361,536	117,904	100,571	105,421	109,919	109,566
Slovenia	36,711	35,416	34,817	33,433	32,767	30,794	29,048	28,954	29,493	28,712
Slovakia	89,535	84,012	81,951	81,816	82,981	54,922	52,887	55,493	58,153	60,745
Finland	86,421	82,410	82,751	83,688	83,438	153,076	140,324	145,848	152,573	155,246
Sweden	149,901	145,601	148,859	151,794	152,233	278,583	242,852	291,092	321,963	341,023
United Kingdom	965,953	943,677	943,891	953,309	972,076	1,565,156	1,359,646	1,465,188	1,486,986	1,631,894

Note on the data. The units of measurement are: gross value added in euro million.

Table A2
Hourly Wages and Salaries and Technology

	Hourly Wages and Salaries					Technology				
	2008	**2009**	**2010**	**2011**	**2012**	**2008**	**2009**	**2010**	**2011**	**2012**
Belgium	23.9	24.8	25.6	26.3	27.0	5.8	5.8	5.8	5.9	5.9
Bulgaria	2.1	2.4	2.6	2.8	3.0	4.0	4.1	4.3	4.2	4.3
Czech Republic	6.7	6.7	7.1	7.6	7.7	5.3	5.4	5.4	5.5	5.4
Denmark	30.2	31.1	32.1	32.7	33.3	5.8	5.7	5.7	5.8	5.5
Germany	21.8	22.3	22.4	23.0	23.8	5.6	5.5	5.4	5.2	5.4
Estonia	5.8	5.6	5.5	5.8	6.1	5.6	5.5	5.4	5.5	5.5
Ireland	24.8	25.2	24.9	25.0	25.1	5.9	6.0	6.0	6.2	6.2
Greece	13.5	13.7	13.7	13.1	12.2	4.6	4.6	4.6	4.7	4.6
Spain	14.3	15.1	15.3	15.6	15.5	5.1	5.2	5.3	5.4	5.4
France	20.9	21.1	21.7	22.3	22.7	5.6	5.6	5.6	5.7	5.5
Italy	18.2	18.8	19.4	19.6	19.9	4.5	4.5	4.5	4.4	4.4
Cyprus	14.1	14.6	14.8	15.1	15.0	5.2	5.3	5.2	5.1	5.1
Latvia	4.6	4.5	4.3	4.5	4.8	4.7	4.6	4.7	4.7	4.7
Lithuania	4.2	4.0	3.9	4.0	4.2	4.9	4.9	5.2	5.4	5.4
Luxembourg	26.6	27.8	28.5	29.4	30.0	5.8	6.0	5.9	5.8	6.0
Hungary	5.5	5.1	5.2	5.4	5.5	5.1	5.2	5.3	5.5	5.3
Malta	10.4	10.6	10.9	11.2	11.5	5.8	5.6	5.6	5.7	5.7
Netherlands	22.9	23.5	23.9	24.2	24.5	5.7	5.6	5.7	5.8	5.8
Austria	19.5	20.3	20.6	21.3	22.4	5.7	5.6	5.6	5.7	5.6
Poland	6.3	5.4	6.0	6.1	6.2	4.7	4.8	4.8	4.8	4.7
Portugal	9.9	10.2	10.2	10.1	9.4	5.5	5.6	5.8	5.8	5.7
Romania	3.2	3.1	3.2	3.2	3.2	4.4	4.6	4.5	4.4	4.2
Slovenia	11.6	12.2	12.4	12.6	12.7	4.5	4.9	4.9	4.7	4.8
Slovakia	5.4	5.6	5.7	5.9	6.1	5.5	5.6	5.7	5.5	5.3
Finland	20.9	21.9	22.4	23.0	24.0	5.7	5.6	5.5	5.4	5.5
Sweden	21.2	19.7	22.5	24.3	26.0	5.9	5.9	6.0	6.1	5.9
United Kingdom	17.7	16.0	17.0	17.1	18.3	5.8	5.7	5.8	5.8	5.8

Note on the data. The units of measurement are: gross value added in euro million.

Table A3
Correlation Matrix - 2008

	L	**Y**	**W**	**A**
L	1.00			
Y	0.95	1.00		
W	0.18	0.36	1.00	
T	-0.02	0.15	0.65	1.00

Table A4
Correlation Matrix - 2009

	L	**Y**	**W**	**A**
L	1.00			
Y	0.95	1.00		
W	0.16	0.35	1.00	
T	-0.07	0.08	0.63	1.00

Table A5
Correlation Matrix - 2010

	L	**Y**	**W**	**A**
L	1.00			
Y	0.95	1.00		
W	0.17	0.35	1.00	
T	-0.06	0.08	0.57	1.00

Table A6
Correlation Matrix - 2011

	L	**Y**	**W**	**A**
L	1.00			
Y	0.95	1.00		
W	0.17	0.35	1.00	
T	-0.10	0.05	0.56	1.00

Table A7
Correlation Matrix - 2012

	L	Y	W	A
L	1.00			
Y	0.95	1.00		
W	0.17	0.35	1.00	
T	-0.09	0.07	0.59	1.00

Appendix B: The data

The data used for estimating Equation 7 refer to average period between 2008 and 2012. The definition and the sources of the data are as follows:

Total Hours Worked (*L*)
Definition: Total average number of actual annual hours of work, in private sector.
Source: Labour Force Survey
The data on employment was multiplied by average number of weekly hours of work. URL for employment: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_egan2&lang=en, extracted on 23-April-2014
URL for average number of usual weekly hours of work: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_egan2&lang=en, extracted on 13-April-2014

Wage Rates (*W*)
Definition: Hourly wages and salaries in cash and in kind borne by employers for the purpose of employing staff, in industry, construction and services (except public administration, defence, and compulsory social security).
Source: Labour Cost Survey
URL for wage rates: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lc_lci_lev&lang=en, extracted on 23-April-2014

Gross Value Added (*Y*)
Definition: Output is measured at basic prices, in private sector.
Source: National Accounts
URL for output: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_nace21_c&lang=en, extracted on 23-April-2014

Technology (*A*)
Definition: Average of two indices namely (i) availability of latest technologies (component index 9.01) and (ii) FDI and technology transfer (component index 9.03) of the Global Competiveness Report (Various Issues).

Appendix C: Estimation Techniques

Table C1
Estimating labour demand assuming equilibrium condition

	RE	**FE**	**Pooled OLS**	**OLS (5-year average)**
C	3.349	3.352	3.349	3.451
	(16.317)	(16.316)	(16.273)	(4.575)
ln W_{it}	-0.77	-0.768	-0.77	-0.843
	(-37.679)	(-37.584)	(-37.580)	(-11.945)
ln Y_{it}	0.968	0.968	0.968	0.995
	(128.275)	(128.251)	(127.935)	(37.516)
ln A_{it}	-0.668	-0.672	-0.668	-0.832
	(-5.481)	(-5.506)	(-5.466)	(-1.925)
R^2	0.993	0.993	0.993	0.986
Adj R^2	0.993	0.993	0.993	0.985
F-stat	6107	2631	6107	532
N	130	130	130	26

Table C2
Estimating labour demand assuming disequilibrium condition

	RE	**FE**	**Pooled OLS**	**OLS** (5-year average)
C	3.143	3.136	3.143	3.286
	(14.806)	(14.754)	(14.801)	(7.268)
ln W_{it}	-0.789	-0.789	-0.789	-0.782
	(-35.701)	(-35.658)	(-35.690)	(-16.665)
ln Y_{it}	0.965	0.965	0.965	0.962
	(113.164)	(113.144)	(113.127)	(51.532)
ln A_{it}	-0.507	-0.504	-0.507	-0.582
	(-4.112)	(-4.084)	(-4.110)	(-2.287)
R^2	0.993	0.993	0.993	0.994
Adj R^2	0.993	0.993	0.993	0.993
F-stat	4960	2127	4960	1060
N	110	110	110	22

Notes

[1]Technological changes could be attributed to the development in information and communications technology (ICT), a development which is considered by Blinder (2006) as the third industrial revolution.

[2]A review of the literature on the share of labour is given in Schneider (2011).

[3]Contribution of emerging countries can be associated with globalisation through trade, inward FDI, and international migration. This process is associated with the spread of technological advance and also with a deteriorating bargaining power of hired employees.

[4]As Jacobson and Occhino (2012) argue, labour income is more evenly distributed across households than capital income. The decline in labour share resulted in total income being less evenly distributed and more concentrated at the top of the distribution. Therefore, this contributed to increase income inequality.

[5]Dynan *et al*. (2004) show that the rich do save more, while Kwak (2014), referring to this possibility, argues that there is a strong argument to be made that a capitalist society needs systematic redistribution to survive.

[6]Curci *et al*. (2011) also put forward this argument, and contend that arresting the decline in the wage share can help put recovery from the global economic crisis on a more sustainable path. A comprehensive income-generating strategy would have expansionary effects on aggregate demand and employment, without aggravating fiscal deficits.

[7]Rodrik (1999) equates income inequality with social conflict, and conducts a series of quantitative tests to show that income inequality impedes the social harmony required to sustain economic growth. The connection between income inequality and social well-being is also discussed in Wilkinson and Pickett (2009), who show that population health tends to be better in societies where income is more equally distributed. They refer to recent evidence that suggests that many other social problems, including mental illness, violence, imprisonment, lack of trust, teenage births, obesity, drug abuse, and poor educational performance of schoolchildren, are also more common in more unequal societies.

[8]On this issue see the definition adopted by the OECD (http://www.oecd.org/std/productivity-stats/40284233.pdf) and the Bureau of Labour Statistics (http://www.bls.gov/news.release/pdf/prod2.pdf)

[9]This index is readily available in the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN) AMECO database. This indicator assumes that the self-employed earn the same average earnings as employees by adjusting the labour share and by taking compensation per employee as percentage of GDP at factor cost per person employed. GDP at factor cost is GDP at market prices minus taxes on production and imports plus subsidies. In national accounts it is equal to the aggregation of labour compensation and operating surplus.

[10]EU-15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom while EU-27 includes EU-15 and new Member States' economies, namely Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. The addition of new Member States does not alter the overall trend of EU-15 in a significant way due to the relative small share of their economies.

[11]A discussion on the properties of the CES is presented in Miller (2008).

[12]Technology measures shifts in production function that cannot be explained through labour or capital changes. In this sense, A_{it}^{χ} captures any systematic factor other than labour and capital.

[13]When time-series data are used, the efficiency term of the production function is often interpreted as capturing Hicks-neutral technological change. Alternatively, one can allow for a non-neutral type of technological change (David and Van de Klundert, 1965), in the sense that the factor augmenting efficiency changes are not assumed to be the same for labour and capital. Although the technical change parameter is usually applied to time-series data, we shall use the concept of efficiency in our cross-section analysis to allow for shifts in the production function due to differing factor enhancing endowments across countries.

[14]Private sector is defined as total activities less public administration, defence and compulsory social security.

[15]Luxembourg was omitted from the regression analysis as it was an extreme outlier. Luxembourg had an unexceptionally large output-to-labour ratio because of a high net number of cross-border workers. Therefore, estimation of Equation 5 gave a large standardised residual for Luxembourg. It is important to outline that national accounts employment data for industry is not available in hours worked, thus this study had to rely on Labour Force Survey data.

[16]On the basis of the computed t-value (4.29), we reject the null hypothesis that α_2 is equal to 1.

[17]On this issue see Briguglio and Vella (2015).

[18]The labour market institutions could also be factored in by augmenting Equation 5 with the tax wedge, sourced from the Tax and Benefits Indicators Database of the European Commission. This tests the hypothesis that the higher the tax wedge the higher is the disincentive to work, thereby affecting the bargaining process of employees. The results of estimation gave practically the same results as those obtained by regressing Equation 8, meaning that the coefficient on A remains significantly negative.

[19]NAIRU or NRU both refer to a rate of unemployment compatible with labour market equilibrium.

[20]The data on NAIRU was obtained from the annual macroeconomic database (AMECO) of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN)

[21]The countries with excess labour demand are Germany, Poland, Cyprus, and Slovakia.

[22]On the basis of the computed t-value (4.06), we reject the null hypothesis that α_2 is equal to 1.

[23]Alternative approaches were to use the value of A and an index for ranking countries according to the absolute value of A which gave similar results.

[24]From the correlation coefficients it can be concluded that exogenous variables are not highly collinear. This means that multicollinearity is inconsequential.

[25]This was one factor identified in Piketty (2014).

[26]Keynes (1930) wrote that within his own lifetime "we may be able to perform all the operations of agriculture, mining, and manufacture with a quarter of the human effort to which we have been accustomed."

[27]This argument can be articulated in a Marxist discourse as to who is to appropriate the fruits of technological advance, that is, whether employees should do this by enjoying more leisure at the expense of profit, or whether owners of capital should do this by increasing their profit.

[28]This could happen if employees adjust their work speed so as to fill the time available for the work's completion in line with Parkinson's Law.

Bibliography

Acemoglu, D., (2003*a*) "Cross-country Inequality Trend", *The Economic Journal*, vol. 113, no. 485, pp. 121–149.

Acemoglu, D., (2003*b*) "Labor- and capital-augmenting technical change", *Journal of the European Economic Association*, vol. 1, no. 1, pp. 1–37.

Acemoglu, D., (2002) "Technical Change, Inequality, and the Labor Market", *Journal of Economic Literature*, vol. 40, no. 1, pp. 7–72.

Acemoglu, D. and Angrist, J., (2001) "How large are human-capital externalities? evidence from compulsory-schooling laws" in *NBER Macroeconomics Annual*, eds. B.S. Bernanke and K. Rogoff, MIT Press, Cambridge, pp. 9–59.

Acemoglu, D., Gancia, G., and Zilibotti, F., (2014) "Offshoring and Directed Technical Change", *Barcelona GSE Working Paper Series*.

Arpaia, A., Pérez, E., and Pichelmann, K., (2009) "Understanding labour income share dynamics in Europe", *Economic Paper Working Paper No. 379*.

Arrow, K.J., Chenery, H.B., Minhas, B.S., and Solow, R.M., (1961) "Capital-labor substitution and economic efficiency, *The review of economics and statistics*, vol. 43, no. 3, pp. 225–250.

Askenazy, P., (2003) "Partage de la valeur ajoutée et rentabilité du capital en France et aux États-Unis: une réévaluation; suivi d'un commentaire de Xavier Timbeau", *Economie et statistique*, vol. 363, no. 1, pp. 167-189.

Athreye, S. and Cantwell, J., (2007) "Creating competition?: Globalisation and the emergence of new technology producers", *Research Policy*, vol. 36, no. 2, pp. 209–226.

Atkinson, A.B., Piketty, T., and Saez, E., (2009) "Top incomes in the long run of history", *NBER Working Paper No. 15408*.

Autor, D.H., Donohue III, J.J. and Schwab, S.J., (2006) "The costs of wrongful-discharge laws", *The review of economics and statistics*, vol. 88, no. 2, pp. 211–231.

Bassanini, A. and Manfredi, T., (2012) "Capital's Grabbing Hand? A Cross-Country/Cross-Industry Analysis of the Decline of the Labour Share", *OECD Publishing, Social Employment and Migration Working Papers No. 133*.

Baumol, W.J. and Wolff, E.N., "Side effects of progress", *Jerome Levy Economics Institute of Bard College, Policy Brief No. 41*.

Bentolila, S. and Saint-Paul, G., (2003) "Explaining movements in the labor share", *Contributions in Macroeconomics*, vol. 3, no. 1.

Bengtsson, E. and Ryner, M., (2014) "The (International) Political Economy of Falling Wage Shares: Situating Working-Class Agency", *New Political Economy*, pp. 1–25.

Bernanke, B.S., (2007) *The level and distribution of economic well-being*, Greater Omaha Chamber of Commerce, Nebraska.

Blinder, A.S., (2006) "Offshoring: the next industrial revolution?", *Foreign affairs*, vol. 85, no. March/April, pp. 113–128.

Briguglio, L.P. and Vella, M., (2015) "Labour demand in the EU and returns to scale: A production function approach", *The Journal of International Trade and Economic Development*, pp. 1–14.

Brynjolfsson, E. and McAfee, A., (2012) "Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy", *MIT Center*

for Digital Business Research Brief.
Checchi, D. and Cecilia, G., (2010) "Labour market institutions and the personal distribution of income in the OECD", *Economica*, vol. 77, no. 307, pp. 413–450.
Coote, A. and Franklin, J., (2013) *Time on Our Side: Why we all need a shorter working week*, New Economics Foundation, UK.
Curci, F., Khatiwada, S. and Tobin, S., (2011) "Market turbulence, employment and social unrest: Trends and outlook", *World of Work Report*, vol. (2011, no. 1, pp. 1–30.
David, P.A. and Klundert, T.v.d., (1965) "Biased Efficiency Growth and Capital-Labor Substitution in the U.S., 1899–1960", *The American Economic Review*, vol. 55, no. 3, pp. 357–394.
Dean, G.A., (1965) "The Stock of Fixed Capital in the United Kingdom in 1961", *Journal of the Royal Statistical Society*, vol. 127, no. A, pp. 327–358.
Dustmann, C., Frattini, T., and Preston, I., (2008) "The effect of immigration along the distribution of wages", *Review of Economic Studies*, vol. 80, no. 1, pp. 145–173.
Dynan, K.E., Skinner, J., and Zeldes, S.P., (2004) "Do the rich save more?", *Journal of Political Economy*, vol. 112, no. 2, pp. 397–444.
Egger, H. and Kreickemeier, U., (2009) "Firm Heterogeneity And The Labor Market Effects Of Trade Liberalization", *International Economic Review*, vol. 50, no. 1, pp. 187–216.
Elsby, M.W., Hobijn, B., and Şahin, A., (2013) "The decline of the US labor share", *Brookings Papers on Economic Activity*, vol. 2013, no. 2, pp. 1–63.
European Commission, (2007) *The labour income share in the European Union: Employment in Europe 2007*, European Commission, Brussels.
Freeman, R.A., (2011) *Accounting for the Self-Employed in Labour Share Estimates*, OECD Publishing.
Gollin, D., (2002) "Getting income shares right", *Journal of political Economy*, vol. 110, no. 2, pp. 458–474.
Gomme, P. and Rupert, P., (2004) "Measuring labor's share of income", *Federal Reserve Bank of Cleveland, Policy Discussion Papers.*
Hansen, G.D. and Prescott, E.C., (2005) "Capacity constraints, asymmetries, and the business cycle", *Review of Economic Dynamics*, vol. 8, no. 4, pp. 850–865.
Helpman, E., Itskhoki, O., and Redding, S., (2010) "Inequality and unemployment in a global economy", *Econometrica*, vol. 78, no. 4, pp. 1239–1283.
Hurst, E., Li, G. and Pugsley, B., (2014) "Are household surveys like tax forms? Evidence from income underreporting of the self-employed", *Review of economics and statistics*, vol. 96, no. 1, pp. 19–33.
ILO, (2012) *Global Wage Report 2012/13: Wages and Equitable Growth*, International Labor Organisation, Geneva.
IMF, (2007) *World Economic Outlook*, IMF, Washington.
Jacobson, M. and Occhino, F., (2012) "Behind the Decline in Labor's Share of Income", *Federal Reserve Bank of Cleveland, February*, vol. 3.
Jaumotte, F., Lall, S., and Papageorgiou, C., (2013) "Rising Income Inequality: Technology, or Trade and Financial Globalization", *IMF Economic Review*, vol. 61, no. 2, pp. 271–309.
Jaumotte, F. and Tytell, I., (2007) "How has the globalization of labor affected the labor income share in advanced countries?", *Research Department, IMF Working Paper.*
Kallis, G., Kalush, M., O'Flynn, H., Rossiter, J., and Ashford, N., (2013) ""Friday off": Reducing Working Hours in Europe", *Sustainability*, vol. 5, no. 4, pp. 1545–1567.
Karanassou, M. and Sala, H., (2013) "Inequality and Employment Sensitivities to the Falling Labour Share", *The Economic and Social Review*, vol. 43, no. 3, pp. 343-–376.
Keynes, J.M., (1930) *Essays in persuasion*, WW Norton & Company.
Krueger, A.B., (1999) "Measuring Labor's Share", *American Economic Review*, vol. 89, no. 2, pp. 45–51.
Kwak, J., (2014) *Good Times for Capital: In the Global Scenario*. Available: http://baselinescenario.com/2014/03/10/good-times-for-capital/ [2014, 06/01].
Lavoie, M. and Stockhammer, E., (2012) *Wage-led growth: Concept, theories and policies*, ILO, Geneva.
Lawless, M. and Whelan, K. T., (2011) "Understanding the dynamics of labor shares and inflation", *Journal of Macroeconomics*, vol. 33, no. 2, pp. 121–136.
Miller, E., (2008) "An assessment of CES and Cobb-Douglas production functions", *Congressional Budget Office Working Paper 5*.
Nickell, S. and Saleheen, J., (2008) "The impact of immigration on occupational wages: evidence from Britain.", *Federal Reserve Bank of Boston, Working Paper No. 08-6.*
OECD, (2012) *Reducing income inequality while boosting economic growth: Can it be done?*, OECD Publishing.
Onaran, Ö. and Galanis, G., (2012) "Is aggregate demand wage-led or profit-led?", ILO, *Conditions of Work and Employment Series*, no. 31.

Ostry, M.J.D., Berg, M.A., and Tsangarides, M.C.G., (2014) *Redistribution, inequality, and growth*, International Monetary Fund.

Palley, T., (2011) "America's flawed paradigm: macroeconomic causes of the financial crisis and great recession", *Empirica*, vol. 38, no. 1, pp. 3–17.

Piketty, T., (2014) *Capital in the Twenty-first Century*, Harvard University Press.

Piketty, T. and Zucman, G., (2015) "Wealth and Inheritance in the Long Run" in *Handbook of Income Distribution*, ed. F.B. A. Atkinson, Volume 2 edn, Elsevier-North Holland, , pp. 1303–1368.

Raurich, X., Sala, H., and Sorolla, V., (2012) "Factor shares, the price markup, and the elasticity of substitution between capital and labor", *Journal of Macroeconomics*, vol. 34, no. 1, pp. 181–198.

Reed, H. and Latorre, M., (2009) "The economic impacts of migration on the UK labour market", *Institute for Public Policy Research, Economics of migration Working Paper No. 3*, vol. 3.

Roach, S., (2009) "Labor versus Capital" in *Stephen Roach on the next Asia: Opportunities and Challenges for a new globalization* John Wiley & Sons, Canada.

Rodrik, D., (1999) "Where did all the growth go? External shocks, social conflict, and growth collapses", *Journal of economic growth*, vol. 4, no. 4, pp. 385–412.

Schneider, D., (2011) "The labor share: A review of theory and evidence", *SFB 649 Economic Risk, Discussion Paper 2011*, vol. 69.

Stockhammer, E., (2012) "Why have wage shares fallen? A panel analysis of the determinants of functional income distribution", ILO, *Conditions of Work and Employment Series*, no. 15.

Storm, S. and Naastepad, C., (2009) "Labor market regulation and productivity growth: evidence for twenty OECD countries (1984–2004)", *Industrial Relations: A Journal of Economy and Society*, vol. 48, no. 4, pp. 629–654.

Sweeney, P., (2013) "An inquiry into the declining labour share of national income and the consequences for economies and societies", *The Statistical and Social Inquiry Society of Ireland.*

Thøgersen, J., (2015) "Population Ageing and Capital Accumulation: A Simple OLG Model with PAYGO Pensions", *Theoretical Economics Letters*, vol. 5, no. 2, pp. 155–162.

Wilkinson, R.G. and Pickett, K.E., (2009) "Income inequality and social dysfunction", *Annual Review of Sociology*, vol. 35, pp. 493–511.