What do we talk about when we talk about Productivity Indicators.- Warning on frequent misleading interpretation of published productivity measures

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WHAT DO WE TALK ABOUT WHEN WE TALK ABOUT *PRODUCTIVITY INDICATORS*?

Warning on frequent misleading interpretation of published productivity measures

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1 'Productivity', a key issue in the political arena

The common understanding of 'Productivity' is quite straightforward: Its value increases if a company either produce more of some goods or services with the same resources (personnel and the rest of productive factors) or produce the same quantities of good and services with less of some of the resources. Or a given mix of both types of moves, including trade-offs between favourable and unfavourable moves. In the above quite intuitive formulation –which, broadly coincides with experts'- you may substitute 'a company' by 'any organisation producing goods or delivering services', or by an 'industry' or economic sector, or by the entire country (the whole of its sectors).

Newspapers and media in general talk frequently about productivity. For example, in terms of ".. *the problem of our economy is that productivity is comparatively low/is-lagging-behind* (and here the figure for a productivity index referred to the country)". Or *"…There is a need for serious reforms be undertaken addressed to increase productivity, in order our economy become more competitive and so …*"; or *"..industry's Unions and Employers Association representatives agreed finally on an increase on salaries for this year equal to the last year increase in productivity less half a point. The agreement comes subject to* ..".

In any case, data on productivity levels –at the sector or country level- have last years become a familiar component in the media news and socio-political debate. The problem is that those data on productivity (which usually are of *labour* productivity) do not talk to us actually of productivity in the sense stated at the beginning, though this is the implicit meaning media

and experts do transmit. And, of course, those data are presented to us as an out-of-discussion 'measure of productivity', since the acknowledged sources for them are some official statistics institution, national or international, such as Eurostat –for the EU countries-, OECD, BLS (US), .. etc.

By way of example: According to Eurostat, the EU's country with the highest *labour productivity* level in 2013 was Luxembourg: 163.9; and the following one in the ranking was Ireland (135.5). Quite below appear Germany (107), France (116) and Spain (111), for example[1]. One certainly gets surprised by reading that Luxembourg workers are about 64% more efficient than German workers. Where are those Luxembourg's set of factories or services companies whose employees work with so much productivity (that is, producing so much more goods o delivering so much more services per person) than their German counterparts? Direct observations show that obviously, this is not the case. The above *productivity* differences, 163.9 vs. 107 are against all evidence [2]. Or the above indexes do not refer actually to the common-knowledge concept of productivity stated at the beginning – despite their being so used in the media and the political arena.

Then, what actually means those '(labour) productivity indexes' for such and such country? How are they calculated by the specialised agencies (first the national ones, then the Eurostat, OECD, etc.)?

The present notes, intended for also be read by non-professionals, try to clarify such questions. They start by presenting a summary of the way economists and statisticians calculate the more frequently used productivity measures, at companies level -namely, *Total factor productivity* and *Labour productivity*- which are the conceptual basis. Then, attention is driven to how their adaptations to sector ('industry') and whole-country level are calculated by statistics agencies. This allows finally to discuss and make clear the real meaning of these indexes at the sector and country level. And so to prevent the frequent misleading use and interpretation of statistical data on productivity, not only in the media and the socio-political arena but also in the academic field, which lead to distorted conclusions regarding the real world.

2 How productivity indexes are calculated

Let us start by underlining the dominant idea regarding the topic: that productivity at companies level is something directly connected to the economic growth of the country - usually measured by the increase in the Gross Domestic Product (GDP) per capita. That idea would go like this: the increase in GDP-pc depends mainly on the overall economy's productivity increase; which in turn results from each economic sector's productivity increase; and for each sector the increase depends on its companies' productivity increase.

According to that, the starting step would be how productivity is defined and measured at the firm's level. And then how the aggregation process up to sector and country levels is done. So, let us start with how productivity is measured at the enterprise level.

[1] Eurostat data for ten and five years before show similar values and differences.

[2] The above Eurostat figures represent: Making the mean of labour productivity indexes for the whole EU countries equal to 100, which is the corresponding figure for each of them. Thus, in 2013 Luxembourg's productivity level would be 63.9 % above the EU's mean, France's would be 16% above, Germany's 7% above, etc.

[Though you might want to skip the following point on *Total factor productivity*, going right away to the next one, *Labour productivity*; your getting the essential of the latter will not become substantially affected].

(2.1) The basis: the standard productivity index at the company level

The usual productivity measures for a company, in experts' works, are the *Total Factor Productivity* (TFP) index, and the (partial) *Labour Productivity* index. The former stands however for the 'proper' productivity measure. It is the most used in experts' studies and academic papers.

Its basic definition is in fact the one in the paragraph at the beginning; though made operative through a given, certainly not simple, formula, since the reality to measure is in fact complex. To start with, the usual in the business world is that a firm produces not just one but a lot of different 'products'; and uses more than just one 'factor' –the latter, even in the rare cases of enterprises producing just only one product (as it is the case of an only-milk farm, for example). It is also usual that from period to period the units of its different 'products' show simultaneous changes of different sign (increases and decreases); while at the same time, there are also changes of different sign in the units of the 'factors' contracted or used. All that makes it that to get a single figure for the concept of 'productivity' of a company in a given period is not any simple.

Broadly speaking, the standard TFP formula for a given period comes to be a quotient in which the numerator is a weighted sum of the units of the different goods or/and services produced (invoiced) by the firm in such period, and the denominator a weighted sum of the units of labour and of the other factors contracted or consumed in the same period. Those weights are usually the respective prices of products and factors in a given, past, reference period. Those prices are then taken as parameters (kept as constants) for calculating the TFP indexes for different, subsequent periods. (You may see a more precise description of that standard formula in Appendix 1).

In any case, the calculation outcome consists of a series of TFP figures, for each of the periods under calculation; by way of example: $TFP^{year\ 2012}$=1.34; $TFP^{year\ 2013}$=1.42; $TFP^{year\ 2014}$= 1,38. Though the figures we will more likely find in the papers on the topic are not those *absolute* values properly said but its respective '*rate of change* of the productivity' from period to period. By way of example:

rate of change in 2013 = $(TFP^{year\ 2013} - TFP^{year\ 2012})/ TFP^{year\ 2012}$) → (1.42–1.34)/1.34= 0,06; **(+ 6%)**
≡ $(TFP^{year\ 2013} / TFP^{year\ 2012})$ -1 → (1.42/1.34) – 1 = 0.06
rate of change in 2014 = $(TFP^{year\ 2014} / TFP^{year\ 2013})$ -1 → (1.38/1.42) –1 = –0.028; **(-2,8%)**

Although these rates are usually calculated in an alternative, more sophisticated, way -which gives however similar values (especially for moderate changes, as between ± 1 to 8%):

rate of change in 2013 = $ln(TFP^{year\ 2013} / TFP^{year\ 2012})$ = + 0.058
rate of change in 2014 = $ln(TFP^{year\ 2014} / TFP^{year\ 2013})$ = – 0.028

This 'sophisticated' alternative has the advantage for experts and practitioners that it can also be calculated _for each period– as the difference between the rate-of-change in the aggregate of 'products' (outputs) and the rate-of-change in the aggregated of 'factors' (inputs); (see Appendix 1). Hence, what we may more frequently find in experts' reports or articles on productivity measures for such and such company is a calculation process consisting of some

kind of approach[3] to both rates of change: for the aggregate-of-outputs and for the aggregate-of-inputs. Thus, following the example, such calculation could give for 2014 something like*: (Average rate of change in Products, +7,6 %) – (Average rate of change in Factors, +10,4%) = Change in Productivity, -2,8%.*

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Note that, given its definition, the TFP value for a given period (f.e., the value 1.4 above) is equivalent to 1 + (net margin rate); this firm's margin rate being calculated at constant prices: as if prices, for products as well as production factors, had remained the same, for the company, as those in the year taken as a base for calculations.

Also that, as it can be deduced, the common interpretation of the rates of change of the TFP, over several periods, as measuring the trend in the Productivity of the concerned firm is based on the assumption that the firm's set of products has not changed over the periods, and the same for the production factors it employed. And this is an assumption rarely met in the business' real life. (more on this at the end of Appendix 1).

To Appendix 1, on TFP measures determination and meaning →

Are these experts' *TFP measures* applied to such and such companies the starting data for, throughout aggregation processes, to calculate the productivity –o its change- for a whole industry or economic sector, and then for the whole country? Not actually; though it can be said that TFP measures lend an inspiring background. In any case, that rather (unavoidably) complex way of calculation is not the starting point for determining the productivity measures referring to industries (sectors) and countries we can find in wide audience publications and official statistics [4].

The starting point for the sector or country-level productivity measures we can read in the press -whose sources used to be publications by institutions such as Eurostat or OECD-- is something simpler, based on the *Labour productivity*, mimicking the calculation of it at the enterprise level.

(2.2) The star: Labour Productivity

It is the other usual productivity measure at the company level. Quite easier to determine than *TFP*. And more widely used among practitioners and in wide-audience publications. It is defined as *the quotient between a company's total output and the volume of its workforce* and is technically labelled as *Labour partial-productivity*[5]. That rather general concept has in practice different translations/ interpretations. Among the more usual ones:

[3] Rarely do experts/researchers have available the detailed required data from the firms (the respective units and prices for each different product and factor, for such and such year) that they would require for carrying out the 'real' calculation of the above formulas. Such detailed information is normally considered confidential by firms.

[4] This is because, among other things, to calculate the above rates for all the companies of even a single industry would have huge information costs: To get the number of units for each output and for each input of each company, as well as of their respective prices –provided such companies would be willing to disclose that information. Obviously –and that is much more determining- companies consider that kind of internal data as strategically confidential. And, of course, in a market economy, they have not any obligation to deliver them to a statistics agency.

[5] 'Partial' because it relates the whole output with only one of the inputs: Labour.

[type A] [type B]

$$LP = \frac{N.\ of\ Units\ \ sold^{(***)}}{N.\ of\ \ Employees^{(**)}},\ \text{or}\ \frac{Sales^{(*)}}{N.\ of\ \ Employees^{(**)}},\ \ldots;\qquad \frac{Value\ \ Added^{(*)}}{N.\ of\ \ Employees^{(**)}}$$

Which, in turn, we can find applied in different versions:

(*) , either at current or constant prices;

(**) , either as just *contracted people* or '*N. of full- time equivalent'*; also sometimes: *N. of Total hours worked*

(***), only viable in the scarce cases where the analysed company produce a single output (f.e. Hl. of milk)

As far as ***Value added***, it is calculated –broadly speaking- as the sum of personnel costs plus the company's profits.[6]

These *Labour productivity* measures enjoy a great appeal from people reading productivity analysis papers or reports: these indexes sound less 'abstract', and more directly understandable than the 'professional' *TFP*. At least at first glance; though the shortfalls and drawbacks of using those *LP* indexes are well known:

Regarding type 'A' ones, because 1) they imply assigning all the basket of outputs to one of the inputs, labour –independently of how the units of the rest of inputs (equipment, subcontracted services, energy, etc.) have changed from period to period; which leads to figures of an uncertain –if not misleading- meaning. And 2) the last-decades-accelerated trend to mechanisation, automation, and outsourcing –which implies that Labour is progressively substituted by other factors (equipment, energy consumption and outsourcing services)– means that the numerator tends to increase over time while the denominator keeps constant or decreases. As a consequence, these type 'A' measures tend to show a persistent increase across time even if employees' efficacy and ability in their jobs are the same; which makes them not significant as productivity measures; and as far as type-B measures, because the value-added-per-employee will necessarily appear higher for a company operating with high margins –thanks to enjoying some market power- in comparison with another company that faces hard competitive pressure and therefore operates with lower margin rates. Even if their respective employees are equally productive and smart. Thus, the former company will get higher profits per employee and may also pay higher salaries; so, it will show higher value-added-per-employee. Therefore, for comparisons among different companies, a higher *value-added-based LP* index does not necessarily mean higher productivity properly said.

However, on the side of advantages, it is easy to see that applying a type B *Labour Productivity formula* to an industry or economic sector, or the whole economy, is something much easier, feasible and straightforward than in the case of a *TFP* measures. Let us see the application of the LP idea at those upper levels.

3 (Labour) Productivity measures at the sector and country level

Most of the data we may read on productivity at sectors or countries level refers to LP; and, more specifically, to *Labour-Productivity-based-on-value-added* (*LPva*) in its version of:

$$\text{LPva}_{\text{sector '...'}} = \frac{\text{Value added, at-constant-prices}}{\text{(average) N. of Employees, } full-time-equivalent} = \frac{VA}{E};$$

for a given period 'x'; (year, semester, …..)

[6] A more refined definition of Labour productivity at-constant-prices, based on the terminology of TFP, is also becoming popular among experts. See further footnote 16 in the Appendix 1.

It is easy to calculate for a given economic sector by taking the usually available national statistics. Thus, in the case of the numerator, raw data on the value added for (all the companies included in) a sector can be drawn from the Value Added Tax (VAT) national system. And as far as the denominator, regular employment statistics use to be detailed by sectors.

Then, if this *LP* is calculated for all economic sectors, an average for the whole economy may then be determined. However, these overall *LP* measures at the country level may also be (and usually are) calculated directly: By taking national-level statistics for employment, for the denominator; and by determining, for the numerator, the total value added at the national level as from the VAT system statistics; which, broadly speaking, is equivalent to the Gross Domestic Product (GDP) [7]. In any case, Labour productivity at the country level is usually defined as:

$$\text{LP (va € per person), whole country} = \frac{\text{Gross Domestic Product, at - constant - prices (GDPcp)}}{\text{Total N.of Employees f_t_e (annual average)}} \equiv \frac{VA}{E}$$

However, the Eurostat database, for example, does not make properly available the above absolute (in €) data values for the EU countries but just comparative indexes:

Table 1
Comparative Labour Productivity (value added €, per person), between EU countries:

Country	2007	2013
Average EU (27 countries)	100	100
Some countries' data:		
Luxembourg	179,7	163,9
Ireland	136,2	135,5
France	115,4	116,-
Germany	108,2	107,-
Spain	103,-	111,2
:		
Greece	95,3	92,7
Bulgaria	37,4	43,4
:		

$[\ LP(va\ €)^{\text{Country 'X'}} / LP(€)^{\text{Average for EU countries}}\ ] \times 100$

Source: Data from Erostat's table "Labour productivity per person employed" (ESA95), as published in the Eurostat web as of June 2015.

And these are the data that have been mentioned at the beginning of these notes: Luxembourg appearing surprisingly as the country with the highest (labour) productivity, and Spain having surpassed Germany (!).

What it does is available in absolute (€) values from Eurostat is a variant of the LPva ratio: (**€ *per hour worked***). Thus, following with the above countries-example:

Table 2
Labour Productivity, value-added; € per hour worked *, for some EU countries:

Country	2007	2013
Average EU (27 countries)	31,4 €	32,2 €
Some countries' data:		
Luxembourg	64,9	58,2

[7] More precisely, GDP is defined as the sum of value added over all sectors, but adding taxes and deducting subsidies on final products.

Ireland	45,1	48,8
France	44,9	45,6
Germany	42,-	42,8
Spain	28,5	32,1
:		
Greece	21,5	20,2
Bulgaria	4,3	4,9
:		

(*) ***VA/E***; ***VA*** measured as GDPcp; ***E*** measured as 'Total N. of hours worked'

Source: Data taken from Eurostat's table "Real Labour productivity per hour worked (€)", [nama_aux_lp], as published in the Eurostat web database as of June 2015.

Again –be at the sector or country level-, half of the time the data we will find in economic newspapers or the original statistical sources –f.e., Eurostat (EU) or OECD publications- will not refer to the above absolute, monetary values (so much € in the year, per person, or per hour worked) but to the corresponding change of those values from period to period. Changes which we may find expressed either in terms of *index* or in terms of *rate*. Thus, in the case of the *index* (of change, over time) option, it will have been calculated as (taking, by way of example, the year 2005 as the initial, reference year):

$$\textbf{LP\^{}} \text{ = Labour Productivity } \textbf{index} \text{ of change: for the Year 2013'} = \frac{(VA/E)^{Year\ 2013}}{(VA/E)^{Year\ 2005}} \times 100\ ;$$

[so, f.e. a value of 104,5 would mean that the productivity of the Sector (or of the Country) –measured as Value added at constant prices, per Employee (full-time equivalent)- has increased by 4.5% since 2005.]. [8]

Thus, following with the example:

Table 3

LP^, **Labour Productivity** index of change, for some EU countries:

Country	2005	2007	2013*
Average EU (27 countries)	100,-	103,6	106,4
Some countries' data:			
Luxembourg	100,-	103,-	92,3
Ireland	100,-	102,4	110,7
France	100,-	103,-	104,5

[8] You might also find the same ratio expressed in the equivalent terms of,

$$\textbf{LP\^{}}_{(2015)} = \frac{(VA^{Year\ 2015}/VA^{Year\ 2014})}{(E^{Year\ 2015}/E^{Year\ 2014})} \times 100;\ \equiv \left(\frac{VA\^{}_{(2015)}}{E\^{}_{(2015)}}\right) \times 100;$$ for Year 2015, regarding 2014;

and so on for an annual-growth time-series, and/or for a different reference year (in the example, each previous year)

The version on the right is the more usual way of calculating the *LP index* by national statistical agencies: As the quotient between the **Value-added *index***, and the **Employees *index)***.

When the option is the *rate* (percentage) of change, it may have been calculated either in the usual way or in the 'sophisticated' one of:

$$LP\ r = \textbf{Labour Productivity}\ \text{rate (\%) of change for period 'x'} = \ln\frac{(VA/E)^{Year\ 2015}}{(VA/E)^{Year\ 2014}};\ \times 100$$

Since –as pointed out before- it allows for the useful possibility of expressing the same value also as the difference between the rate of change of the VA and the rate of change of the E: $\textbf{LP r} = \ln(VA\^{}) - \ln(E\^{})$

That is, putting it narratively: *LP r =* ***Labour Productivity*** *rate (%) of change =*

= (% of change in the Value-Added) – (% of change in Employees)

Germany	100,-	105,4	107,2
Spain	100,-	102,2	115,-
:			
Greece	100,-	108,7	102,-
Bulgaria	100,-	106,-	121,6
:			

(*) For each country: [VA-€-per-hour-worked Year 2013] / [VA-€-per-hour-worked Year 2005] x 100

Source: Data taken from Eurostat's table "Real Labour productivity per hour worked (for each country, the Year 2005 value =100)", [nama_aux_lp], as published in the Eurostat web database as of June 2015.

which tells us the same story as the previous Table 2, though in a different way. That is, France would have increased its Labour Productivity from 2007 to 2013 by around 1.5 %, Greece would have seen it decrease by around 6.1%. etc.

Having read till here, you might have got the idea that there seems to be some contradictions between the messages the above tables 1 and 2 give to us. For example, according to Table 1, Germany's labour productivity would be lower than Spain's, but according to Table 2, it would be just the opposite. So, you would have every right to ask, which is the right conclusion and why such a contradiction?

The short answer is that Table 1 refers to *Value Added* (VA) in terms of € per person employed, and Table 2 in terms of € per hour worked. The non-so-short answer (since the former one does not clarify that much) would imply first to ask to Eurostat helpdesk services for additional data on the relationship between the 'hours worked' data and 'persons employed' data they have taken for each country; as well as to ask for more detailed information regarding their respective determinations for value-added data. To tell the truth, I have not done that job when writing these notes; neither would I expect the analyst responsible for the Economy section of a newspaper –even an international one- would do it before writing her/his article on the topic. Let us just keep with the conceptual conclusion: that data on productivity we may read sometimes in a report or in the media referring apparently to the same label –f.e., *labour productivity*- may have in fact different meanings. And not a minor, piecemeal, difference, but one that may change the conclusions regarding comparative productivity levels among countries, or when comparing across years for a given country [9].

To sum it up, and by way of example-questions: Why does the above 'official' data make Luxembourg appear –against all evidence- as the EU's country with the highest labour productivity? Is Spain's labour productivity in 2013 higher o lower than Germany's? Is Spain's labour productivity about 20% higher than Greece's (table 1) or about 59% (Table 2)?

[9] In the specific case of Eurostat data, it must be pointed out that the calculation for countries' Labour Productivity does not take for the denominator the 'N. of Employees full-time-equivalent' as the standard definition does but just the total number of Employees, be their dedication full or part-time (likely due to lack of homogeneous data on full-time-equivalent for all the 28 EU countries) *. Therefore, the LP index for an EU country with a comparatively high proportion of part-time employees will appear (in Table 1), artificially, something lower. Probably, the contradictions pointed out before regarding the LP figures for Germany, Spain and Greece have to do with these specific variants of making calculations.

(*) Labour productivity per person employed (ESA95);
http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00116&plugin=1

4 What do those *Labour Productivity* indexes actually tell –and can't tell- to us

In summary, as it can be seen from the above, the usual *labour productivity* index at the country level measures in fact some kind of average of the net income (personnel costs, including variable compensation, plus company's profits) per employee the country's companies get in a given period. Put it schematically,

$$LP\ (va) = \frac{\text{Personnel Costs (Salaries \& other compensations; Social Security charges)} + \text{Company profits}}{\text{N. of Employees}}$$

This is substantially different from the very idea of workers' (or companies') productivity or efficacy level, i.e.: commercialised (physical) units, per (physical) unit of work. Let us underline why:

- If a high proportion of the employees of a given company -as, f.e., an investment bank- are rather executive officers (EO), very well paid, then the company's value-added per employee will be notoriously high. Of course, any high executive, including the ones with total annual compensation (fixed salary plus bonuses) in the range of million/s €, is statistically speaking, an employee.
- Consequently, when in a given economic sector most of its companies show the above features, the average value added per employee calculated for that sector will be quite, quite higher compared to other more common commercial or industrial sectors in the same country.
- Finally, if in a given country, those sectors with such a high weight of very well-paid EOs have a dominant weight in the country's economic activities, then that country will statistically appear as with a value-added-per-employee (in practical terms, GDP per-employee) quite higher than other countries with a more mixed composition of 'ordinary' industrial, commercial and services sectors.

So, here we have an explanation for the paradox of Luxembourg appearing in the statistics as the EU country with the highest (*labour) productivity*: The dominant Luxembourg economic activity comes from financial and legal services companies working for companies and investors from abroad. Most of Luxembourg's economic activity relates to investment banks, specialised financial services, and convenience sites of foreign companies. The proportion of EOs (banking managers, investment agents, specialised consultants, … etc.) in the firms established in the country is dominant. Compensation paid to these EOs –big salaries, plus even bigger bonuses- tend to be several times the average compensation of an EU specialised industrial worker. And foreign firms with convenience sites in the country used to mean –statistically speaking– firms established in the country declaring important profits but few employees, if anyone.

Therefore, it is not properly true that the productivity of Luxembourg employees is so high as statistics show. Or, put it in another way, in fact, LP statistics do not say to us that Luxembourg employees' productivity is so much higher than their French or German counterparts; though certainly, that is how many analysts, experts and wide audience media 'read' and *use* those statistics. What those *labour productivity* statistics figures actually say to us is that, for Luxembourg, the sum of total compensation paid to employees (plus social charges) plus companies' profits (which makes up the total value added), divided by the number of employees, gives (surprisingly, for a close-to-fiscal-paradise country?) a comparatively very high amount of Euros.

In any case, nothing to do with the proper idea of employees' productivity or companies' efficacy as stated at the beginning.

More in general, let us consider an economic sector whose companies enjoy comparatively high margins –which means they hold some kind of sale-prices power. That situation allows companies to get high profitability and likely also to pay high salaries to employees; which will translate into their exhibiting a high *labour productivity* score. Thus, the simple fact that most of the sector's companies hold some privileged market position will make that such sector display a higher value-added-per-employee, which will be read as higher *labour productivity*, even if the average efficacy (productivity properly said) of their respective employees is the same than in other sectors not enjoying so generous rates of margin. The same reasoning applies to comparisons over time: if the companies that make up the core of a sector increase in a significant way their market power –because of a concentration process, for example- the sector average margin rate will increase regarding former years, and therefore the sector LP index will so increase; which will be read by experts and analysts as the sector having increased its productivity.

Moving from sector (industry) to country level: If a country where most of its economic sectors enjoy higher margin rates compared to other countries –that is, that the former have some kind of international prices/market power-, such country will show a higher *labour productivity* index, even though the efficiency, training, etc. of its workforce may be on average the same that in those other countries. Looking the other way around: A comparatively lower *labour productivity* index may mean just that the country's average salaries are comparatively lower relative to other countries. Let us illustrate that with the following sketch:

> A big German (or French) carmaker has one of its factories in Portugal. There, workers' salaries are significantly lower than in Germany (or France) -which probably was a reason for the carmaker opening that factory in Portugal. The workers of such a factory work with the same real productivity as their German (or French) counterparts –which is hardly surprising since they are working with the same equipment and technology (robotic chains) and have received the same training for that. However, when calculating the *labour productivity index* for the Portuguese factory we will end with a value lower than for the carmaker's factories at home –just because the Portugal's lower salaries.

Thus, the simple fact that average salaries in country A are lower than in country B –all the rest the same (including real employees' productivity)- will make A appear in the international statistics with a lower *labour productivity index* than B. And, for the same reasons, a decrease in the average salary in a given country (because economic crisis, f.e.) will result –ceteris paribus- in a decrease in its productivity index.

One of the ironic consequences of that is that worsening of labour conditions (real work-time, and jobs conditions) in a sector or country may make appear higher LP indexes for it. Thus, the 2008-onwards economic crisis has brought substantial reductions in employment –f. e. in Spain, among other EU countries. In parallel, or as a consequence, job conditions have tended to get tougher -especially in terms of *real* working time per week higher than contracted, and companies growing to apply changing job schedules ('flexibility'). All that due mainly to the widespread of shorter-term contracts as well as to a growing employees' uncertainty regarding their current job position be held. As long as this process has been significant for Spain, f.e., we could easily predict that its LP indexes will have improved along 2011-2014 since such worsening of job conditions means that the numerator of the LP index will have decreased less in proportion than the denominator. And, indeed, table 3 above seems to come to confirm such a prediction.

To sum up, the '*true' productivity level* –i.e., what it is assumed could increase by getting improvements in technology, in the organisation of the productive activities, or in the degree

of efficacy, qualification, training, and skills of employees, managers included- is, of course, one of the elements that improve companies' net income per person employed (or value-added; which broadly speaking is the sum of cost-per-employee plus company profits-per-employee), but not the only one: Comparative high margins because monopolistic or market-privilege positions may play the dominant role.

Thus, against what is usually implicitly assumed, the *official* Productivity figures (Labour Productivity figures, actually) do not measure in fact the productivity level but just the companies' net income per employee. That is, they measure companies' monetary *outcome* (net income got from the outside, per employee) not one of its determining variables (efficiency or productivity properly said).

However, the mainstream discourse when reading and interpreting those statistics of productivity data –f.e., a comparatively low figure for the LP index for such and such country– is that that country should take measures for improving its *workers' efficacy*; implicitly understanding by that to improve their effective job-time, qualifications, skills, ..etc. and/or to adapt them to new production activities.

5 The quite-less-frequent statistical data on *Multi-factor Productivity*

A better alternative than the dominant *Labour Productivity* indexes?

To a much lesser extent, public statistical agencies also pay some attention to 'multi-factor productivity', *mfp*. The label (multi-factor) refers to the idea of a more complete and/or accurate measure, which takes not just one factor, Labour, but also the usual other ones - Equipment (Capital), Materials, Services, Energy, etc. However, the published data on *mfp* do not use to enjoy significant appeal either in the media or the political debate. Mainly because they come just in terms of rates (or indexes) of change (growth), not in absolute values, which do not allow for productivity comparisons –be among sectors, or among countries. But also because reading and interpreting these *mfp* data require getting into complex technicalities –including definitions and assumptions that are in fact a matter of debate in professional and academic literature.

Thus, Eurostat does not properly publish data on TFP or ***mfp***; only methodological references for calculating them; and this is within the section devoted to indexes of economic growth[10]. These guidelines are in turn referred to the OECD manual on the topic[11].Which is also followed by the US *Bureau of Labor Statistics* (BLS) and the UK's *Office of National Statistics* (ONS).

The computing formula used for these *mfp* measures is a given adaptation of the standard expression for the *rate of growth* (change) in TFP literature (appendix 1, expression 'b'), or of its equivalent in terms of *index* [12]. However, most of the published data (by BLS and ONS) on *mfp* –rates or indexes of growth- refer in fact to a simplified two-inputs approach: *Labour* and *Capital*. Only in some cases (some industries) data referred to a model encompassing the rest of (aggregates of) factors –namely: *Materials, Energy* and *Services*- are provided; which is then labelled as KLEMS *mfp* measures[13].

[10] The main reference is a methodological comment in Eurostat (2013), "European System of Accounts – ESA 2010" Section 22, pages 501 and 502. (2013).

[11] OECD, 2001.

[12] $TFP^{\wedge} = \frac{(O^{\wedge}_1)^{v^*_1} \cdot (O^{\wedge}_2)^{v^*_2} \cdot \ldots \cdot (O^{\wedge}_i)^{v^*_i}}{(I^{\wedge}_1)^{a^*_1} \cdot (I^{\wedge}_2)^{a^*_2} \cdot \ldots \cdot (O^{\wedge}_j)^{a^*_j}}$

[13] That stands for: Capital (K), Labour (L), Energy (E), Materials (M), and Services (S)

However, even in the two factors case, the data made available by statistical agencies are difficult to read and interpret because they come in the way of complex technical tables, resulting from debatable assumptions, and fuzzy computational definitions of variables. Especially regarding the measure of capital inputs, or 'capital services' -which stands for the (value of the) use or consumption of input Capital (with a sense of 'true' costs of Capital) for the corresponding period- and the share to assign to it in the total output. That makes the published *mfp* data more like material addressed to an experts' audience. Though even for productivity experts those *mfp* figures (rates or indexes) are not in fact of a clear-cut, straightforward meaning (see Appendix 2).

In that sense, the available quantitative results at the whole economy level –as from BLS and ONS data releases- suggest that *mfp* measures –indexes or rates of change/growth- reflect more changes in economic activity (as an economic growth indicator) than productivity growth. And, more in general, since any TFP-type indicator (be it applied at the company, sector, or whole economy level) gathers the trend both in productivity-properly-said and in activity level (see Appendix 1), it could be argued that the available statistical data on *mfp* rates of growth/change, be these positives or negatives, would in any case rather reflect the joint effect of those two components: the trend in the average productivity of the country's companies, and the trend in the GDP. Hence, available *mfp* figures may be misleading if they are taken literally as an indicator of productivity.

Additionally, and as already mentioned, *mfp* measures are just indexes or rates of change, which do not allow for comparisons of the *productivity levels* among countries (or among industries). As far as they would partially reflect productivity trends, they might allow us just to know how much the (undetermined) productivity level of a country (or of an industry) comes changing relative to others.

To sum up, the problems pointed out in the previous section regarding the misleading interpretation of the more usual available productivity indexes at the sector and country level –*labour productivity* indexes- are not overcome when, in some cases, statistical agencies (such as BLS and ONS) also provide a more sophisticated index under the label of *multi-factor productivity*, *mfp* –mostly limited in fact to a *two-factor* approach: Labour and Capital. Taking into account how those *mfp* measures are determined, the meaning or interpretation of the resulting figures is rather uncertain and likely misleading as a country (or sector) productivity indicator. It could be said that they reflect more the trend in economic activity (as an economic growth indicator) than the trend in productivity properly said -in the usual sense of efficacy of personnel, of the equipment used, the subcontracted services, etc., and of the managers organising the production activities.

To read more about *Multi-factor productivity measures at the sector or country level* →

APPENDIX 1:

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The basic productivity index: *Total Factor Productivity (TFP)*, or *multi factor productivity (mfp)* at the enterprise level

A formal presentation and discussion

These lines are intended they be understandable for non-experts, i.e., without having to get into the formulae. What the formulae say is put also in common language within the text. The mathematical expressions stand just for the sake of being precise or of avoiding ambiguities (as well as deference to expert readers)[14].

I: Determination

For the usual case of a company using some given types of production factors, or *inputs* (personnel, materials, services, energy, etc.) for providing in the market a given basket of goods, or *outputs* (some given products or services), the TFP (or mfp) formula goes like this:

$$TFP^{x} = \frac{\sum_i \left(O^x \cdot p\right)_i}{\sum_j \left(I^x \cdot k\right)_j} \ ,$$

Where,
x = measured period (f.e., year 2014; quarter, 2014-3rd, … etc.);
symbol Σ stands, as usual, for *summation*: for all company's products (i = 1, … n), in the numerator; for all inputs or factors (j = 1, …, m), in the denominator.
O = Number of units of output 'i', the company has sold during such a period 'x'
I = Number of units of input 'j' the company has used (contracted or consumed) during such a period; i.e., of each type of employees, of materials, of equipment, of services, energy, … etc.
p = weight assigned to output 'i' ; usually, it is taken as such the price of this output in a given reference period, '0'.
k = weight assigned to input 'j'; usually it is taken as such the price-cost of such input for the same reference period, '0'.

Thus, the units of the company's products (O_i) and of resources it used (I_j) in a given period are the variables; and p_i and k_j are parameters. And, certainly, it is easy to see that such a TFP index responds to the productivity concept stated at the beginning (→): if, f.e., the number of units of one of the products this year is something higher than the previous year's, keeping all the rest unchanged, then the above TFP index will show an increase; and the reverse regarding a decrease in the units of just one of the factors, keeping unchanged the rest of variables. And –what is most important– the formula also allows for taking into account the real-life complexity: companies' activity showing –for a given period- changes of different sign in products, as well in factors, simultaneously.

(→) However, the units of outputs commercialised by a company may decrease just because of an overall downfall in demand; or may increase because of an economic recovery. Therefore, the TFP index gathers two joint effects; on the one hand, 'productivity properly said' (efficacy of the personnel, and of the used equipment, the contracted services, etc., as well as of the managers organising the use of all those factors); and, on the other

[14] For a more complete, handbook-like, presentation on TFP, it could be seen: https://www.amazon.es/Evaluación-EFICIENCIA-comparativa-INDICADORES-TÉCNICAS/dp/1980436002 ,pp. 28-51

hand, ups and downs in real sales (units of outputs) because of overall downfall/recovery in demand.

In any case, the above index is the standard measure and terminology in experts' papers. And it merits pointing out that in its usual applications (i.e., taken as parameters the ones described above) TFP is in fact, as it can be seen, a quotient between two monetary values: The value of all the outputs (sales), at constant prices –numerator-, and the value of all the inputs applied (total costs), also at constant prices –denominator [15]. Hence, for a normal situation of a given private company (operating at profits), we must expect its value to be something higher than 1 [16].

However, what is most likely to be found in studies, articles and economic reports is not the above TFP measure but either its *index of change* or its *rate of change*, from period to period. The latter not calculated in the usual way, [$r=(TFP^x/TFP^{(x-1)})-1$], but as $r=ln(TFP^x/TFP^{(x-1)})$; that is:

(rate of change) (index of change)

$$r^x = \ln \frac{\sum_i \left(O^x \cdot p\right)_i}{\sum_j \left(I^x \cdot k\right)_j} \Big/ \frac{\sum_i \left(O^{x-1} \cdot p\right)_i}{\sum_j \left(I^{x-1} \cdot k\right)_j}, \qquad (TFP^{\wedge})^x = \frac{\sum_i \left(O^x \cdot p\right)_i}{\sum_j \left(I^x \cdot k\right)_j} \Big/ \frac{\sum_i \left(O^{x-1} \cdot p\right)_i}{\sum_j \left(I^{x-1} \cdot k\right)_j}$$

And usually expressed in percentage terms (the resulting values for r^x multiplied by 100). The latter, let us say a 'sophisticated' way of calculating the rate or % of change, gives approximately the same value that the former, the ordinary way. But it has a very useful property: it allows it to be also expressed –and calculated- as the difference between the average rate-of-change of Outputs and the average rate-of-change of Inputs:

$$r^x = \ln \sum_i \left(\frac{O^x}{O^{x-1}}\right)_i v_i - \ln \sum_j \left(\frac{I^x}{I^{x-1}}\right)_j a_j \qquad [a]$$

Where coefficients ***v*** are calculated as the share of each output in the total sales of the company in period x-1; [thus, $v_1=(p_1 \cdot O_1^{x-1}) / \Sigma_i(p_i \cdot O_i^{x-1})$, etc.]; and coefficients ***a*** as the share of each input in the total costs of the company for the same period; (in both cases, values at constant prices). (hence, $\Sigma v_i = 1$, and $\Sigma a_j = 1$)

To put it in another way:

> ***r.100*** *= % of growth (change) in Total Factor* ***Productivity*** *=*
> *= (average % of change in Outputs) – (average % of change in Inputs);*

And, the last step, if we modify slightly the calculation for the above two averages by applying Törnqvist-like weights as coefficients *v* and *a*, then we end with the perhaps more popular expression in Productivity literature:

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[15] For some curious reasons, this fact –which among other things facilitates the reading of the formula's quantitative results by non-experts- tends not to be acknowledged in experts' papers, when not rejected by them with contempt, as an "accountants' issue".

[16] In connection with that, the TFP terminology is also applied to a refined definition of *Labour productivity* at-constant-prices, which is gaining appeal among experts:

$$'Net'\ Labour\ productivity \equiv NLP^x = \frac{\sum \left(O^x \cdot p\right)_i - \sum \left(I^x \cdot k\right)_{j,\neq labour}}{\sum \left(I^x \cdot k\right)_{Labour}}$$

where, as it can be seen, the numerator fits with the overall definition of value added: *Sales at-constant-prices (c.p.) less Total Costs (c.p.) except those of Labour*. And the denominator is precisely the *costs of Labour*.

$$r^x = \sum_i v^*_i \cdot \ln\left(\frac{O^x}{O^{x-1}}\right)_i - \sum_j a^*_j \cdot \ln\left(\frac{I^x}{I^{x-1}}\right)_j ; \qquad [b]$$

Where: $v^*_i = (v_i{}^x + v_i{}^{x-1})/2$; $a^*_j = (a^x_j + a^{x-1}_j)/2$

Which you might find also expressed in a more compact notation, as:

$$r^x = \Sigma_i\, v^*_i \cdot \ln \hat{O}_i - \Sigma_j\, a^*_j \cdot \ln \hat{I}_j \qquad [b]\ ^{17}$$

Where $\hat{O}_i$ denotes the index of change of the units of output *i*, from period *x-1* to period *x*; etc.

Finally, as for the equivalent of former [a] and [b] expressions in terms of *index-of-change* of the TFP:

$$(TFP\hat{}) = \frac{(O\hat{}_1)\cdot v_1 \cdot (O\hat{}_2)\cdot v_2 \cdot \ldots\ldots \cdot (O\hat{}_i)\cdot v_i \cdot \ldots\ldots}{(I\hat{}_1)\cdot a_1 \cdot (I\hat{}_2)\cdot a_2 \cdot \ldots\ldots \cdot (I\hat{}_j)\cdot a_j \cdot \ldots\ldots} \qquad [a2]$$

$$(TFP\hat{}) = \frac{(O\hat{}_1)^{v^*_1} \cdot (O\hat{}_2)^{v_2} \cdot \ldots\ldots \cdot (O\hat{}_i)^{v_i} \cdot \cdot \ldots\ldots}{(I\hat{}_1)^{a^*_1} \cdot \cdot (I\hat{}_2)^{a^*_2} \cdot \ldots\ldots \cdot (I\hat{}_j)^{a^*_j} \cdot \ldots\ldots} \qquad [b2]$$

It must be noted, however, that most authors like better to present the above computing formulae/definitions (especially the ones in terms of *index* of change; see footnote 21) as an independent deduction from the mathematical setting of the *production function* in the orthodox economic theory[18].

II: Limitations

Total Factor Productivity Measure (formula) is designed under the assumption –rooted in the mainstream economics theory– that the range of products or services (outputs) delivered by a company to market remains unchanged over time; and that are just the respective units of each different output that changes from period to period. And the parallel is also implicitly assumed regarding the production factors (inputs): that the set of inputs for producing the basket of outputs remains the same in each period.

Those changes in the respective units –of *stable* sets of outputs an inputs are just what the TFP definition/formula is designed to compute.

However, in the real world the composition of a company's basket of products or services becomes subject to significant changes over the years: new products enter the basket and others drop out of it, to the firm adapting to market demands; etc. And the same happens regarding the set of inputs (different type of workers, materials, equipment, external services, etc.) due to the introduction of technological innovations, cost-reducing company decisions, etc. In this regard, empirical observation tell us that the productivity increases measured by the standard TFP index result mainly from changes in the firms' production technology –and thus in inputs composition– to get reductions in their total cost (for a given basket of outputs).

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17 And, of course, you may find also that authors denote outputs, inputs, etc. with letters different than here.

18 As an example of that, you might see: Van Bevern, Ilke (2012) "Total Factor Productivity estimation: A practical review", *Journal of Economic Surveys*, V. 26, n. 1, Feb 2012 (pp. 98-128).

> Let us to underline what the entrance of a new, different, output or input means in our topic: By way of example, either in companies' practice and for a proper application of the TFP formulae, two car models in a carmaker catalogue –with different features (and thus, cost) and therefore different sale price– are for all purposes two 'different' outputs. As for inputs, when a company decides to outsource any of its activities, a new different input becomes to enter into the company's set of inputs. This is even if this is not the first outsourcing of the company: To outsource production activity 'a' is to contract a kind of external service different in nature from that of outsourcing production activity 'b'; among other things, the respective cost prices and units's nature will likely be disparate.

As a consequence of the former, a methodological problem arises in the determination of TFP measures: when a new product enters into a period's set, there is not a former price for it. But a price, a parameter, is needed for carrying out the adding up calculation for the TFP's numerator (or the equivalent when directly calculating rates of change). In parallel, changes in the technology applied by the firm mean that, in calculating the TFP'a denominator, we will lack the respective 'cost prices', for the reference period, to be used as parameters for the new inputs entered into the basket of inputs.

This lack of data leads ('forces') practitioners and researchers engaged in TFP determinations to make arbitrary assumptions about the parameters (prices) for the 'new' outputs and inputs, to be used for the reference's period. And, as a consequence, the resulting series of TFP values may have a low degree of confidence as productivity indicators; which may easily translate into misleading conclusions.

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APPENDIX 2

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To read more about …

Multi-factor Productivity measures, at the sector and country level

MFP measuring, as from OECD and Eurostat

Eurostat does not properly publish data on TFP or ***mfp***; only methodological references for calculating them; and this is within the section devoted to indexes of economic growth[19]. These guidelines refer in turn to the OECD manual on the topic[20].

This OECD handbook defines an *index of change of mfp* for a given country as: A weighted mean of the *mfp* index-of-change for the different economic sectors/industries of the country, being the weights the share of each sector in the whole economy in terms of value added. Therefore, the key issue becomes the *mfp* definition or formula they propose for a given economic sector/industry.

Regarding that, the manual starts by simplifying the 'multi-factor' idea to just a 'two-factors' one: "Labour" and "Capital". That is, to a composite *'Labour & Capital' productivity index-of-change'* for a given sector, which is in fact defined as an extension of the *Labour Productivity index-of-change* seen before. That extension turns out however to be a simplified application of the index version of the standard TFP formula [21], where the denominator is limited to two inputs, and the numerator to one only output: the (index of change of the) sum of the Value Added of the sector's companies. Thus, for a given economic sector or 'industry', and a given period, 'x',

Joint "*Labour-&-Capital_Productivity*" index of change $= \boldsymbol{L\&K\_P\hat{}} = \dfrac{VA\hat{}}{(E\hat{})^{sl} \cdot (K\hat{})^{sk}} \times 100$

Where ***K^*** is defined as the 'Capital index of change', $K\hat{}=K^{period\ 'x'}/K^{period\ '(x-1)}$, so mimicking the 'Labour index of change', ***E^,*** referred here before (footnote 9). The key new variable is therefore $K^{period\ x}$ (from here on, K^x), which is defined as the value of the 'Capital Services' for the period; albeit in a rather generic way, more conceptual than operative. On the other side, exponent ***sl*** is defined as 'the weight of factor Labour in the sector's value added', and exponent ***sk*** as the weight assigned to factor 'capital', (therefore, $sl+sk=1$); though, again, lacking a precise definition for the latter [22]. Thus, the key methodological issues here are: how

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[19] The main reference is a methodological comment in Eurostat (2013), "European System of Accounts – ESA 2010" Section 22, pages 501 and 502. (2013).

[20] OECD, 2001.

[21] Thus, as from footnote 16's rate of growth, index version: $TFP\hat{} = \dfrac{(O\hat{}_1)^{v^*_1} \cdot (O\hat{}_2)^{v^*_2} \cdot \ldots \cdot (O\hat{}_i)^{v^*_i}}{(I\hat{}_1)^{a^*_1} \cdot (I\hat{}_2)^{a^*_2} \cdot \ldots \cdot (O\hat{}_j)^{a^*_j}}$

[22] As can be seen, the denominator of the above OECD's formula for *L&K_P^* can be read as a given mean of the *Labour index of change* and the *Capital index of change*; more precisely, a geometric weighted mean. Or, in other terms, a Törnkvist index –as it is presented in the OECD manual.

It merits to additionally note that the proposed formula ***L&K_P^*** is mathematically equivalent to a more direct-meaning one: a geometric mean of the *Labour Productivity* index of change (**LP** ^) and the *Capital productivity* index of change, ***KP*** ^, defining this as $VA\hat{}/K\hat{}$. That is: $\boldsymbol{L\&K\_P\hat{} = (LP\hat{})^{sl} \cdot (KP\hat{})^{sk}}$.

the flow 'Capital Services',(K^x), for an industry is defined and measured; and how is it defined the 'share of it in the Value Added' (parameter *sk*, which then determines *sl)*.

Regarding the first, the 'capital services' measurement, it is however dealt with in the OECD manual as a rather complex conceptual-computational issue. They implicitly discard to take as 'Capital services' a direct measure; namely, an aggregate of the amortisation & depreciation costs according to the sector's companies' accounts, plus some interest costs on their productive net investments. Instead, a theoretical concept of 'input Capital' at the sector level is constructed, as a compound of different types of Capital which include, besides 'physical' capital, 'R&D capital', 'intellectual property capital', and other non-usual components in companies accounts. And then some ways of estimating the respective flows of those 'capital components' are pointed out, rather than made precise. However, the methodological explanations or definitions on all that remain rather open, not made operationally precise, and stated in a rather vague or fuzzy way: Comments on several possibilities are offered [23], but more in the way of a paper for an academic debate than a manual for practitioners or statistics readers.

This methodological approach (that is shared by the US's BLS and the UK's ONS) makes that the actual meaning of the resulting figures for the *mfp* of a sector –and then, of the whole economy- become certainly not a straightforward issue[24].

MFP measures available

BLS.- The US *Bureau of Labor Statistics* do publish data on *mfp* for the main industries/sectors and for the whole private sector. In that case, annual *rates of change*; that is, a direct adaptation of the standard computational formula in TFP literature (expression [b] in Appendix 1). This adaptation consists –as in the case of the OECD manual- of simplifying the outputs side of the formula –for a given sector- to just one output-aggregate[25]; and 2) simplifying the right side of the formula to just two inputs: Labour (L) and Capital (K). Thus (changing the BLS notation to the one in the OECD manual, for facilitating the comparison)

$$\rightarrow \mathbf{L\&K\_P}_{\text{rate-of-change}} = \mathbf{O}_{\text{rate-of-change}} - (\mathbf{sl} \cdot \mathbf{L}_{\text{rate-of-change}} + \mathbf{sk} \cdot \mathbf{K}_{\text{rate-of-change}})$$

According to BLS methodology (BLS, 2007), Labour and Capital rates-of-change above are in turn calculated (defined) as " .. a weighted average of the growth rates of detailed types of capital, and labor inputs". However, as far as the option regarding the units (values) of the 'different types of capital", how they are calculated, and how parameter *sk* is determined, the approach is quite similar to that in the OECD manual, commented above: going beyond the usual capital concepts in companies accounts[26]; as well as also similar as far as its lack of

[23] Even in some parts of the manual, it is suggested that the *stock* of 'capitals' in the sector could be taken as an acceptable 'proxy' for K^x, which is defined as a *flow*.

[24] Even in the same Eurostat text cited before (footnote 1), there are critical comments on difficulties regarding interpreting the real meaning of the final values obtained for the *mfp* measures; be a two-factor or a "five-factors" KLEMS model.

[25] An overall measure of the sector's output which BLS methodology refers to as ".. a Tornqvist output index developed by BLS)", (BLS, 2007).

[26] As, for example: *Information processing capital intensity*, *Research and development capital intensity*, and *Intellectual property products intensity.* Even in one of the BLS methodological explanations (BLS, 2016a, Read Me) the definition for total 'cost of input capital' –that appears as a synonym of 'capital services'- includes as a component the *corporation profits* (!) –as well as '(part of) taxes on imports and properties'

concreteness and use of debatable assumptions. Therefore, the fuzziness on the meaning regarding the resulting *mfp* measures is similar[27].

Going to the resulting figures, BLS publishes annual data of *L&K_P* rates-of-growth for the aggregate of all 'private business sector', not detailed by sector; that is, at the whole economy level -public sector excluded- (BLS, 2016a). And additionally, for selected sectors -18 manufacturing industries-, detailed annual data are offered, applying a KLEMS *mfp* model (BLS, 2016b). However, both types of data appear as in a for-experts format: Excel tables with tens of columns, one of them, *mfp*; and most of the rest related to the determination of 'input Capital' variables.

Analysing the first type of data tables (*L&K_P*) at the whole economy level there appear negative rates-of-growth for some few specific years[28]; which would mean sporadic decreases in productivity. This is difficult to understand for a proper 'productivity' indicator. It would mean that the efficacy and yield from human resources –companies' management included- as well as from the use of equipment and other capital inputs, becomes suddenly lower, then recuperating the following year(s). Which is rather unlikely: just some years workers getting lazier, the use of capital inputs getting less effective, .. etc., and the opposite having occurred the precedent and following year(s). Two of those years are 2008 (-1,2%) and 2009 (-0,2%); just the two ones with negative GDP growth in the US in the period 2005-2015, because of the economic crisis (BEA, 2011, pp. 1). Thus, the hypothesis that those sporadic decreases in *mfp* measures are explained just by a decrease in activity level (GDP) rather than by a decrease in the country's productivity seems the more plausible one.

ONS.- The *British Office of National Statistics* follows the same BLS methodological approach: an adaptation of the standard formula in TFP literature. That is, *mfp* measures in terms of rate-of-growth; though formally presented as a development from the economics' production function theory (Appleton and Franklin, 2012). The applied *mfp* model is however a two-factors one: Labour and Capital, where definitions of variables related to 'Capital inputs' raise the same remarks commented before for OECD and BLS; and where the outputs side is also simplified to the aggregate of sector's output, defined in that case as the sum of its companies' (gross) Value Added.

However, ONS, does not properly publish *mfp* data for overall readers but in the way of academic-like papers. Thus, in the cited paper by Appleton & Franklin (2012), estimates (sic) for the *L&K_P* rates-of-growth for the years 1998-2010 are presented; both, detailed by industries (market sectors) and for the whole UK economy. This has been followed by updates to 2012 data (Field & Franklin, 2014), and to 2013 data (Connors & Franklin, 2015); and the last available up-date on that line, by Blunden and Franklin (2016), where the same type of indicators are extended to the 1970-2014 period.

As underlined by the same articles' titles, they respond more to a methodological-experimental work, within an economic growth (national) accounting framework. The latter makes sense, since, again, the empirical data from the referred papers suggest that the *mfp* (*L&K_P*, in fact) measures they present reflect more the trend in activity level (macroeconomic growth) than the trend in productivity. Thus, after repeated positive *L&K_P* rates-of-growth, at the country level, till the year 2007 (of around +2,5 %), it appears for the year 2009 an impressive downturn of -5,2 % (Blunden and Franklin, 2016, pp. 5); which -for the same reasons pointed out before regarding BLS data- is not plausible as reflecting a real

[27] In that sense, it merits to underline a remark stated by the same BLS on its TFP web page: "Output and the corresponding inputs for non-manufacturing industries are often difficult to measure and can produce productivity measures of inconsistent quality. Customers should be cautious when interpreting the data."

[28] BLS (2016a), worksheet PG%, column X

downturn in productivity. Again, 2009 was precisely a year when the UK's GDP dropped -around 6%, according to the same paper- as a consequence of the overall crisis; so we can deduce that the referred downward in the *mfp* measure reflects more the trend in the UK economic activity rather than a decrease in its overall productivity-properly-said. More even, in the cited Blunden & Franklin paper (page 5, Fig. 1), there appears a clear high correlation between both measures, *mfp* and GDP rates-of-growth, for both positive and (the few) negative ones.

Meaning and limitations of published *mfp* measures

To sum up, the core issue of any *mfp* model is the way of measuring the flow of input 'Capital' ('capital services') for a given economic sector -and then for the whole economy. In fact, most of the contents of the methodological papers on *mfp* from international statistical agencies turn around this topic. Their common approach to this point responds to the idea of an indirect measurement for a construct, 'Capital services', which implicitly is considered as 'the true consumption/use of capital' (as better than the equivalent from the direct measure from corresponding companies accounts). That construct includes –besides the usual capital types in companies' accounts literature- additional 'capital inputs', for which definitions are between technically complex and fuzzy.

More precisely, when national or international statistical agencies move to also determine *mfp* measures *(L&K_P* measures, mostly) for some industries or the whole economy, they have had to engage in 1) choosing some definition for the macroeconomic construct 'Capital inputs', and making assumptions for determining their components (capital stocks), 2) making estimates or using proxies to calculate the rates of change of the *capital services* (capital flows, or costs) derived from each of those capital components, and 3) making assumptions for determining a value for the share of that *capital services* in the total sector's output (***sk*** parameter). Therefore, the actual meaning of the resulting figures for such *mfp* measures is uncertain, of low reliability, if not misleading as a 'total productivity' measure. And hence of doubtful usefulness.

In that sense, the available quantitative results at the whole economy level –as from BLS and ONS data releases- suggest that *mfp* measures –indexes or rates of change/growth- reflect rather the changes in economic activity (as an alternative economic growth indicator) than productivity growth.

And, more in general, since any TFP-type indicator (be applied at the company, sector, or whole economy level) gathers the trend both in productivity-properl- said and in activity level (see Appendix 1), it could be argued that the published *mfp* measures, be positives or negatives, would rather reflect the joint effect of those two components: the trend in the average productivity of their constituent companies, and the trend in their economic activity. Hence, available *mfp* figures may be misleading if they are taken literally as an indicator of productivity.

Last but not least, *mfp* measures are just indexes or rates of change, which do not allow for comparisons of the *productivity levels* among countries (or among industries). As far as they would partially reflect productivity trends, they might allow us just to know how much the (unknown) productivity level of a country (or of an industry) comes changing relative to others.

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