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A Quality Adjusted Labour Input Index of the European Union for a Better Understanding of Productivity Developments: Productivity Paths in the EU

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***A quality adjusted labour input index of the European Union for a better understanding of productivity developments:* productivity paths in the EU**

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Abstract:

Models analysing economic trends often use labour input figures available from National Accounts. However, changes in the labour composition (i.e. skills) are not reflected in these datasets. The potential implications for productivity analysis are important.

Some datasets (i.e. labour force surveys or KLEMS) include breakdowns of labour by skills. Yet, single measures of total labour input considering the change of the skills of the workforce over time are not widely available. Eurostat and JRC develop a Quality-Adjusted Labour Input (QALI) indicator for EU member states. QALI, now published as experimental statistics, combines national accounts data with survey data. QALI measures the change of labour input considering the hours worked and their composition (by skills or age). The shares of the compensation of the employees are the weights. The resulting estimates show that QALI growth is better aligned to GDP growth than hours worked growth.

In this paper, we show how our perception of productivity differences change when considering labour composition. For it, we analyse the productivity figures derived from adjusting the labour input using the so called Quality Adjusted Labour Input (QALI) for the 10/21 industries of EU28, Euro Area and its member states 2002-2018. We show that labour input adjusted by QALI results provides outcomes significantly different compared to 'un-adjusted' data. Thus, under/overestimation of labour input is likely for specific periods (e.g. during the economic 2008 crisis). Thus, we propose that practitioners consider QALI results to adjust hours worked. This would help to get a more precise measure of labour productivity trends.

Keywords:

Labour productivity indicators, QALI, statistics comparability, labour productivity trends, contributions to productivity growth.

Productivity measures: inputs and outputs

The hours worked are recommended as labour input measure for productivity analysis versus person engaged or jobs (ESA2010 §11.27 /SNA2008 §2.157). The productivity gap of EU vs USA is narrowed if considering the productivity per hour worked instead of the productivity per person engaged because hours worked per person and year are larger by far in the USA.

In order to perform a comparable assessment of productivity in this context, it is necessary to account for a suitable indicator that relates the output metrics (Gross Value Added – GVA, in our case) with the inputs (labour in this context).

Regarding the output metrics, despite ESA2010 §11.38 defines productivity as “measure of output from a production process, per unit of input”, GVA based indicators are more suitable for comparison across industries and across countries. The increasing outsourcing and slicing of Global Value Chains make that output based productivity indicators tend to be less meaningful[1] as the output of one industry can be almost completely based on inputs from other industries/countries. In this concern, real GVA is more suitable than nominal indicators for time comparisons since nominal figures overestimates observed GVA –and also productivities- in inflationary scenarios, and the opposite in case of deflationary scenarios. Nominal figures can play a major role in biasing productivity analysis across countries because of price dynamics, since inflation levels and trends are likely to be different across countries. Hence, in order to analyse growth and trends is preferably to use chain-linked volumes indicators, despite that they are not additive. Across industries, differences may arise because of the intensity of non-market activities where output is obtained by the cost method, or because of the imputed rents in the Real Estate sector.

In what concerns input metrics, according to ESA2010 §11.27, the total of hours worked is the appropriate measure for productivity calculations and the most appropriate measure of labour inputs. It is theoretically superior to employment in persons (PER) as it better accounts for the country and industry specificities of part-time and secondary activities[2]. However, it is not a perfect indicator in what concerns comparability across countries and industries. Across countries, we must point out that:

- the use of different sources (LFS, Business Surveys, Administrative surveys or others) and
- different methodologies followed by countries in order to estimate hours (such as the Direct method, Component method or others)

are influencing the estimation of hours worked and, consequently, of the derived LPIs from them (see Ward, Zinni and Mariana, 2018; and Amores, Bolivar and Velázquez, 2020) for more details in this aspect).

At industry level, besides the larger variability that we can expect because of granularity and the breakdown level (compared to total economy level) we also may expect biases due to the existence of secondary activities of persons. Despite that the use of HW instead of PER correct the bias due to differences in part-time shares by industry, it does not properly account for the correction of secondary jobs. Also differences in the intensity of employee vs. self-employed works by industry may also produce differences across industries, since the methods to estimate hours worked for employees and self-employed may also differ resulting in additional noise.

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1 However, gross output is critical for KLEMS-based approach of productivity analysis.

2 National account’s figures of Employment in Persons (PER) by industry only reflect the workers for which their jobs in such industry are their main activity.

Quality Adjusted Labor Inputs: how is the EU-QALI built?

Beyond these issues, not all hours worked are equally productive (SNA2008, §19.55). The effect of labour composition is being not considered. To account for it, Eurostat published the Quality Adjusted Labour Input index, QALI (SNA2008, §19.56) for EU countries, which explains GDP developments better that the hours worked.

Index number theory has developed multiple functional formulae to assess the evolution of an economic magnitude and allow for comparisons in different moments of time (or space) of it. Productivity measurement is a field where these discussions have led to extensive examinations and fruitful results. According to the manual of Consumer Price Indexes of the International Labour Organization (ILO, 2004), the Törnqvist formula has proven to be one of the best choices among the main approaches in index number theory to establish different criteria for the choice of index numbers. Among the different reasons that justify this statement we can consider:

- First, it is a changing-weight index and, as such, it is able to capture for substitution effects between different inputs as prices changes over time.
- The Törnqvist index is strictly related to the translog function. As such, the Törnqvist index can project the value of a homogenoeus translog function starting from a period base without the knowledge of the parameters of the function (*exact* according to the terminology of Diewert, 1976). That is, $f(x_t) = f(x_0)T(x_0, p_0, x_t, p_t)$ where T is a Törnqvist index and x_0, p_0, x_t, p_t are the observed quantities and prices of base year and projection year. If f is a translog production function, the Törnqvist index will be a quantity Törnqvist index. If f is a translog unit cost function, the Törnqvist index will be a price Törnqvist index.
- Besides, we can use the Törnqvist index to project the values of any arbitrary twice-differentiable linear homogeneous function, since the homogeneous translog function can provide a second-order approximation of it (superlative according to the terminology of Diewert, 1976).
- The translog function is quite convenient as it is more flexible than other production functions, such as Cobb-Douglas or CES production functions, as the second order parameters of the translog function represent substitution elasticities among inputs. Besides, the translog production function allows the variation of elasticities of substitution among inputs in the same way as input proportions vary (see Dean, Harper and Sherwood, 1996).

The Törnqvist index is not the only one with these good properties. Other superlative indexes, such as the Fisher or Walsh indices, portray good properties and even meet a larger number of ideal Fisher properties (see ILO, 2004, Chapter 16). However, the Törnqvist index is the only one that is exact for the approximation of a linear homogeneous translog function (Diewert, 1976). In addition, for practical purposes, Fisher, Walsh and Törnqvist indexes are quite approximate for practical purposes as stated at Hill (2006), Diewert (1976) or ILO (2004, Chapter 17).

One of the major drawbacks of Törnqvist index (and also of Fisher and Walsh indexes) is that they are not consistent in multiple stages aggregation, that is, it makes a difference to calculate the index for a broad category if we calculate it directly from the elemental indexes included in that category, or if we calculate it starting from intermediate sub-categories of elemental indexes. Nevertheless, despite this inconvenient fact, it is possible to prove that it is approximately consistent in aggregation, see ILO (2004, Chapter 17).

The Eurostat QALI index and the underlying data for its production are obtained as described in the Eurostat's methodological note at: https://ec.europa.eu/eurostat/web/experimental-statistics/qali, where the Eurostat data on QALI is available. We used the QALI by skills/age at the NACE Rev.2 (ISIC v4) A*10 aggregation.

The number of hours worked is divided into different groups according to skill (e.g. high, medium and low skilled labour) or age groups. The growth in quality adjusted hours for a period (t) compared to the previous one can be represented using a Törnqvist index — typically defined as a weighted geometric average of growth rates of hours worked (*h*), where the weights are labour income shares (*w*) across the different groups (*i*) and $e_{i,t}$ represents earnings across different groups (*i*)

$$Q_{t-1}^{t} = \prod_{i} \left(\frac{h_{i,t}}{h_{i,t-1}} \right)^{\left(\frac{w_{i,t} + w_{i,t-1}}{2} \right)} \qquad w_{i,t} = \frac{e_{i,t}}{\sum_i e_{i,t}}$$

Income shares are used here as a proxy for productivity for the weights based on the neoclassical assumption that workers are paid at their marginal productivity. QALI indexes are calculated with base on the previous year Q_{t-1}^{t} and later chained QALIs are calculate linking annual indexes multiplicatively.

The qualities for dividing the workforce into groups to assess productivity performancesare as follows:

Table 1. Summary of qualities of labour

Age[4]	Skill[5]
15-29	High (ISCED97= 0-2)
30-49	Medium (ISCED97= 3-4)
50+	Low (ISCED97= 5-6)

QALI is calculated for all Member States and all industries (A*10 and A*21, depending on the availability of microdata), where the structure of hours worked is taken from LFS by age and skill and then are scaled to national accounts totals. Earnings per hour by skill and age are calculated from SILC or SES survey depending on the industry. Earnings per hour by skill and age are multiplied by the estimated hours worked to calculate annual earnings $e_{i,t}$.These earnings are again scaled to the national accounts totals (D1) for different age groups and skill levels. These are the input data for the construction of QALI.

Comparability issues in the estimation of hours worked

In order to analyse the productivity trends we will use growth rates of Real Labour Productivity per Hour Worked (RLPR) as the key indicator, calculated as

$$RLPR_{2010}^{t} = \frac{GVA_{2010}^{t}}{H\_EMP^{t}}$$

With GVA_{2010}^{t} as the Gross value added at in chain linked volumes (millions of Euros) of year t, with base year 2010 and H_EMP^{t} is the Total hours worked by persons engaged (millions) in year t.

In order to account for labour composition and its influence in productivity trends we derive an adjusted measure for labour input from HW and QALI that partially corrects this composition issue. The chained QALI indicator provides a measure for the evolution of the quantity of hours by country and industry adjusted for age and skill. Using the available chained QALI index with base 2010, we create a time series of HW adjusted by the QALI index:

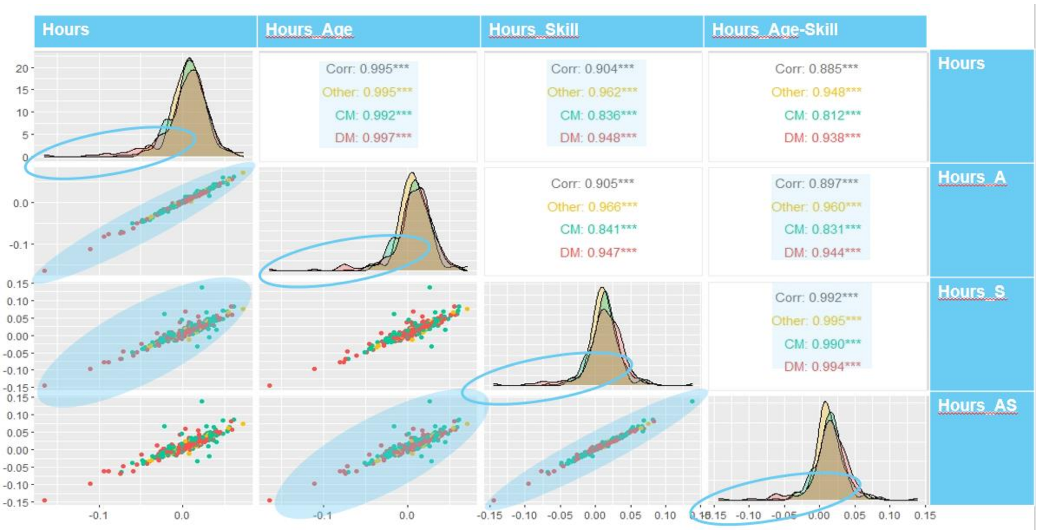
$$AH_{EMP}{}^{t}_{2010} = H\_EMP^{2010} \times ChQ^{t}_{2010}$$

Based on these adjusted hours, we define an Adjusted Real Labour Productivity per Hour Worked

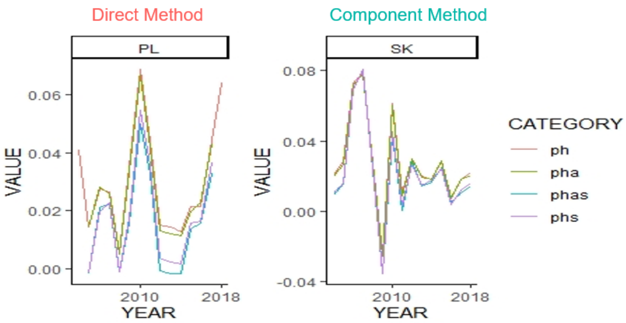
$$ARLPR^{t}_{2010} = \frac{GVA^{t}_{2010}}{AH\_EMP^{t}_{2010}} = \frac{RLPR^{t}_{2010}}{ChQ^{t}_{2010}} \times \frac{H\_EMP^{t}}{H\_EMP^{2010}}$$

Despite the theoretical superiority of hours worked (HW) as measure of labour input, it is necessary a precise and comparable measurement to be really useful. Heterogeneity in the sources and, most importantly, heterogeneity in the methods used for compiling hours may result in potential inaccuracies and flaws due to imperfect measurement.

In what concerns the method used (see Ward, Zinni and Mariana (2018) and Amores, Bolivar and Velazquez (2020)) international comparability of levels of HW (and consequently of derived LPIs in levels based on HW) is rather arguable even at the level of the whole economy. However, evidence does not support the existence of a bias in international comparisons of productivity trends as growth rates of hours worked and hence productivity growth does not show significant differences in the growth rates over a period of time. Our analysis casts that there is a high correlation whatever the method for HW, although correlations seem to be higher for DM than CM. Also productivity growth in Hours (H) are more similar to Hour-Age (HA) than Hours-Skill (HS); besides Hours Age-Skill (HAS) are growth are more similar to Hours-Skill than to Hours-Age. The volatility of countries using Direct Method (DM) M is higher than Component Method (CM) as expected (actual vs. usual hours)



We show an example of interannual productivity growth for two MS using different adjusted hours concepts (PL representing DM, and SK representing CM) where the features can be observed.

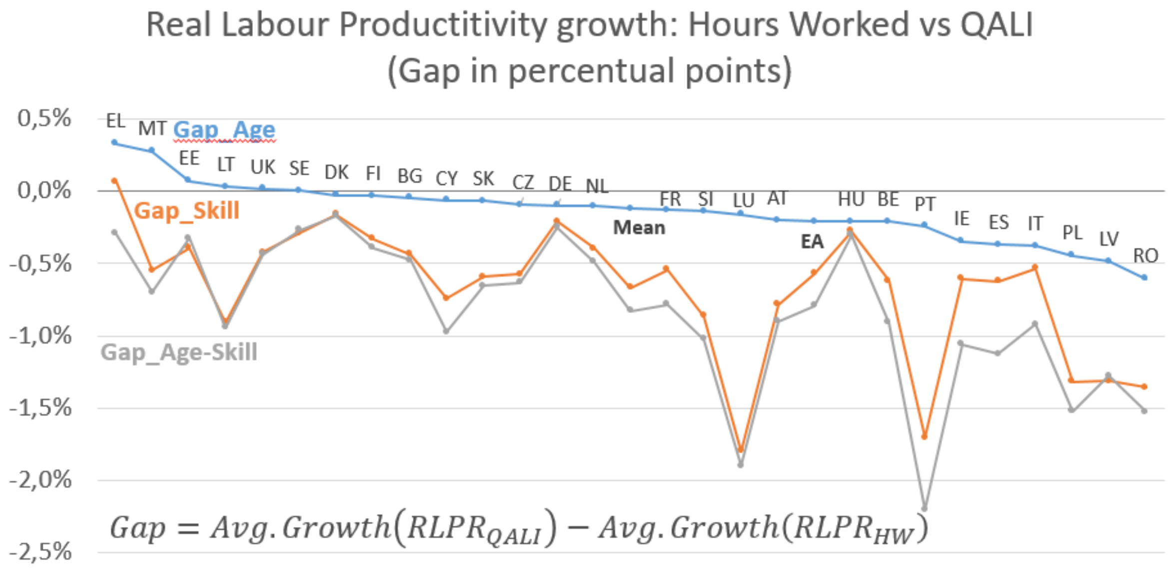


Does it make any difference to consider the composition of the workforce?

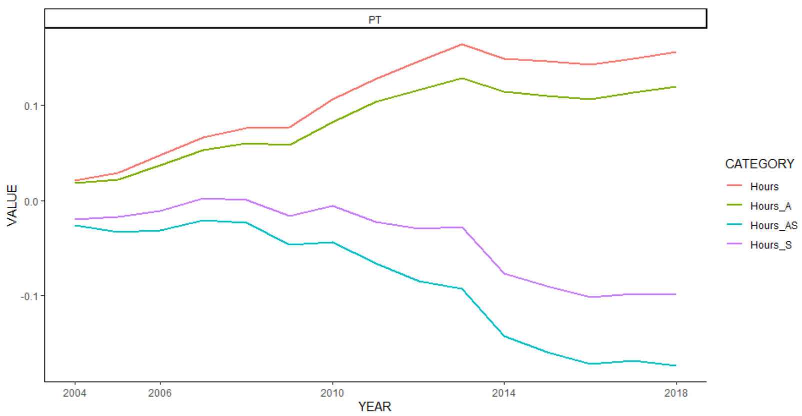
Even though, initially, the former analysis may lead us to think that the differences in the analysis of productivity trends may not be significant, the reality is far beyond this fact.

Conclusions of our previous analysis informed us that the method used for estimation of input hours is not relevant in terms of growth rates. Hence our analysis are not biased because of this issue. However, using hours adjusted by age, by skill and age-skill makes a difference in the evolution of productivity trends.

First, in general, we see that the use of bulked 'un-adjusted' hours provides an underestimation of hours growth and, hence, an overestimation of productivity growth. In fact, QALI results provides outcomes significantly different compared to 'un-adjusted' data. In general, hours adjusted by age usually grows faster than hours adjusted by skill and hours adjusted by age and skill. This bias seems to be likely larger for specific convulse periods (ca. 2008 crisis). The gap of productivity if assessed with unadjusted hours worked or adjusted hours worked may differ by country and the QALI used, but in global terms is around -0.5% per year. Age gap is smaller than Skill gap but the general trend is the HW tend to overestimate productivity growth as we can see in the next figure.



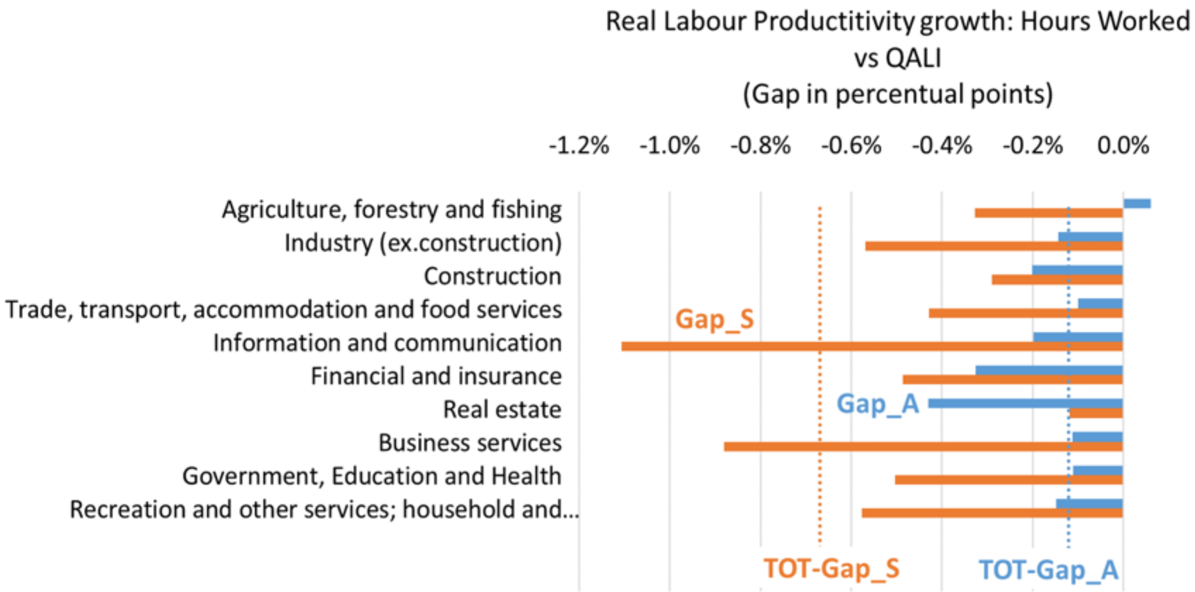
This difference gets wider when assessing cumulative growth of over a period, and it can turn even in a negative productivity growth. See the following example of cumulated productivity growth for Portugal.



Productivity trends by industry and industry contributions to labour productivity growth

The use of adjusted hours to assess labour productivity trends by industry also shows a similar gap as the one seen for the global economy by countries.

In general, productivity growths assessed by the average growth of real labour productivity is much smaller when measured with hours corrected by the effect of labour composition than using unadjusted hours. This gap is mostly negative (except in Agriculture of Age adjusted hours) and again, usually higher if measured with skill adjusted hours than age adjusted hours.



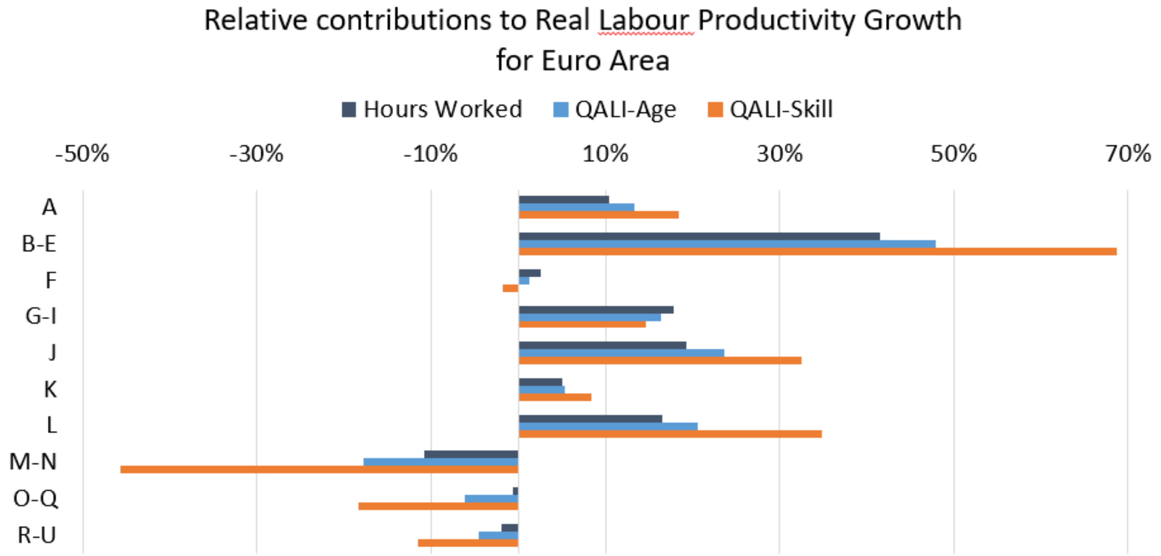
The gap is higher perceptible in industries with higher share of high skilled workers (Information and Communication and Business Services), whereas in industries where worker skills can be considered less relevant (Construction, TT&Accomodation, and Agriculture) the gap is smaller.

Finally, we assess how economic activities contribution to labour productivity growth is affected by the use of hours adjusted by labour composition. The contribution of an economic activity to labour productivity growth in total economy is calculated as proposed in OECD (2019) pp. 126-127. In the same way as productivity paths are affected by the use of different concepts of adjusted hours, the same happens to contributions.

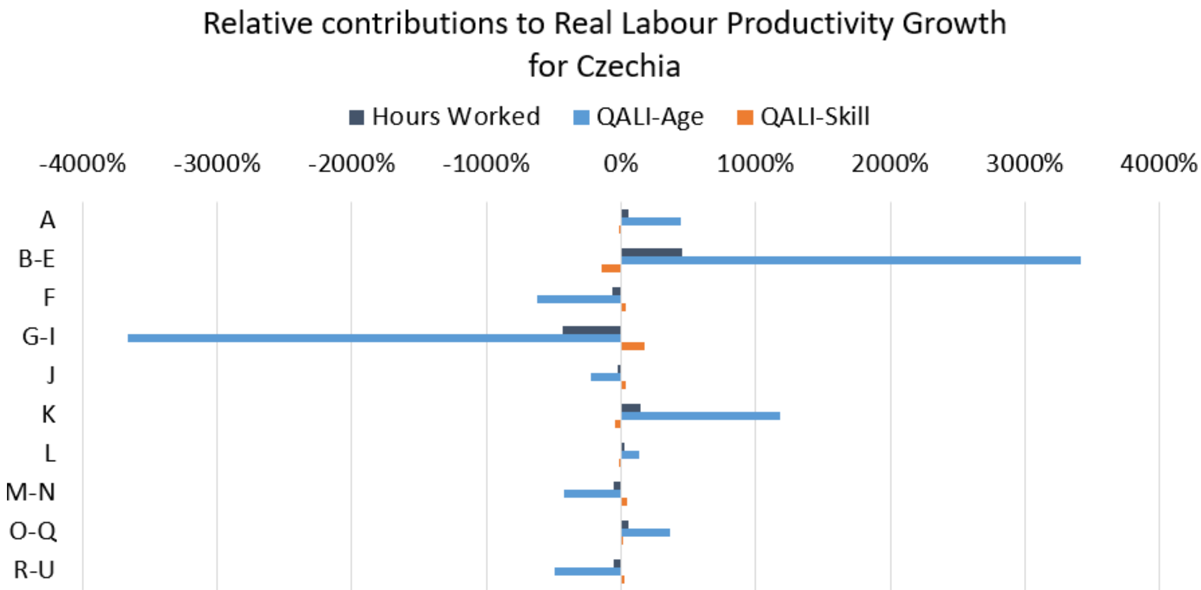
Contributions are assessed by the difference between the relative growths of constant GVA and labour input for each industry, each one weighted according to the size of the activity and labour of the industry with respect to total economy. Hence, it is logical to expect that if unadjusted hours tend to underestimate growth hours, contributions of adjusted hours will tend to shrink compared to the previous one. However, since global productivity is also shrinking when assessed with adjusted hours, the relative weight of the contribution may differ. For those countries where observations are available for the whole A10 classification for a period given, we have made this calculation. Results evidence different behaviours according to every country.

In general, we can see that industry contributions to productivity growth change when considering QALI and labour force composition than when using unadjusted hours. The differences are larger when considering skill-adjusted hours rather than age-adjusted hours.

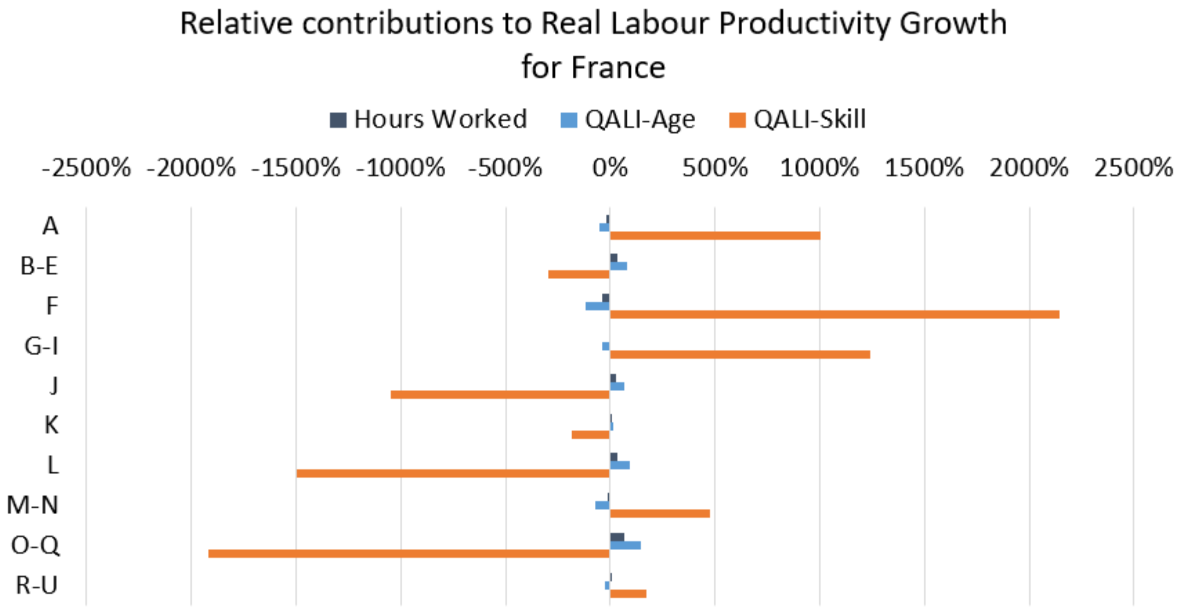
However, for some countries we see that (given that there are industries with positive and negative contributions) we see that the use of adjusted hours induces an explosive effect. That is, positive and negative contributions tend to move away from each other. This is the case of the Euro Area.



Other countries, like the Czech Republic, the effect is rather the opposite. Industry contributions for skill-adjusted hours are lower (in absolute terms) compared to age-adjusted contributions, and even lower than unadjusted contributions.



Finally, for other countries, like the France, we observe a sign twist. Recall that the productivity growth of skill-adjusted hours grew to a much slower path, turning even into negative growth in the long term. This leads to a sign shift of contributions when using skill-adjusted hours.



Hence, the main conclusion of this part is that the contribution effect on an industry to global labour productivity growth is highly dependent on the labour input used. And general conclusions must be taken cautiously.

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