



ON PRODUCTIVITY MEASUREMENT AND INTERPRETATION. SOME INSIGHTS ON ITALY

by: R. De Santis* and V. Ferroni**

ABSTRACT

Over the period 1995-2016, the Italian performance in terms of productivity was poor in historical terms and in comparison with its main international partners. This issue goes beyond Italy, with declining productivity growth being observed in other advanced economies. Possible explanations for the slowdown include factors such as lower capital investment by firms, decreased competition, excessive regulation, capital misallocation. The slowing rates of measured productivity growth has also raised questions on the adequacy of current compilation methods (i.e. the mis-measurement hypothesis). The “ICT revolution” has created new ways of exchanging and providing goods and services as a result of increased connectivity. These developments challenge the way economic activity is “traditionally” measured. There are also a number of measurement problems associated with estimating output and input volumes especially related to the quality of prices indexes for some products and services. These problems have an impact on productivity estimates and might impair international comparability. In this paper we intend to investigate, after having surveyed the main empirical and theoretical advancements in productivity measurement, what the core problems in productivity measurement and interpretation are, with a specific focus for Italy.

JEL:

E1, E22, E24, E30

Keywords:

Productivity, GDP, mismeasurement,
prices, digitalization.

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INTRODUCTION

There are many different approaches to productivity measurement and their calculation and interpretation requires attention. It is worth to underline that, differently from GDP, there is not a mandatory common international regulatory framework for productivity compilation methods not even for European Union countries. Despite the fact that the majority of countries follow the “Measuring Productivity” OECD manual with the suggested methodology, heterogeneity in data compilation exists. The most commonly used productivity measures are labor productivity and multifactor productivity which adjusts for the contribution of capital and materials and provides a measure of the pace of technological change. The capital productivity (CP) index is less utilized because of its many limits and measurement shortcomings.

The generalized slowing rates of productivity growth since the second half of the 90ies, regardless of the metric chosen to measure it, has raised questions about the theoretical basis of GDP and value added, and whether current compilation methods are adequate to capture them (i.e. the mis-measurement hypothesis). In this framework, we intend to investigate what the core problems in productivity measurement and interpretation are, with a specific focus for Italy.

The paper is organized as follows: in the first paragraph we present a survey of theoretical and empirical literature on productivity, in the second paragraph we describe the main stylized facts of productivity growth in Italy in the period 1995-2016, in the third paragraph we analyze in details the core problems in productivity measurement and interpretation for Italy, conclusion follows.

PRODUCTIVITY MEASUREMENT: A SURVEY OF LITERATURE

Measures of productivity (i.e. the efficiency at which inputs are turned into outputs) are fundamental for economic growth analysis. There are many approaches to productivity measurement and their calculation and interpretation requires cautious attention, especially for what concern international comparisons¹.

Labor productivity is a partial measure and reveals the joint influence of many factors. Its growth comes from increases in the quantity of capital available to each worker (capital deepening), changes in the education and experience of the workforce (labor composition), and improvements in technology (MFP growth). Labor productivity can be measured as GDP per hour worked even if other measures are available such as value added per hour worked without including public administration. Productivity based on hours worked better captures the use of the labor input than productivity based on the numbers of persons employed (head counts). It is worth to notice, however, that, despite the progress and ongoing research efforts, the measurement of hours worked still suffers from a number of statistical problems that can hinder international comparability.

Economic Focus:

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¹ For an exhausting survey of the relevant literature see Chad Syverson, 2011.

The MFP measure shows how inputs to production are used to generate output². Its growth reflects changes in output that cannot be accounted for by changes in input and occurs through improvements in technology, higher value products and services, and better organization of production. MFP is a measure closer to the concept of productive efficiency than labor productivity (LP) as it removes the contribution of capital deepening from the residual³. It also captures changes in output that arise from other factors such as statistical errors in inputs measurement. In this work we intend to focus on productivity growth over the medium-long term while we will not concentrate on measurement errors linked to cyclical changes in input utilization.

To calculate MFP, which is a measure of total productivity, inputs need to be combined in a total input measure and the calculation of MFP using the traditional accounting methods requires independent measures of inputs and outputs. This precludes using the traditional accounting method for measuring changes in industry productivity. Hence, economy-wide MFP estimates reflect productivity growth in only the market sector part of the economy⁴.

The productivity measurement as surveyed by Syverson (2011) has at least three areas with a specific need for additional research and development of data and methodology: i) price indices for output measures by industry, ii) measurement of hours worked by industry, iii) the quality of existing measures of capital input.

As data on output is mainly available in terms of the value of production (sales revenue plus inventories), the data has to be converted from value data to volume data. The influence of changes in price is usually removed through deflating by an appropriate price index⁵. MFP and LP calculate industry output as real value added (gross production less the value of intermediate inputs) deflated by the relevant price index. However, price indices for output measures by industry, in particular for high-technology industries and economically relevant services (i.e. financial sector, health care and education) are difficult to measure. There are also many problems associated with the accurate measurement of hours worked, in particular when disaggregated by industry. Specific challenges in this context include a successful combination of information from the two main statistical sources,

² Productivity and particularly the Multifactor Productivity (MFP) were described in the relevant literature as estimates of what we do not know about the economy (Solow 1957; Abramovitz 1956).

³ Productivity measures are derived from the Swan-Solow growth model, where output growth was explained by input growth and a residual (the so called "Solow residual"). An example is a Cobb-Douglas production function, where output (Y) is a function of capital (K) and labour (L) inputs, and there are constant returns to scale. Output growth (indicated by a dot over the variable) is a function of the growth in inputs. The residual can be interpreted as disembodied technological progress (A) and any measurement error in capital or labor inputs.

$$Y = AK^\alpha L^{(1-\alpha)}; \dot{Y} = \alpha \dot{K} + (1-\alpha) \dot{L} + \dot{A}$$

⁴ LP can be measured for both the market and non-market sectors of the economy. This is because labour input can be measured in real volume terms as hours worked. As the residual, LP growth measures the contribution to output growth of all factors other than the growth in labour input. It is important to note that both growth in capital and growth in MFP contribute to LP growth.

⁵ There is a considerable literature on the choice of an appropriate price index showing that the choice can significantly affect the estimates of productivity (Griliches 1991).

enterprise and household surveys, and the measurement of the labor input and the compensation of self-employed.

As output and input quality can change over time, improvements in quality should be quantified and treated as an increase in volume. In practice, statistical institutes are limited in the quality adjustments they can make, and the extent to which these fully adjust for quality is indeterminate.

Two main problems in measuring inputs that can introduce errors into the estimates of productivity are: i) difficulties in measuring the volume of capital services and ii) lags between investment when it is counted as adding to the productive capital stock and when it is actually utilized in production. These issues arise mainly where there are large infrastructure projects and when a major new technology is introduced. Investments in knowledge and in human capital therefore take years before they add to productive capacity.

The advancement in research on productivity using micro data, mostly referred to firm data, has expanded further the field of analysis but it has been increasing also measurement and data quality problems. In this framework, as suggested by Syverson (2011) there are at least three main sets of measurement issues concerning respectively: i) output measure, ii) inputs measure and iii) aggregating multiple inputs in a MFP measure.

As for output measure, it is worth to underline that many businesses produce more than one output. It is not straightforward whether in this case the outputs have to be aggregated to a single output measure and how. Even detailed producer microdata do not typically contain measures of output quantities.

For what concern inputs measure, for labor there is the choice of whether to use number of employees, employee-hours or some quality-adjusted labor measure (i.e.; wage bill)⁶ while capital is typically measured starting from the establishment or firm's book value of its capital stock. This kind of measurement raises several questions concerning i) the goodness of capital stock to proxy the flow of capital services, ii) the measurement of capital stock by the producer's reported book value, and the choice of deflators, iii) the measurement of capital stock using observed investments and the perpetual inventory method and the assumption about depreciation.

It is worth to underline that input measurement choices have to be considered carefully since any output driven by unmeasured input variations due for example to input quality differences or intangible capital will be considered as productivity.

As for the multiple inputs aggregation in a MFP measure, it is worth to underline that MFP differences reflect shifts in output while holding inputs constant. To construct the output–input ratio that measures MFP, it is necessary to weight the individual inputs appropriately when constructing a single-dimensional input index.

⁶ The wage bill is often used based on the notion that wages capture marginal products of heterogeneous labor units.

The correct weighting as suggested by Syverson (2011) is easiest when the production function is Cobb–Douglas because in the Cobb–Douglas the weights are constant:

$$TFP_t = A_t = \frac{Y_t}{K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m}}.$$

In this case, the inputs are aggregated by taking the exponent of each factor to its respective output elasticity. It turns out that this holds more generally as a first-order approximation to any production function. The input index in the MFP denominator can be constructed similarly for general production functions. Even after determining how to construct the input index, it is necessary to measure the output elasticities α_j , $j \in \{k, l, m\}$. Several approaches are common in the literature. If cost shares can be measured and the scale elasticity either estimated or assumed, then the output elasticities α_j can be directly constructed. If some additional restrictive assumptions are assumed (i.e.; perfect competition and constant returns to scale) then the elasticities equal the share of revenues paid to each input. One widely used approach assumes cost-minimization to construct the elasticities directly from observed production data. Another approach is to estimate the elasticities α_j by estimating the production function. In this case, MFP is simply the estimated sum of the constant and the residual.

In the Cobb–Douglas case the estimated equation is:

$$\ln Y_t = \alpha_0 + \alpha_k \ln K_t + \alpha_l \ln L_t + \alpha_m \ln M_t + \omega_t.$$

Hence the MFP estimate would be $\hat{\alpha}_0 + \hat{\omega}_t$, where the first term is common across production units in the sample (i.e.; the industry level), and the second is idiosyncratic to a particular producer. This approach however raises econometric issues. Input choices are likely to be correlated with the producer's productivity ω_t : more efficient producers are, all else equal, likely to hire more inputs. There is also potential selection bias when a panel is used, since less efficient producers - those with low ω_t - are more likely to exit from the sample⁷.

SOME STYLIZED FACTS ON ITALIAN PRODUCTIVITY GROWTH

In contrast to the 1970s and 1980s, when it was the best growth performer among its major European partners, Italy has suffered a steady and prolonged productivity stagnation since the 1990s. In the context of the recent global financial crisis, the legacy of this fall has arguably made the Italian recession deeper and more persistent than in many other advanced economies. In what follows we intend to underline major stylized facts related to Italian productivity trend.

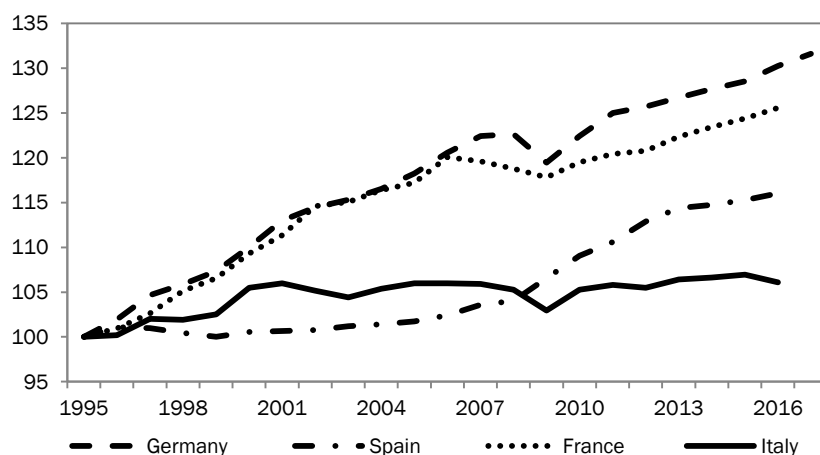
⁷ More details on measurement issues can be found in the large literature on the subject; see, for example, G. Steven Olley and Ariel Pakes (1996), James Levinsohn and Amil Petrin (2003), and Daniel C. Akerberg et al. (2007). Examples of models that derive industry equilibria with heterogeneous-productivity producers include Melitz (2003), Marcus Asplund and Volker Nocke (2006), and Foster, Haltiwanger, and Syverson (2008).

Stylized fact 1. Regardless of the metric chosen to measure productivity, Italian productivity growth has stagnated over the last 20 years.

Italian labor productivity growth has been low, both by historical and compared to European partners⁸. Chart 1 displays that after the crisis the level of the Italian labor productivity showed a temporary reduction. This trend was generalized across European partners with few exceptions (i.e.; Spain). In the aftermath of the crisis however the other main European countries showed a rebound that cannot be found in the Italian data.

Over the entire period 1995-2016, the average annual growth rate in value added was 0.6%. Labour productivity rose by 0.3% due to labor input increasing by less than the growth in value added. The growth in labor productivity in 1995-2016 was driven only by capital deepening, which contributed for 0.4 percentage points, with total factor productivity contributing for -0.1 percentage points. Non-ICT capital contributed for 0.2 percentage points, while ICT capital (i.e.; computer hardware, communications equipment and computer software) contributed for 0.1 percentage points. In the same period, capital input (1.4%) and the combined inputs of capital and labour (0.7%) rose more than value added and both capital productivity and total factor productivity fell (respectively -0.9% and -0.1%)⁹.

Chart 1 Labour productivity in EU countries: 1995-2016
(index 1995=100, real labour productivity per hours worked)



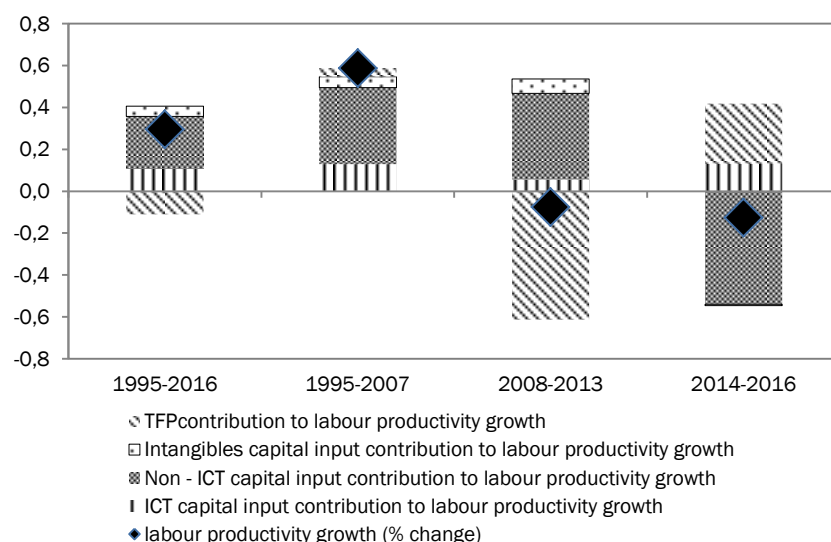
We divide the entire period into three sub-periods: i) the pre-crisis period (1995-2007); ii) the two crisis period (2008-2013) and iii) the recovery period (in Italy from 2014). Before the crisis, labour productivity growth was slightly positive while MFP growth was null on average. During the crisis, all the indicators showed a decline in productivity growth. Since the recovery, productivity showed a slow recovery in MFP growth while labour productivity growth measured on

⁸ Given some differences in the observation sample used by the various countries the international comparison is biased by some discrepancies. According to Istat the discrepancies account for less than 0,1%.

⁹ Istat, Productivity Measures, November 2017 <http://www.istat.it/en/archive/205543>.

hours worked was slight negative. Chart 2 decomposes the rate of labour productivity growth into drivers of capital deepening (i.e. the rate at which the capital-labour ratio is increased) and of MFP for the three sub periods above mentioned.

Chart 2 Decomposition of labour productivity growth



Source: Istat.

The period after the global financial crisis in 2008 shows overall the decline in labour productivity growth to be driven by a sharp reduction in the underlying rate of MFP growth. Over the 2008-13 period, capital deepening gave a very positive contribution as a result of significant shedding of labour during the crisis period and in particular during the period 2008-09. Eventually the analysis of the data available for the recovery period (2014-2016) indicate a negative capital deepening and a positive contribution of the MFP¹⁰.

Stylized fact 2. Since 2009, the decline in labour productivity is due to both a marked reduction in MFP growth and, since 2014, the absence of capital deepening.

Over the longer term the slowdown in MFP growth seems to have been the key contributor to the slowdown in labour productivity growth in Italy since the mid-1990s. In fact, MFP growth in the main advanced economies has decelerated significantly since the crisis¹¹,

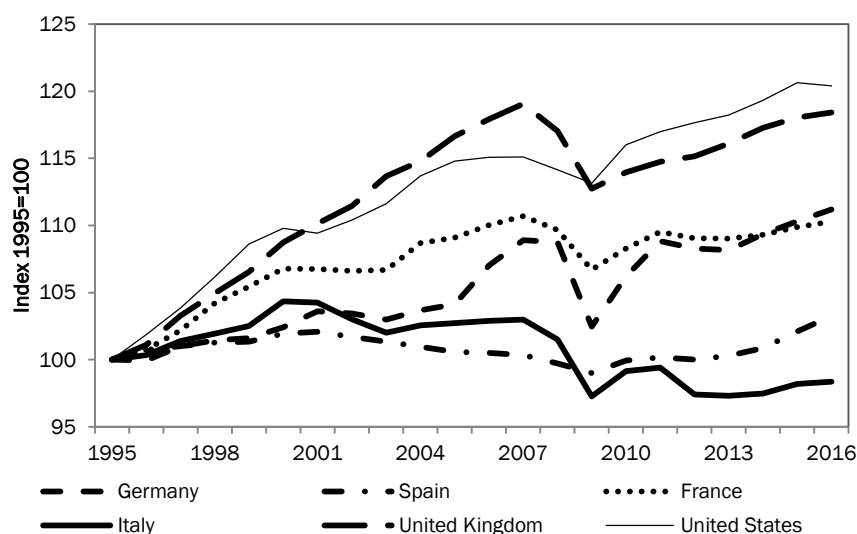
In Italy, the slowdown in capital deepening since 2014 reflects both a strong drop of gross fixed investment and a recovery in employment growth. Investment growth rate were on average negative since the

¹⁰ It is worth noting that 2016 data are still an estimate and will be revised further in the next months.

¹¹ A common hypothesis to explain part of the slowdown is increasing mismeasurement, particularly associated with the “free” goods provided by IT firms like Google and Facebook (Ahmad et al 2017).

beginning of the crisis and started to gradually recover in 2015-2016 but at a lower rate with respect to pre-crisis rates. However, the decline in capital deepening since 2014 also reflects a marked offsetting effect arising from growth in employment, which has been relatively strong compared to the rebound in economic activity. This effect has contained the rate of capital deepening and, in fact, fully offset the low (albeit now modestly expanding) rate of investment growth since 2015¹².

Chart 3 Multi factor productivity trends in industrialized countries
(index 1995=100)



Source: Ameco.

A number of reasons have been put forward to explain the negative trend in capital deepening since 2013. These include: i) the strong concentration of the recovery in consumer-driven sectors where growth is heavily concentrated in those services that are often the most labour-intensive and in which the potential for capital-labour substitution remains somewhat limited, coupled with a persisting weakness in investment in construction and ii) the impact of the global financial crisis and ongoing credit constraints in its aftermath; These elements are likely to help explaining the low rates of capital deepening seen over the period of recovery¹³.

According to recent studies in progress based on firm level data¹⁴, the rate of capital depreciation due to technological obsolescence is on

¹² Capital deepening refers to the process of increasing the capital-labour ratio by giving labour more capital to work with. However, the capital-labour ratio may also indicate "artificial" capital deepening in periods of low net investment if significant shedding of labour mechanically increases the ratio of the existing net capital stock to a reduced workforce. During the depths of the crisis, Italy saw some support to capital deepening – and, indeed, a slight increase in the rate of capital deepening – mainly as a result of heavy shedding of labour in some sectors (which mechanically supported capital deepening, notwithstanding markedly reduced net investment).

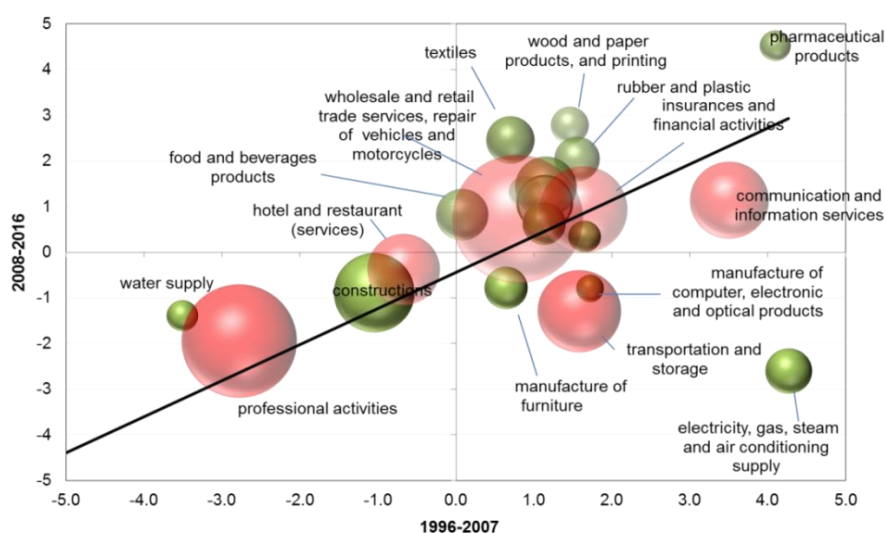
¹³ The results of the analysis for Italy are line with the ones found by ECB (2017).

¹⁴ Bank of Italy, Economic Bulletin, July 2017.

average 5% per year in Italy. Upon specific hypothesis, the strong reduction in investment in the midst of the economic crisis led not only to a decrease in installed capacity, but also caused it to become much less technologically updated. In a growth accounting exercise, results show that the poor growth of productivity during the crisis was principally due to slack in investment more than it would appear using the national accounts standard measure of capital.

Stylized fact 3. At sectoral level weak labour productivity is not widespread but mostly concentrated in services. The pattern of weak labour productivity growth at the sectoral level can be seen using a more detailed sector breakdown. The long-term trend towards services as an ever-greater proportion of the total economy might be expected to result in a reduction in aggregate labour productivity growth, as productivity growth in these sectors is typically lower than in other (mainly industrial) sectors. It is worth to underline however, as mentioned in paragraph 1, that, the measurement problems for the services sectors are greater than those for the manufacture.

Chart 4 Pre and post crisis labour productivity growth by sectors
(average annual % changes)



Source authors calculations on Istat data.

Note: labour productivity is defined as value added per hours worked. Colors refer to: industrial sub sectors (green) and services (red); bubbles size reflect the share of each sector on value added in 2016; sectors on the 45° line are those in which the pre- crisis and post-crisis period average are equal.

As shown in Chart 4, some sectors (i.e. services subsectors) show falls (often significant) in average rates of labour productivity growth between the two periods (see the sectors to the right of the 45° line) while in the manufacturing sectors there has been an improvement. Some subsectors of the manufacturing improved their performance after the crisis such as textiles, wood and paper, rubber and plastic or food and beverages products while pharmaceutical products which outperformed before and after the crisis. Construction sector recorded

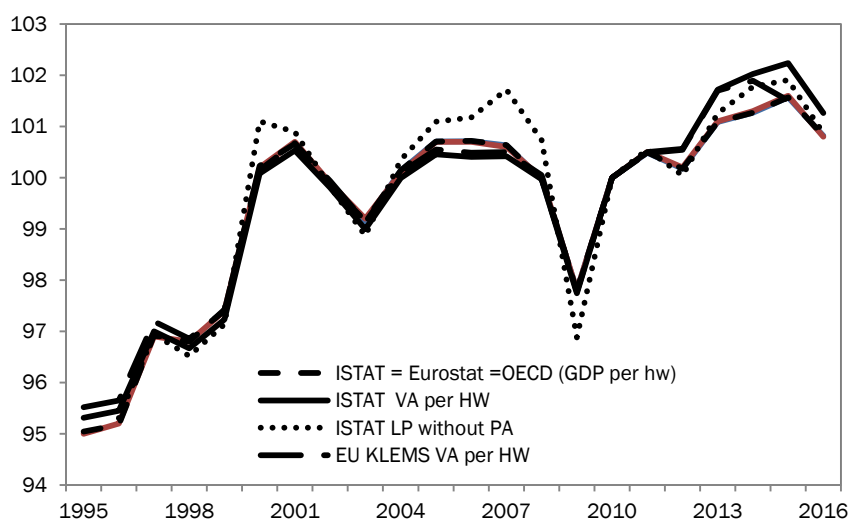
the same annual average in both periods. The chart shows in a clear way that the Italian productivity problem is mostly related to the negative performance of services, in particular professional activities. Wholesale and insurance and financial activities did not improve their position after the crisis while communication and information services and transportation and storage decreased their productivity after the crisis.

SOME INSIGHTS ON PRODUCTIVITY MEASUREMENT AND INTERPRETATION FOR ITALY

In line with what discussed in paragraph 1, it is worth to underline that there are some main problems in productivity measurement and interpretation that have to be carefully considered once analyzing productivity trends. These include for measurement primarily: i) the heterogeneity in international compilation methods and ii) the measurement of information and communications technology (ICT)-related goods and services. For what concern the interpretation of productivity data, there are at least three features that have to be examined in studies on Italian productivity: i) recent peculiar behavior of data revisions, ii) the heterogeneity across firms within sectors and across sectors and iii) the data aggregation.

For what concern the productivity compilation methods it is worth to underline that there is not a mandatory common international regulatory framework not even for EU members. Countries mostly follow the OECD manual methodology but several discrepancies in productivity measurement across EU countries remain especially for what concern the service sector. In chart 5, it is possible to notice differences among the labour productivity indicators for Italy provided by various sources.

Chart 5 Labor productivity measures among different sources
(index 2010=100)



Sources: OECD, Eurostat, EU KLEMS and Istat.

Labor productivity indexes measured on GDP per hours worked are the same for OECD, Istat and Eurostat while there are some minor differences between Istat and EU KLEMS for the productivity measured on value added per hours worked. This difference can be related to the revisions of the national accounts which occurred in September after the release of EU Klems update. A more volatile path of the labour productivity is indeed traced by the measure of labour productivity which excludes the Public Administration sector. In Italy, the adopted methodology by Istat closely follows the approach outlined in the OECD Manual on Productivity Measurement¹⁵.

In this framework, the EU KLEMS project aims to create a common database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all EU members from 1970 onwards. The project attempts to overcome current deficiencies in official industry level statistics, especially with regard to data for service industries. The achievement of the project are promising but more efforts are needed to overcome the heterogeneity in productivity measurement.

For what concern the measurement of information and communications technology (ICT), in Italy the contribution of intangible capital to labour productivity growth has been rather limited, with a particularly small contribution from spending on research and development. Italian companies have a lower propensity to innovate than their main European competitors, especially in connection with the adoption of ICT technologies¹⁶. Part of this difference however might be also due to measurement issues. Inadequate measurement of both intangible investments and improvements in the quality of ICT-related goods and services may bias estimates of outputs and inputs and result in misleading conclusions regarding labour productivity and MFP growth.

Efforts to ease these problems are ongoing but still inconclusive and contain: i) concerted efforts aimed at creating better measures of “intangible assets” in national accounts data sources via the inclusion of “intellectual property products” in the European System of National and Regional Accounts (ESA 2010); ii) attempts to reassess the development of ICT-based prices.

As for the first point, in the new version of the Italian national accounts according to the ESA 2010 and thus in line with all the European countries, Research and Development expenses are considered as an investment since they contribute to the accumulation of production

¹⁵ Output is the chain linked valued added at basic prices. Labour input is measured as total hours worked by all persons engaged in production. Capital input is measured as the volume of capital services provided by the stocks of three categories of ICT assets, eight categories of tangible non-ICT assets and three categories of intangible non-ICT assets. Productivity measures are estimated using national accounts data released in accordance with NACE Rev.2 classification. Estimates are provided for 38 industries, as well as for the total economy. Both industry level and aggregate estimates are calculated net of real estate activities, of activities of households, of activities of extraterritorial organizations and of all activities of the General government sector. In the benchmark year 2011 the total of the above defined sectors accounted for 70.4% of total value added and 83.0% of total hours worked”. (Istat 2017). Concerns on capital measurement arise if we consider the impact of technological progress on capital obsolescence. Until now this issue is not considered in the national accounts (OECD, 2009).

¹⁶ See De Santis, Ferroni, Jona Lasinio (2017).

capacity through intangible capital; in the past, these were recorded as current expenditure. Currently the main international organization (i.e. OECD, Eurostat, European Commission) are exploring the possibility to expand the inclusion of intangible asset in the European System of National Accounts¹⁷.

As for the second point the inadequate adjustment for quality change that affect the distinction between price and volume changes when estimating growth of output and capital inputs that we discussed above is particularly relevant for ICT product. The latter tend to undergo frequent changes in quality and specifications. When technological progress is rapid, standard methods may undervalue the quality improvements embodied in new models, leading to overestimation of the growth of quality-adjusted prices and underestimation of output volume growth. Recent studies finding evidence of overestimation of price change in official price indices for ICT and software have revived the discussion of price mismeasurement¹⁸.

On this issue, a recent paper by Ahmad et al. (2017) provides a simple first indication of the possible scale of price mismeasurement constructed by comparing measured price changes across countries for three kinds of products: ICT equipment, software and databases, and communications services. Many of the differences across countries in the measured price change since the second half of the '90s are substantial. To illustrate the potential scale of mismeasurement, prices of computers and telecommunications equipment show little change over the two decades in Spain, and declines of between 70 and 90% in Australia, Canada, Germany, the Netherlands, UK, US. In Italy and Austria, price fall by only around 20% over the two decades, but remain broadly flat in the second decade¹⁹.

Ahmad et al. (2017) provides various attempts to measure the bias determined in GDP and productivity indicators due to potential ICT products price mis-measurement and Italy ranges among the countries more severely biased. At European level despite some progresses the harmonization of personal consumption expenditure deflators compilation methodology is still incomplete. For example Giraud et al (2017) find evidence of overestimation of price change in official price indices for Italy accounting for about 0.2 percentage points of the GDP differences between Italy and France.

For what concern the interpretation of productivity data, it is worth to underline that the Italian productive structure presents some peculiarities that require a closer look. First of all, as underlined in the previous paragraph, there is an heterogeneous performance in terms of productivity across sectors. The main culprit for productivity weakness seems to be the service sector while manufacturing sector proved, on average, to be resilient and at least as dynamic as its main

¹⁷ See Byrne and Corrado (2017).

¹⁸ See, Ahmad et al. (2017) and De Loecker and Goldberg (2014).

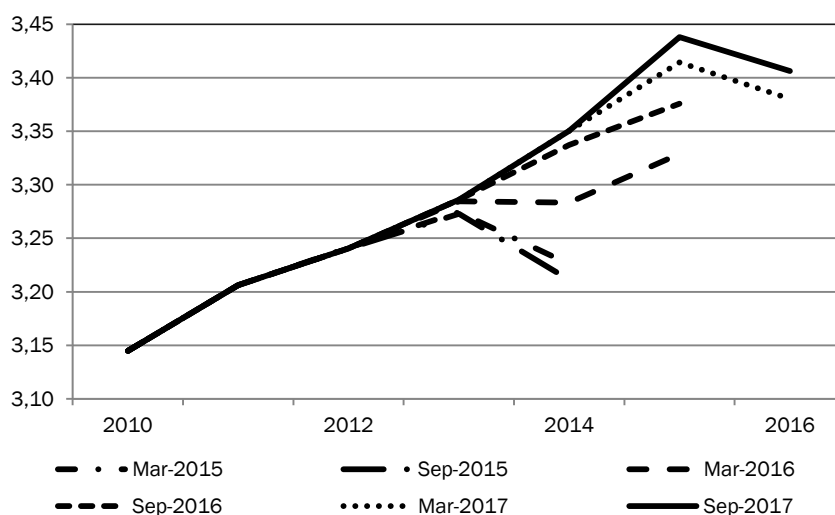
¹⁹ The large differences in price movements for software also point to different index construction and quality adjustment procedures. Investment in software includes significant in-house production, where countries may be generating price indices using a cost-of-production approach. Wages are the most important component of the deflator for this software, and wages of software writers are unlikely to have diverged as much as the price indices for software.

European pairs. Manufacturing productivity showed, since 2010, a greater acceleration than in France and Spain thanks to substantial structural adjustments *“carried over by firms which reallocated resources to the most efficient companies; furthermore the crisis contributed to select the entry and the survival in the market of more competitive firms and to increase R&D intensity”* (Bugamelli et al 2018).

Despite, by definition, statistical revisions should provide errors that on average are null, Italian national accounts revisions²⁰ since 2012 have been showing a peculiar pattern for the manufacturing sector (see Chart 6).

Indeed, since 2003 productivity measured as value added on hours worked in the manufacturing sector has been growing steadily²¹ and starting from 2012 Q1 revisions to national accounts showed a better picture every new release. Major revisions occurred to the manufacturing sector value added (numerator) more than on the hours worked (denominator).

Chart 6 Revisions in labour productivity
(manufacturing sector, value added/ hours worked %)



Source: Istat (2017).

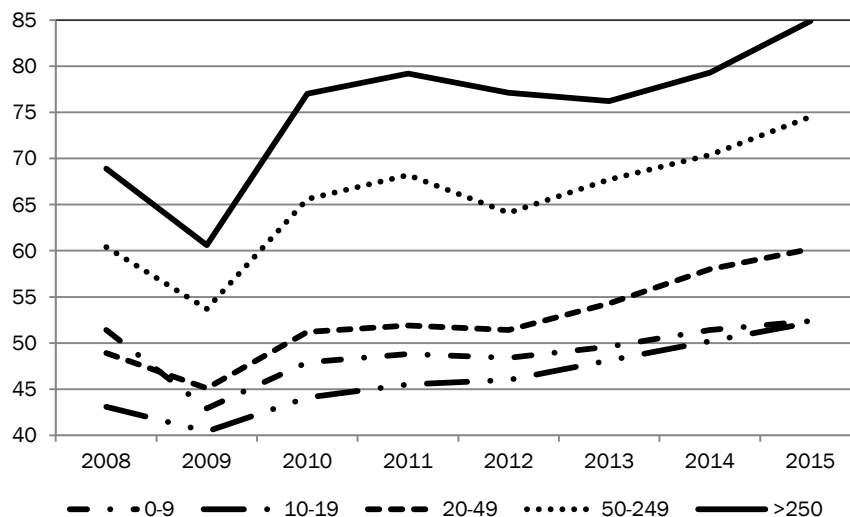
Another aspect that needs to be investigated is the heterogeneity across firms within each sector. In fact, Italy is the country with the most fragmented and polarized productive system if compared to other EU economies²². For example manufacturing sector is characterized by a high degree of heterogeneity in performance (Chart 7).

²⁰ National statistics Institutes are committed to release twice a year (beginning of March and end of September) annual national accounts (and their revisions) compliant with the definitions of the European System of Accounts (ESA 2010) and Council Regulation (EC) n. 549/2013.

²¹ It increased by 1.6 % per year on average between 2003 and 2007, and accelerated to 1.9 % after 2009.

²² In Italy microenterprises, i.e. those with less than 10 employees, account for 95 percent of the total number of firms and for 29 % of total value added. On the other tail of the distribution, large companies, with more than 250 employees, do not reach 0.1 per cent in terms of number of firms, against 0.5 and 0.2 in Germany and France, respectively.

Chart 7 Gross value added per employee – manufacturing
(thousand euro, number of employed person)



Source: Structural Business Statistics Eurostat.

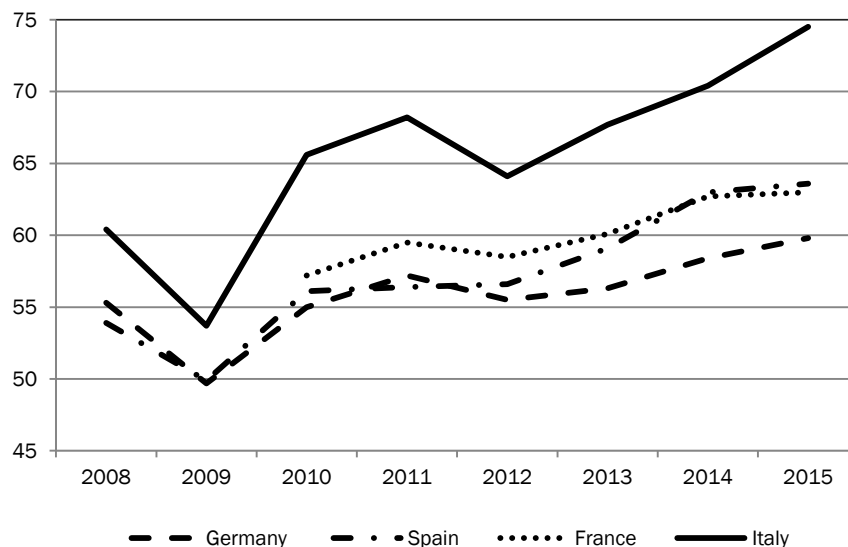
Productivity growth of the top 10% firms, in the post crisis period, not only dominates the one of the median firm and of the bottom 10% but it is also steadily increasing. This result supports the idea that the most efficient part of the Italian productive system, after the crisis, has been showing important recovery signals in terms of productivity in the manufacturing sector and that the main culprit of productivity stagnation most likely is the services sector.

It is well known and supported by the relevant literature (Bugamelli et al 2010) that the Italian productive system is essentially formed by two main groups: i) a smaller group of medium and large-sized firms, which are efficient: their performance and strategies linked to innovation, technology and exports are in line with the main European countries and ii) a bigger group of micro firms, which on the contrary have a low propensity to innovate and compete on global market; these firms are characterized also by a vulnerable financial structure. The firms belonging to the first group have been able to react to the financial crisis. On the opposite side, the micro firms were highly hit by the financial and sovereign debt crisis and by the effects of globalization.

In Chart 8, there is evidence that labour productivity was higher in Italy than in Germany, France and Spain when considering medium and large firms (from 50 to 249 employees)²³.

²³ See also De Nardis (2014).

Chart 8. Gross value added per employee - manufacturing
(thousand euro, 50-249 employees)



Source: Structural Business Statistics Eurostat.

Another interpretation argument that requires attention is the role of data aggregation which seems to be not neutral in the Italian productivity performance measurement.

There is a growing literature on the role of allocative efficiency of resources as a determinant of productivity growth and, in this contest, recent empirical works find that the allocative efficiency is one of the major explanation of the Italian gap, compared to its peers, in terms of productivity growth. Linarello and Petrella (2017)'s evidence of improved allocative efficiency before the crisis when analyzing the universe of Italian firms rather than a smaller subsample stands in contrast with other papers²⁴. Their results depend primarily on their sample selection.

The non neutrality of data aggregation is underlined also by recent studies in progress by Bank of Italy on potential output growth using a production function approach applied to Italian individual firm level data. Preliminary results show that the relationships between inputs and output existing at firm level are preserved under aggregation only if some restrictive conditions hold²⁵. Whether these conditions do not holds, the methodologies based on micro data seems to be more effective to capture some events such as the misallocation of inputs.

²⁴ Linarello and Petrella (2017)'s evidence of improved allocative efficiency before the crisis is in contrast with other works which use the methodology developed by Hsieh and Klenow (2009) based on the idea that misallocation increases with the degree of dispersion in measured TFP and subsamples of incorporated firms.

²⁵ For example when a production function is homogeneous of degree one and there are no frictions in the accumulation and disposal of inputs

CONCLUSIONS

The weak performance since the 1990s of productivity at global level intensified the research on this issue. Questions were raised also on the adequacy of current compilation methods. The literature evidenced that there are several productivity measurement problems associated with estimating output and input volumes especially related to the quality of prices indexes for some products and services. These problems might have had an impact on productivity estimates and consequently have impaired the international comparisons evidences.

In this paper, we underlined as, despite not being a major cause of Italian productivity weak performance, there are some methodological and interpretation issues that need to be addressed in order to evaluate productivity trends properly. More specifically, we see as a major shortcoming the absence at international level of a fully common shared methodology to compile productivity statistics and to adjust data for quality change. The latter problem affects substantially the distinction between price and volume changes when estimating growth of output and capital inputs.

Moreover, although some progresses were achieved in the SNA 2010, still incomplete measurement of both intangible investments and quality of ICT-related goods and services still determines biased estimates of outputs and inputs and might result in misleading conclusions regarding labour productivity and MFP growth.

Specifically for Italy, in this paper we underlined that there are factors that might have “biased” the interpretation of productivity evidence. In fact, the recent peculiar behavior of data revisions, at least for manufacturing sector, suggests that once more information is available the performance of productivity seems to improve. This evidence, that seems to be in disparity with the required statistical properties of measurement errors, needs to be further investigated.

There are also signals that the higher heterogeneity across firms (within and between sectors) in Italy than in other European countries makes aggregate measures of productivity less unsuitable for international comparisons. Eventually recent empirical papers underlined that the presence of aggregation bias might have led to mismeasurement of productivity trends in several empirical analyses on Italian productivity behavior.

REFERENCES

- Abramovitz, M. (1956) Resource and output trends in the United States since 1870, *American Economic Review*, 46(2), pp. 5–23
- Akerberg, Daniel, C. Lanier Benkard, Steven Berry, and Ariel Pakes. 2007. “Econometric Tools for Analyzing Market Outcomes.” In *Handbook of Econometrics*, Volume 6A, ed. James J. Heckman and Edward E. Leamer, 4171–276. Amsterdam and Boston: Elsevier, North-Holland
- Ahmad, N., J. Ribarsky and M. Reinsdorf (2017), “Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth? ”, *OECD Statistics Working Papers*, 2017/09, OECD Publishing, Paris

Asplund, Marcus, and Volker Nocke. 2006. "Firm Turnover in Imperfectly Competitive Markets." *Review of Economic Studies*, 73(2): 295–327.

Banca d'Italia, Economic Bulletin, July 2017

Byrne, D. and C. Corrado (2017), "ICT prices and ICT services: What do they tell us about productivity and technology?", Finance and Economics Discussion Series, No. 2017-015, Board of Governors of the Federal Reserve System.

Bugamelli M., F. Lotti, M. Amici, E. Ciapanna, F. Colonna, F. D'Amuri, S. Giacomelli, A. Linarello, F. Manaresi, G. Palumbo, F. Scoccianti, E. Sette (2018), "Productivity growth in Italy: a tale of a slow-motion change" QEF n. 422 Bank of Italy.

Syverson C., 2011. "[What Determines Productivity?](#)," [Journal of Economic Literature](#), American Economic Association, vol. 49(2), pages 326-365, June.

Cette, G., J. Fernald, and B. Mojon (2016). "The pre-Great Recession slowdown in productivity", *European Economic Review*.

Cooper, William W., Lawrence M. Seiford, and Kaoru Tone. 2006. *Introduction to Data Envelopment Analysis and Its Uses: With DEA-Solver Software and References*. New York: Springer.

De Loecker J and P. K. Goldberg (2014), "Firm performance in a global market", *Annual Reviews*, vol. 6(1), pages 201-227, August

De Nardis S.(2014), "Efficienza e specializzazione, Scenario Nomisma

De Santis R., Ferroni V. and Jona Lasinio (2017) "Investment in innovation and the Italian productivity slowdown: an industry perspective", *Economic Focus* n.1, Dep. Of Treasury, MEF.

ECB (2017), "The slowdown in euro area productivity in a global context" by ECB, *Economic Bulletin*, Issue 3 / 2017.

Haltiwanger, John, Stefano Scarpetta, and Helena Schweiger. 2008. "Assessing Job Flows across Countries: The Role of Industry, Firm Size and Regulations." *National Bureau of Economic Research Working Paper* 13920

Hopenhayn, Hugo A. 1992. "Entry, Exit, and Firm Dynamics in Long Run Equilibrium." *Econometrica*, 60(5): 1127–50.

Istat (2017), "Productivity measures, report.

Linarello and Petrella, "Productivity and Reallocation: Evidence from the Universe of Italian Firms", *International Productivity Monitor*, n.31 Spring (2017)

Melitz, Marc J. 2003. "The Impact of Trade on Intraindustry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695–1725

OECD, *measuring capital*, Oecd manual, 2009

OECD *compendium of productivity indicators* (2017)

Olley, G. Steven, and Ariel Pakes. (1996). "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica*, 64(6): 1263–97.

Solow R. , M. 1957, "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics*, Vol. 39, No. 3 (Aug., 1957), pp. 312-320 The MIT Press

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