Box 1. Total factor productivity (TFP) from a macro- and a microeconomic perspective

Productivity is a concept that emerges naturally in the context of an economic process, being linked to the efficiency with which resources (most often labour and capital) are used in the said process to deliver a certain output. In practice, this concept is mostly measured by the labour productivity indicator, which shows the output generated (on average) by one employee and which has the advantage of being relatively easy to determine. Nevertheless, when interpreting productivity thus calculated, due account should be taken that it is also influenced by changes in the intensity of use of other production factors. In particular, both an increase in capital and improved economic efficiency (which have different implications) result, *caeteris paribus*, in higher labour productivity. Therefore, it is desirable to analyse separately the economic output component that is derived by excluding the influence of inputs and that economic theory refers to as total factor productivity (TFP).

Economic research has shown that TFP developments have significant macroeconomic implications, also in terms of price stability – as the indicator provides information about the growth capacity of the economy in the absence of inflationary pressures – or the preservation of external balance – TFP dynamics are deemed to have a major impact on competitiveness. At the same time, the rise in productivity is of the essence to ensure the sustainability of potential progress towards welfare and development. This is reflected also by recent analyses of the economic situation at the EU level (EC, 2014 or ECB, 2015), which have found that the countries with the least favourable TFP performance were the same to report weak convergence and the most significant vulnerabilities during the financial and economic crisis.

This box aims to study TFP developments in Romania and the factors that may boost or, on the contrary, dampen TFP growth. To this end, the macroeconomic approach is supplemented by an analysis of production processes at the micro level, which allows us to understand why some economic agents are more efficient and to assess to what extent the change in aggregate TFP was ascribable to within-firm efficiency variations or to a reallocation of resources from less efficient companies to more productive ones.

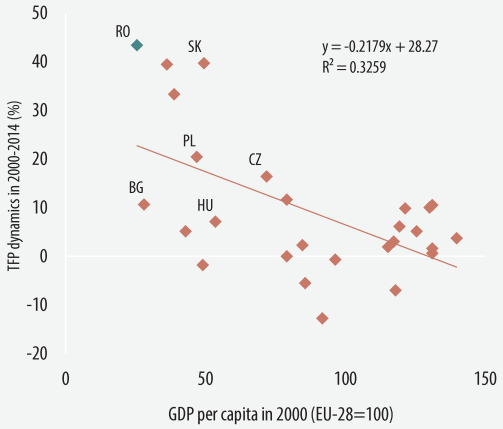
How is TFP measured economy-wide?

TFP at the aggregate level may be estimated using the production function approach. This method consists in specifying a relation between real GDP and the factors of production, i.e. the capital stock and labour. As previously stated, TFP is that component of economic growth that cannot be attributed to or accounted for by factors of production, being interpreted as a synthetic measure of their utilisation efficiency.

One approach to estimating the contributions of production factors – which is in line with the methodology also employed by international bodies, i.e. the European Commission – is to approximate the capital stock by cumulating investment flows and to measure labour as the total hours worked economy-wide by taking into account the population of working age, the participation rate, employment and the average number of hours worked per week[12].

[12] For details about the methodology, see the presentation entitled "Estimating potential GDP via the production function method" given at the NBR Monetary Policy Colloquia (2012).

Chart A. TFP Developments and Initial GDP per Capita

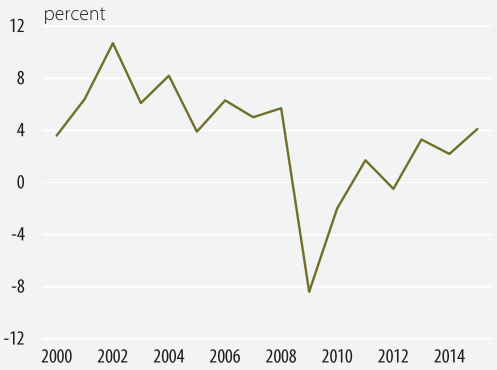


Source: AMECO

Nevertheless, the estimates of the contributions of production factors may vary considerably depending on the approach used to quantify variables. Specifically, the variation of outcomes may stem from the definition of the investment flow, the choice of the base period for approximating the initial value of the capital stock, the calibration of the capital depreciation rate (either constant or time-varying), the impact of the capacity utilisation rate or the measure of labour (in terms of hours worked or the number of persons employed). In addition, the frequency and the magnitude of the data series revisions, which are significant in the case of emerging economies such as Romania, increase the uncertainty of estimates, which stands higher particularly in the last intervals over the reviewed period. Differences may also come from the specification of the production function (which can be a Cobb-Douglas production function, as in the aforementioned approach, or a more flexible functional form, such as the Constant Elasticity of Substitution – CES – production function).

In 2000-2014, Romania posted substantial TFP growth as compared with other EU Member States (Chart A), which was indicative of both rising competitiveness and progress towards real convergence, even though the latter's achievement still lies rather far into the future, as GDP per capita is further markedly below the EU average. For the period spanning 2000 to 2008, amid the structural changes in the economy, the assessment results for Romania mirror the key contribution of TFP to GDP growth. The global financial crisis had major adverse effects on the dynamics of production factors and on TFP[13], which later showed signs of a moderate recovery (Charts B and C). With a view to understanding the fundamentals that caused TFP to resume an upward path, it is important to identify the elements that are specific to efficient firms, a step facilitated by an empirical exercise at a microeconomic level.

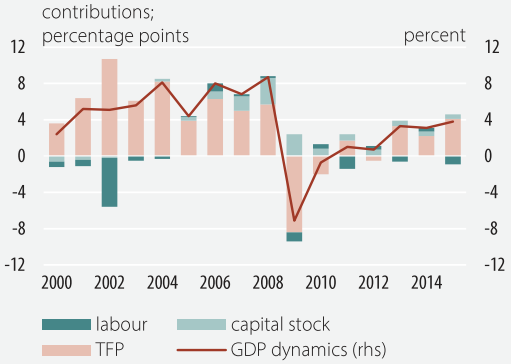
Chart B. TFP Annual Growth Rate



Note: Data series are annual averages of seasonally-adjusted quarterly data.

Source: NIS, Eurostat, NBR calculations

Chart C. Contributions of Production Factors to Annual GDP Growth



Note: Data series are annual averages of seasonally-adjusted quarterly data.

Source: NIS, Eurostat, NBR calculations

[13] An economic crisis usually impacts TFP through the effects of a reduction in R&D expenditure and an inefficient allocation of resources.

The profile of the productive firm in Romania

The firm-level investigation of value added creation is furthered by the available data on the individual characteristics of economic agents. Specifically, TFP was estimated for each company based on an exhaustive panel sample built using financial statements data[14]. Next, the productivity thus derived was linked to a set of explanatory variables constructed in compliance with the literature (Table 1). These variables originate in company financial statements, as well as in the survey on the firms' behaviour on the labour market conducted by the NBR in 2014[15].

In line with the results in the literature, the analysis of the profile of the productive firm shows the latter to be a large, young, private company with majority foreign capital that is part of a group undertaking. These findings support the idea that foreign direct investment inflows played a crucial role in increasing the productivity of the economy, on the back of the superior know-how benefitting the projects thus developed. Moreover, it is plausible that the aforementioned knowledge was passed on to domestic companies as well, via the replication of technology, business methods and/or management models. In a broader perspective, it can be noted that the same pattern may be found several times in the history of the European project, being the main mechanism to achieve convergence between the emerging periphery and the developed core.

The estimations also corroborate the role of (both domestic and especially foreign) competition in boosting a company's productivity. With the intensification of competition, closely linked to the functioning of free market mechanisms, firms were increasingly compelled to admit they only had two options: either to become more efficient or exit the market. Thus, the large structural changes that helped establish a functioning market economy in mid-2000s spurred the swift growth of TFP prior to the crisis.

At the same time, the quality of human capital, i.e. the technical skill endowment of employees, is relevant from a TFP perspective, as nowadays the ever-rising difficulty to find skilled labour has already become a barrier to improving firm productivity. The estimations also show that hiring young and inexperienced workers for skilled jobs entails solely additional costs in their first year of employment. Nonetheless, it is worth mentioning that subsequently they make an increasingly large contribution to TFP growth.

The findings have also stressed the higher productivity of importers than that of companies that do not conduct such activities, i.e. 15 percent higher on average. The explanation lies in the important role of foreign, high-tech and high-yield equipment and possibly of certain inputs also from abroad in companies' activities. Consequently, the estimations emphasize the favourable impact of trade integration of the domestic economy, in that foreign trade companies[16] support a higher productivity of the economy.

[14] The data source is the Ministry of Public Finance, the sample covers the years between 2002 and 2014 and includes over 3 million observations. The estimation procedure was in line with the Wooldridge methodology (2009). For further details, see CompNet (2014) and Van Beveren (2012).

[15] Survey details can be found in Iordache, Militaru and Pandioniu (2016).

[16] A firm's status as an exporter and the number of export destinations have a positive and statistically significant correlation in the estimation, import-related variables reporting however a better explanatory power.

Table 1. Results of the Estimation[a)] of the Links between Firm-Level TFP and Explanatory Variables

Variable name	Possible values	Interactions[b)]	Estimated coefficient
Variables from company financial statements			
Firm size	1 (20-49 employees)	-	0.118***
	2 (50-199 employees)	-	
	3 (>199 employees)	-	
Majority state ownership	0, 1	-	-0.278**
R&D expenditure (lei thou./employee)	any positive number	-	0.002*
Importer	0, 1	-	0.150**
Number of import partners	0, 1, 2, 3 …	-	0.022***
Variables from the NBR/WDN Survey			
Majority foreign ownership	0, 1	-	0.240***
Autonomy	0, 1	-	-0.070*
Firm age	1, 2, 3 …	-	-0.006***
Domestic competition	0 (does not apply)	-	0.052***
	1 (weak)	-	
	2 (moderate)	-	
	3 (severe)	-	
	4 (very severe)	-	
Foreign competition	similar scale to that used for the "domestic competition" variable	-	0.060***
Share of employees with permanent, full-time contracts	0-1	-	0.685**
Share of employees with temporary contracts	0-1	-	0.600*
Share of union members	0-1	Company is over 7 years old	-0.122*
		Company is less than 7 years old	0.458***
Share of high-skilled manual workers	0-1	Share of employees with a job tenure below 1 year	0.259
		Share of employees with a job tenure from 1 to 5 years	0.249*
		Share of employees with a job tenure over 5 years	-0.173*
Share of high-skilled non-manual workers	0-1	Share of employees with a job tenure below 1 year	-0.477
		Share of employees with a job tenure from 1 to 5 years	0.479**
		Share of employees with a job tenure over 5 years	0.760***
Constant		YES	
Sectoral dummy variables		YES	
Number of observations		1,505	
R^2		0.6984	

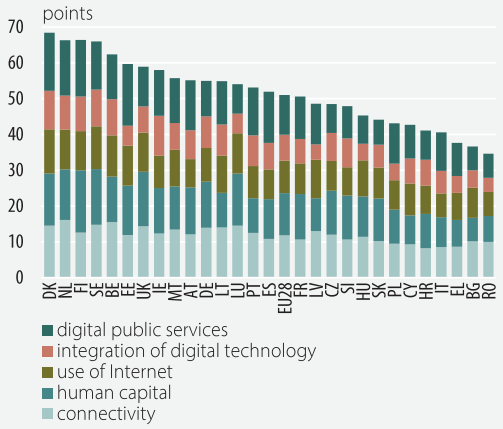
a) The estimation was made using the method of least squares with robust standard errors.

b) Interactions help investigate whether the magnitude or even the sign of the influence of an explanatory variable on a dependent variable changes depending on the values of another explanatory variable.

*, **, *** statistically significant at the 10%, 5% and 1% levels respectively.

Source: MPF, NBR

Chart D. Digital Economy and Society Index (2016)



Source: European Commission

Another key determinant of a company's productivity is the research and development activity. Nevertheless, from this standpoint, the potential is far from being properly harnessed, in light of the very little – in fact the lowest in the EU – interest in fostering business innovation in Romania (Chart D). Surprisingly, an ever larger contribution to economic growth in the past years has come from the fast-paced development of domestic high-tech services supply, which targeted however mostly foreign trading partners.

Within-firm changes versus reallocation of resources between firms

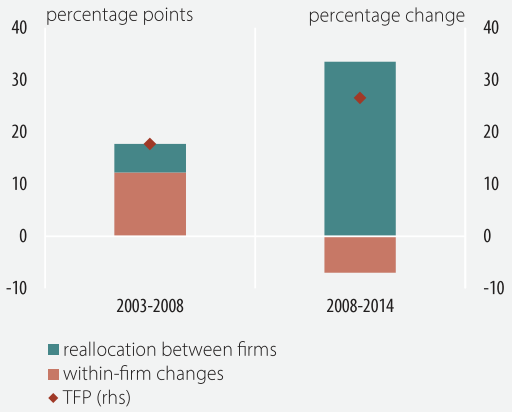
Unlike firm-level TFP, aggregate TFP developments involve an additional dimension that refers to the manner of allocating resources. Specifically, as companies with higher-than-average productivity are allocated a larger share of resources, aggregate TFP will improve, even though firm-level TFP remains unchanged. For instance, in the case of human resources, this translates into a rise in whole-economy productivity, conditional on productive economic agents hiring additional staff, along with downsizing by less productive companies. Foster, Haltiwanger and Krizan (2001) proposed a methodology to highlight the contribution of the reallocation of resources to aggregate productivity growth, in line with the equation below:

$$\widehat{\Delta TFP} = \sum_{i\in s} p_{it-k}(TFP_{it} - TFP_{it-k}) + \sum_{i\in s}(p_{it} - p_{it-k})\left(TFP_{it-k} - \widehat{TFP_{it-k}}\right) +$$
$$+ \sum_{i\in s}(p_{it} - p_{it-k})(TFP_{it} - TFP_{it-k}) + \sum_{i\in E} p_{it}\left(TFP_{it} - \widehat{TFP_{it-k}}\right) - \sum_{i\in X} p_{it-k}\left(TFP_{it-k} - \widehat{TFP_{it-k}}\right)$$

Thus, a change in aggregate productivity ($\widehat{\Delta TFP}$) between times *t* and *t-k* may stem from: (i) the change in firm-level productivity (the first item), this being the case of economic agents that remain on the market in both periods, the so-called "survivors", which are part of cohort S or (ii) the reallocation of resources between firms: survivors, entrants (in cohort E) and exiters (in cohort X) respectively.

The contributions to aggregate productivity growth in manufacturing calculated before and after the financial and economic crisis based on the aforementioned methodology (Chart E) show the chiefly countercyclical influence of labour repositioning to a more efficient production structure. In the pre-crisis period, the reallocation of human resources made a low contribution to TFP growth in manufacturing. However, the crisis paved the way for taking better advantage of the potential to develop efficient projects, on account of a reduction in low-yield activities. Looking ahead, this mechanism for improving aggregate productivity may exert a lower impact, as limitations related to heterogeneous regional development become more apparent, given that the distribution of investment flows conducive to productive economic processes was uneven across the country. Specifically, in certain regions there is a pool of available labour, yet not enough performing companies to use it (as the poor infrastructure adversely affects their profitability). Moreover, there is little possibility of redirecting the said labour supply to investment projects in other areas, in light of the obstacles arising from the quality of infrastructure and the perception of high

Chart E. TFP in Manufacturing: Within-Firm Changes versus Reallocation



Source: MPF, NBR calculations

opportunity costs. In addition, as the aforementioned workers remain unemployed, they experience skill loss and become increasingly less competitive, with the current situation already calling for active policies in both education and social reintegration.

While the higher aggregate productivity and the more competitive structure of the economy have contributed to improving the economic situation over the past years, the picture in terms of jobs still compares less favourably with that in the pre-crisis period. In manufacturing, although industrial output has risen by more than 30 percent from 2008, the increase has been underpinned by a lower staffing level. From this perspective, insofar as more (particularly small- and medium-sized) firms reported efficiency gains, two goals would be concurrently achieved: enhanced efficiency and job creation. Such a development would bring greater sustainability to economic development and prevent the emergence or widening of social imbalances.

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