Productivity slowdown : findings and tentative explanations

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Introduction

For many years now, potential growth has been slowing down in the advanced economies. Growing attention is therefore being paid to the determinants of growth. As the cumulative effects of productivity are the only source of long-term growth, many institutions are concerned about them. For instance, it is striking to see that, in a general context of accelerating technological progress and contrary to what was observed during previous waves of technological change, the latest shifts in technology are failing to be translated into measurable productivity gains.

The objective of this study sheds some microeconomic light on the analysis of the trend in productivity, complementing the macroeconomic analyses that indicate Belgium's position in relation to other advanced economies. This makes it possible to find out more about the sources of productivity growth as well as identify, by means of a series of growth breakdowns, some of the causes of the slowdown that has been at work since the beginning of the 2000s.

This article is structured as follows : the first part examines the various approaches that can be followed to measure productivity. The second part briefly reviews the literature and highlights some of the recurrent findings about the determinants of productivity. The third part puts Belgium's performance into an international perspective, while the fourth gives a series of analyses based on microeconomic data. Based on information from the annual accounts of Belgian firms from the market sector, an estimation of total factor productivity at the individual firm level then helps identify the sources of changes in aggregate productivity growth. It consecutively presents breakdowns by branch of activity and by Region, the different sources of productivity growth and company performance at the top of the productivity distribution as well as the performance of so-called zombie firms. The findings of a multivariate analysis of the determinants of firms' productivity round off this section. Lastly, the conclusions set out all the key messages that emerge from the analysis of the micro data along with some economic policy recommendations.

1. Different concepts for measuring productivity

In practice, there are two distinct concepts for measuring productivity. The first is apparent labour productivity. This is the quantity of value added generated by a worker (either in terms of full-time equivalents, or by hours worked). While this measure has the advantage of being easy to calculate, it only takes the 'labour' input into consideration, neglecting the contribution of capital stock to the firm's production. According to this approach, a company that either produces more for a given level of employment or maintains its current production level by using less labour is more productive.

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Productivity gains thus depend exclusively on better use of the factor labour. However, value creation not only depends on the number of hours worked or on the number of workers employed in a company. It is therefore preferable to use an indicator that reflects the way in which all the factors of production mobilised by the firm contribute to wealth creation. This is the case with the second concept of productivity, namely total factor productivity (TFP).

The first research paper on measuring TFP was published back in 1957 by Robert Solow. His article was part of a wider range of theoretical thinking on aggregate growth components, among which TFP very quickly proved to be essential. After that, a wealth of writing has put the emphasis on the determinants of TFP and on measuring it.

Conceptually, TFP captures the efficiency with which certain inputs (capital and labour, for example) are transformed into outputs (like value added) (see the methodological annex for more details on how we estimate TFP). It represents the change in value added that cannot be explained by changes in the quantity of capital and labour. If a firm knows its own efficiency level, on the basis of which it makes its investment or human resources choices, TFP is not directly observable by economists, who therefore have to estimate it. Empirically speaking, TFP is measured as the residual of a production function. It is regularly considered as a measure of our ignorance of the growth process.

As a residual, TFP can capture other phenomena than technological efficiency. It will thus partly include effects of measurement errors for both value added and the inputs mobilised to generate it, but since these errors are assumed to be random, their occurrence should not affect aggregate trends. Ideally, productivity should be calculated from data expressed in real terms and not influenced by the firm's pricing decisions. Therefore, a series of firm-level price indices would be required to be able to deflate the nominal variables of the production function correctly. Yet all the economist has, at best, are sectoral deflators. Estimated TFP thus partly captures a firm's relative price changes compared with those charged in its branch of activity, and a sharp rise in prices can thus be wrongly perceived as an increase in productive efficiency, while it may just simply reflect an increase in the firm's market power, for instance. So, a degree of caution is in order when it comes to analysing TFP.

Generally speaking, it appears that trends in TFP and apparent labour productivity are fairly comparable. So, in this article, TFP is used as this concept gives a better idea of the productivity of all the inputs mobilised by companies.

2. Literature review

A broad spectrum of the literature in this area endeavours to bring to light a series of levers aiming to improve corporate productivity. This part outlines some of the features of companies that are frequently considered as conducive to fostering high levels of productivity. Certain factors related to the environment or the regulatory framework can also make a contribution.

First of all, productivity levels of firms that trade with the rest of the world, and which are consequently more deeply integrated into global value chains, turn out to be higher (De Loecker *et al.*, 2012). Company performance is correlated with the presence of foreign firms and with the level of trade conducted with them, although nothing can be said about causality. Effectively, selling abroad involves certain additional costs that only the most productive firms can bear (Melitz, 2003). Through their active presence on foreign markets, exporting firms are confronted with other competitors or different technologies, which, in turn, could also bring productivity gains due to involvement in international trade. However, there is less evidence of learning by exporting than that pointing to self-selection for export. Moreover, it appears that it is the large enterprises that are driving productivity growth, as other firms do not perform as well (Fuss and Theodorakopoulos, 2018).

Innovation and use of new technologies (ICT) are vectors of productivity gains, both directly, for the company that generates them, and indirectly, in benefiting from spillover effects from an innovative environment (Hall *et al.*, 2012, in Skorupinska and Torrent Sellens, 2014). The TFP elasticity of the share of total sales generated by innovations is positive and even greater in the case of a capital-intensive branch or one specialising in high-tech products (Hall, 2011).

The integration of ICT into production should be a major vector for improving productivity. But despite the more intensive development of these technologies, their effects on economic growth are quite hard to identify from a statistical point

of view. This observation, better known as "the Solow paradox" ("You can see the computer age everywhere but in the productivity statistics", Robert Solow, 1987), is recurrent and insists that the decline in productivity growth is concurrent with the development of these new technologies. Since then, a large part of the literature has focused on the effects of new technologies on aggregate growth.

As far as Belgium is concerned, a recent study points up the positive influence of investment in ICT on TFP growth between 2004 and 2013, a period for which the authors have data on this type of investment (Dhyne *et al.*, 2018). According to this research paper, this type of investment may help explain as much as 17 % of the TFP dispersion. The reallocation of IT capital in the Belgian economy has also helped to raise its efficiency over this period. But companies are not all equal when it comes to this type of investment or the resultant profits. The marginal product of IT capital is higher in industry than in services. Besides, large enterprises benefit more from this type of investment.

Next, it appears that staff skill levels and, more broadly, the quality of human capital affects firms' productivity. A skilled workforce is often associated with higher productivity levels (Skorupinska and Torrent Sellens, 2014). Conversely, the integration into the labour market of relatively less-skilled workers, whose productivity is lower, can have a negative effect, although temporary, on aggregate productivity (Walkenhorst *et al.*, 2017).

The general framework in which companies develop will exert some influence on their productivity, too. In particular, laws and regulations have an impact on productivity. It is easy to understand why a high degree of competition should enable the most productive firms to expand their market share ; this is also an incentive for companies to innovate, which can make them more efficient. It has been proved empirically that unfavourable regulations, as measured by the OECD's PMR indicators, can slow down the pace at which the less productive firms catch up with the best-performing countries (Nicoletti and Scarpetta, 2003). A more recent study claims that competition-stifling regulations constrain TFP growth, and especially that of companies near the technological frontier (Bourlès *et al.*, 2013). A lot of analyses generally tend to show that fiercer competition within a branch leads to a rise in its productivity.

Acting in a complementary way, the existence of adequate infrastructure, transport infrastructure for example, is crucial for productivity (Bronzini and Piselli, 2009), since it contributes to efficient allocation of the economy's resources. An analysis devoted to retail trade in the United States in the 1990s argued even back then that an increase in productivity was also determined by the reallocation of resources from less productive establishments towards the most productive ones, notably in companies from the same branch, as well as by firm creation and destruction dynamics (Foster *et al.*, 2006). So, there are several mechanisms through which the economy's efficiency can be improved.

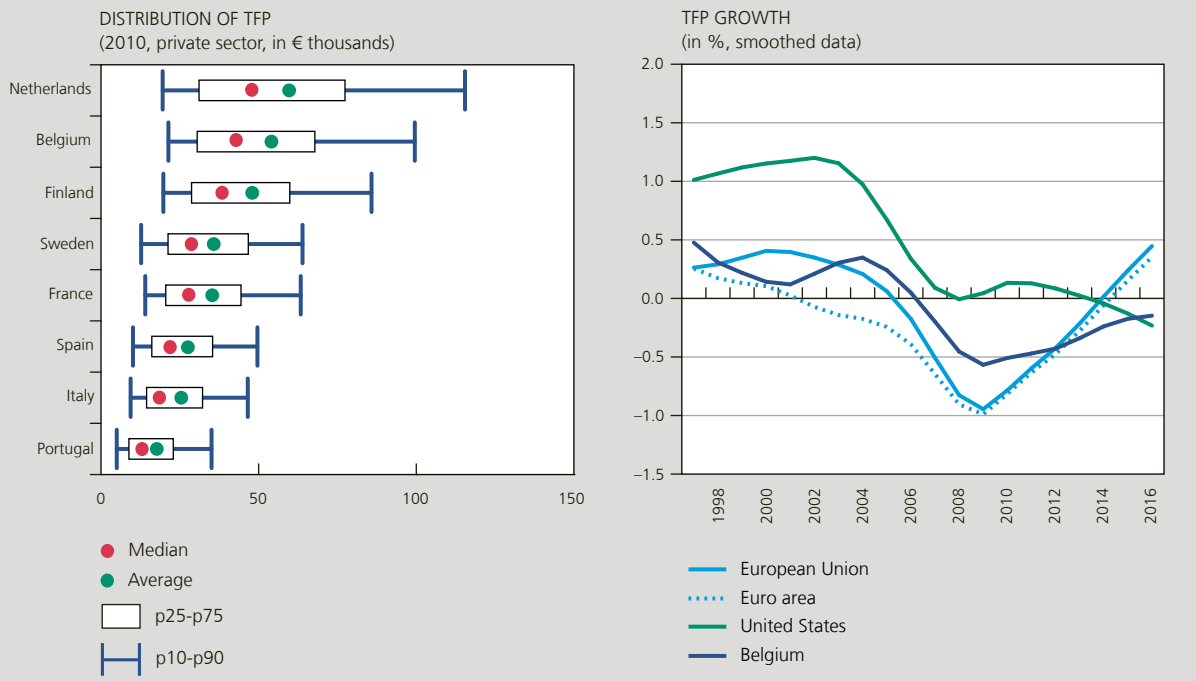
The literature also shows that differences between firms in terms of productivity are relatively persistent over time and higher productivity reduces the probability of firm exit (Farinas and Ruano, 2005). Building up productivity gains over the years is a necessary condition for, but not necessarily enough to ensure, the survival of businesses.

3. International comparison

Data on the distribution of TFP gathered by the CompNet network reveal a high average productivity level among Belgian firms. But they also show that performance varies widely among them. In Belgium, the most productive firms are at the European technological frontier – that is to say, they are the best achievers of their branch of activity at international level – but they sit alongside a large number of companies that perform well below the average for their branch.

Overall, the trend in TFP is quite comparable in Belgium, the EU and the euro area. As early as the end of the 1990s, a slowdown in the trend rate of growth was observed, bottoming out in 2009. When it was at this trough, TFP growth was –1 % in the EU and the euro area and –0.6 % in Belgium. It has been constantly gathering pace since then, but the post-crisis recovery has been less robust in Belgium than on average in the rest of Europe. Since 2012, the growth differential between Belgium and the EU has been constantly widening. According to these figures, TFP growth was even permanently negative in Belgium in 2016, while it wasn't in the European reference zones.

CHART 1 THE MOST PRODUCTIVE BELGIAN FIRMS ARE AMONG THE MOST EFFICIENT IN EUROPE, BUT THERE ARE SIGNS OF A WIDESPREAD SLOWDOWN OF PRODUCTIVITY GROWTH, THAT HAS BEEN MORE MARKED IN BELGIUM



Sources: CompNet, Conference Board.

4. Analysis of Belgian micro data

Aggregate TFP growth can be calculated both on the basis of macroeconomic data and from estimates of productivity at individual firm level, by using microeconomic information disclosed in the annual accounts of companies. It is this approach that will be used in the rest of this article. The sample consists of the annual accounts filed by Belgian firms between 1996 and 2016. In the absence of comparable data for other countries, this analysis is limited to Belgium.

Although the aggregate growth rates obtained using this approach are generally higher than those cited in the last section [(1)], the findings [(2)] confirm the trends pointed up by the macroeconomic data analysis. In line with these data, TFP growth started to slow down well before the financial crisis. It fell back down to its lowest level at the height of the crisis and then started rising again. At the end of the observation period, it was back to its pre-crisis level, but the relatively high growth rate in 2016 was partly due to the exceptionally good performance of a handful of companies that year. This finding will have to be confirmed when data for the year 2017 are available. Nevertheless, on average over the period 2012-2016, TFP growth remained below the average figure recorded between 1997 and 2007.

4.1 Trends by branch and by Region

The available accounting data make it possible to group firms together according to different criteria and thus to measure the performance of certain groups of companies. In this way, the sample of firms can be split up according to branch

(1) The differences between the two approaches arise partly from sampling constraints when estimating a Cobb-Douglas production function using microeconomic data. That means leaving out a series of observations for technical reasons (missing employment figures, negative value added, etc.), while for macroeconomic estimates, these data left out of the micro analysis are absorbed into the aggregate series. The macroeconomic estimates also cover the contribution of other branches of the economy (like the public sector) which have been excluded from the micro analysis.

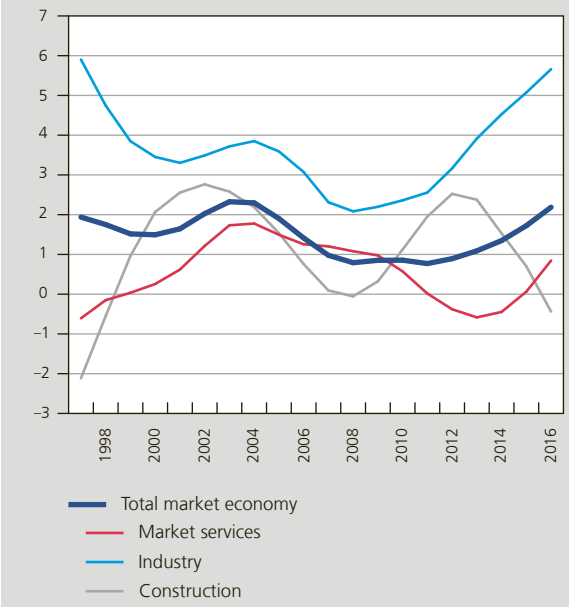
(2) These are smoothed results, given that aggregate growth calculated on the basis of micro data presents a much more volatile profile than the macroeconomic estimates.

of activity. For methodological reasons, observations on firms that have changed branch of activity (defined at NACE 64 level) have been excluded from the analysis for the year in which the change was made.

The slowdown of the productivity growth rate, which could already be observed before the crisis, turns out to be a widespread phenomenon for all branches. This has in fact been noted since 2003 in construction and since 2005 in industry and in market services, the slowdown of productivity growth in this latter branch continued up until 2013. The recovery that emerged at the end of the period will have to be confirmed later.

CHART 2 TFP GROWTH IS HIGHER IN INDUSTRY THAN IN MARKET SERVICES

(TFP growth in %, smoothed data, NACE branches 10 to 82)



Source : NBB.

It is also worth noting that the TFP growth rate in industry is above that of market services and construction for the whole period under review. Industrial firms seem to be capable of improving their production processes more easily than services companies, whose sources of internal productivity growth are traditionally more limited. Similar results were put forward in a study from the Federal Planning Bureau (Kegels and Biatour, 2017), which underlines the high productivity growth rates[1] in industry between 2000 and 2015, and in particular during the post-crisis period. This analysis shows that, on average between 2000 and 2015, the productivity growth rate in industry was more than three times higher than that in market services. These structural differences in productivity growth thus imply that the shift towards the tertiarisation of the economy, which raises the share of services in the total economy to the detriment of industry, weighs down on aggregate TFP growth.

The data also enable a regional analysis of TFP growth to be made. To this end, each firm is associated with a Region on the basis of the last available location[2] of their head office. These findings should nevertheless be interpreted with great caution, given that a very large number of firms set up their head office in Brussels because of its status as a capital Region, without necessarily conducting most of their business there.

(1) In this study, the productivity concept used was apparent labour productivity.
(2) In this way, problems stemming from a firm moving from one Region to another can be avoided.

The breakdown by Region indicates that, in the productivity stakes, Flanders seems to be more rapidly affected by the economic climate than Wallonia. So, the post-crisis recovery began sooner in Flanders (from 2010) than in Wallonia (from 2012 on). Despite this lag of about two years, TFP growth has been quite comparable between these two Regions since 1997.

Productivity growth appears to be relatively less dynamic in the Brussels-Capital Region than in the other two Regions. This can be explained by the predominance of market services in this Region, together with generally negative productivity growth in this branch in recent years.

4.2 Breakdown of productivity growth

Within the same branch or Region, the sources of TFP growth can be very different. More precisely, two sources can be identified.

The first one, referred to as internal growth, consists of an intrinsic rise in productivity within the firm. This dimension captures all decisions taken by the company with a view to boosting its productive efficiency, by improving existing production processes or by developing new processes, by improving the intrinsic quality of its inputs, etc.

The second, called external growth or reallocation of resources, covers all changes in productivity following a transfer of factors of production between firms. It captures the fact that an optimum allocation of resources implies transferring factors of production from less productive firms to more productive ones. So, the best firms can expand while the not-so-good ones shrink, leading to a pick-up of productivity at aggregate level.

This second dimension can itself be broken down into three sub-dimensions:

- intrasectoral reallocation: this is the effect of transferring resources within a branch of activity on aggregate productivity. In order to make a positive contribution to aggregate TFP growth, the most efficient firms in the branch in question need to see their market share increase in comparison to the shares held by their less productive direct domestic competitors.
- entry of new firms/exit of existing firms: to contribute positively to aggregate TFP growth, the new entrants to a branch of activity must be more productive than the average for the firms already there. Likewise, the exit of firms that are less efficient than the average raises their branch of activity's productivity.
- intersectoral reallocation: this is the effect of transferring resources between two branches of the economy. In this case, in order to contribute positively to aggregate TFP growth, this transfer must be in favour of the most efficient branches, i.e. the relative share of more productive branches must rise.

For this analysis, four sub-periods have been determined (namely 1997-2004, 2005-2007, 2008-2011 and 2012-2016), and the contribution of different sources de growth has been calculated for each of these sub-periods. For the sake of clarity of the results, only the sum of the three components of the second dimension is given.

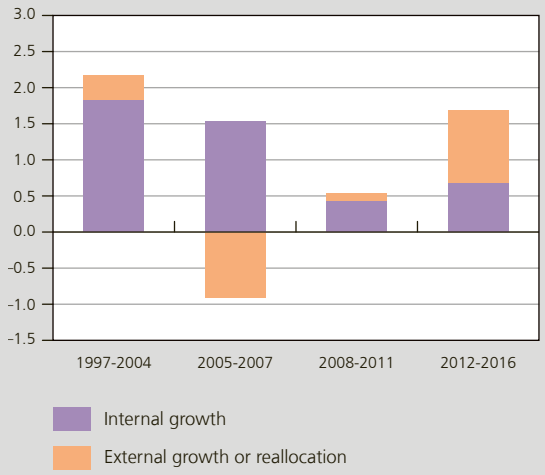
For the major part of the period analysed, the internal component of aggregate productivity growth was the biggest. But its contribution shrank regularly between the first and third observation sub-periods, thus contributing to the decline in aggregate growth before the recession. Between 2008 and 2011, it was roughly four times lower than the level recorded between 1997 and 2004, and it only picked up very slightly at the end of the period. It should nevertheless be noted that the contribution from internal growth has always been positive since 1997.

As for the contribution from the external growth dimension, or reallocation, this is largely attributable to resource reallocation, given that external growth has only a marginal influence on aggregate TFP growth because firm creation and destruction is poorly developed in Belgium.

The source of the slowdown of TFP growth in the immediate pre-crisis period therefore lay mainly in the negative contribution from resource reallocation. Throughout this period, intra- and intersectoral redistributions were both unfavourable. By contrast, during the crisis period, resource reallocation contributed only very modestly to TFP growth; but the contribution from intersectoral redistribution at the time was still negative.

CHART 3 RESOURCE REALLOCATION HAS MADE THE MAIN CONTRIBUTION TO TFP GROWTH IN RECENT YEARS, LARGELY BECAUSE OF A BETTER ALLOCATION OF RESOURCES IN INDUSTRY

(contribution to TFP growth, percentage points, NACE branches 10 to 82)



Source : NBB.

Resource reallocation contributed significantly to the pick-up in growth noted at the end of the period, principally through a better reallocation of intrasectoral resources. So, from 2008, the redistribution of resources within individual branches was on the whole conductive to productivity growth, unlike redistributions between branches (which very often reflect the transfer of resources from the industrial sector to services branches). This positive contribution from a better allocation of intra-branch resources partly reflects some rationalisation of the domestic production network during the recession, which mainly affected the most fragile firms in each branch, an effect that continued after the crisis.

When the sources of growth are split up according to branch of activity, resource reallocation dynamics in industry and market services turn out to be quite different. Since the recession, and more particularly from 2012 onwards, the reallocation of resources towards services has made a very small contribution to TFP growth. Conversely, in industry, the contribution of resource reallocation has been strongly positive since 2012 ; it is even the aspect that has put the most into TFP growth in recent years.

This problem of reallocation in market services is even more acute because the sources of internal growth here prove to be more limited than in industry. Between 2012 and 2016, for example, internal growth was still almost four and a half times lower in market services than in industry. This differential reflects the greater difficulty that services firms have in radically overhauling their processes. However, internal growth in market services companies has shored up aggregate productivity growth across all the periods under review.

4.3 Technological frontier

As already pointed out, productivity gains are not shared out evenly between companies. Firms close to the European technological frontier co-exist with a large number of companies with much lower performance records. Beyond this gap in terms of performance level, it is useful to compare the performance of these two groups of firms in terms of TFP trends.

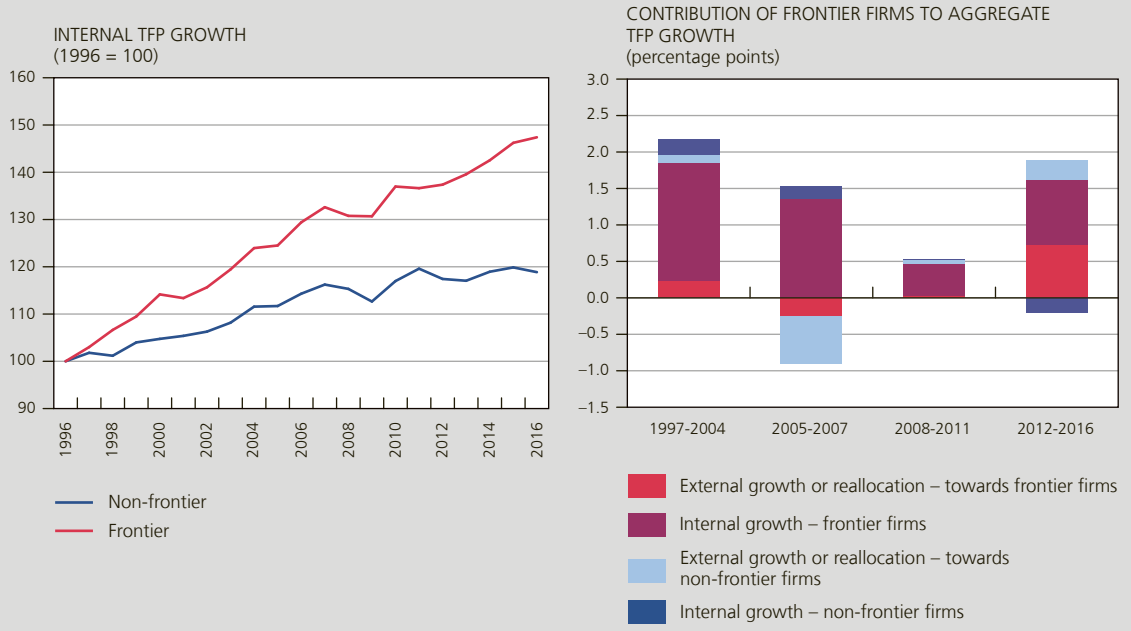
In an optimally functioning economy, firms lagging behind technologically are encouraged to innovate in order to catch up or even overtake the leaders in a branch of activity. If they don't, this lag gets worse over time, and they end up closing down, as their efficiency levels are too low for them to survive in the face of competition from the best firms.

Technological diffusion should therefore enable firms with a technological handicap to close the gap between their position and the efficiency frontier, by accumulating more productivity gains.

To test this, the sample was split into two sub-groups: on the one hand, the group of "frontier firms" and, on the other hand, that of firms lagging behind technologically or "non-frontier" firms. Frontier firms from year *t* represent all firms whose productivity levels are above the 90th percentile of their branch's TFP distribution (at NACE 64 level) for at least year *t* and year *t-1*.

Instead of observing a technological diffusion phenomenon enabling firms lagging behind to catch up with frontier firms, since 1996, on the contrary, the growth performance of the two groups has gradually widened the gap between them. Between 1996 and 2016, TFP growth was almost 29 percentage points higher in frontier firms than in non-frontier firms. This technological disconnect is particularly pronounced in industry.

CHART 4 THE PRODUCTIVITY GAP BETWEEN FIRMS AT THE TECHNOLOGICAL FRONTIER(1) AND THOSE LAGGING BEHIND HAS WIDENED CONSTANTLY SINCE 1996, WHILE THE REALLOCATION OF RESOURCES TOWARDS FIRMS AT THE TECHNOLOGICAL FRONTIER AND THEIR INTERNAL GROWTH HAVE MADE THE MAIN CONTRIBUTIONS TO TFP GROWTH



Source: NBB.
(1) The frontier firm category covers all firms recording productivity levels above the 90th percentile of the TFP distribution for their sector for at least two consecutive years.

The contribution from firms situated at the technological frontier is so big that it offers an almost full explanation for aggregate performance. This contribution is not just the fruit of these firms' internal growth, but also stems from the wider reallocation of resources from non-frontier firms towards frontier firms. This component has been extremely important during the post-crisis period.

A large proportion of frontier firms belong to a foreign group. On average over the period 2010-2015, 11 % of frontier firms were subsidiaries of foreign companies, compared with barely 0.6 % of non-frontier firms(1). Subsidiaries of international groups are therefore over-represented in the most productive segments of the economy. They also play a major role in aggregate productivity growth: on average, 80 % the contribution made by frontier firms to TFP growth (whether positive or negative) comes from foreign frontier firms alone.

(1) The share of subsidiaries of international groups among all firms in Belgium came to 1.6 %.

4.4 Zombie firms

Unlike frontier firms, so-called 'zombie' firms cannot be expected to put up a good performance. According to the OECD, these are companies that have existed for at least ten years and whose operating profits have amounted to less than their financial expenses for at least three consecutive years. These enterprises, which therefore struggle to pay their interest charges, but which nevertheless manage to stay in business, account for no less than 10 % of all firms in Belgium. This percentage, particularly high when compared with that observed in other European countries (according to the OECD, 2 % in France and 3 % in the Nordic countries in 2013), turns out to be quite stable over time. Despite their precarious financial situation, these companies take up a significant part of the resources available in the economy. In the sample of companies used containing data for the period running from 1996 to 2016, these enterprises monopolise around 13 % of total employment and 19 % of the capital available in the economy.

However, this group of firms is very varied : it also includes companies that have good qualities (for instance, some of them are active in international trade, have a high level of human capital or intangible capital, are close to the efficiency frontier, etc.). But, on average, they employ relatively fewer highly-skilled staff (i.e. holders of higher education qualifications) and are less intangible-capital-intensive than non-zombie firms.

TABLE 1 ZOMBIE FIRMS MAKE UP A VERY HETEROGENEOUS GROUP, WITH BOTH GOOD AND BAD FEATURES

	Zombie firms	Other firms
In % of importing firms	26.7	19.4
In % of exporting firms	20.7	14.3
Average % of highly-skilled in total employment (if they employ any)	41.5	49.0
Intangible capital intensity (in € per employee expressed in FTE)	4 741	6 165

Source : NBB.

The estimates of TFP levels show that the average technological handicap between zombie and non-zombie firms is as much as 41 %, after controlling for a set of observed characteristics. It is particularly high for small zombie firms, given that, when weighting companies by their share in total employment, the productivity gap comes down to 11 %, which suggests that the largest zombie firms' performance is closer to that of non-zombies of comparable size. It further appears that 76 % of all zombie firms have never been frontier firms. Likewise, zombie firms suffer from a TFP growth handicap of around 1.8 percentage points in industry and about 1.4 percentage points in market services.

All this begs the question whether it is worthwhile these firms continuing to trade in the Belgian economy without radical restructuring efforts. By mobilising a large share of the resources, companies in poor financial health (which moreover tend to keep the status of zombie firm for a long time) hamper the reallocation of resources towards other firms (from the same branch of activity or other branches). What is more, as they are not confronted with technological progress, workers in these firms suffer from gradual deskilling, which in turn reduces their employability in the medium term.

But caution is the watchword here. Zombie status is not systematically a sign of poor productive efficiency or of a technological lag. This status is solely a reflection of financial variables, so it can for instance apply to firms operating within complex group structures for internal organisational reasons without there being any question of inefficiency or long-term financial fragility.

However, most of these zombie firms record low TFP (growth). Their presence – which, as already mentioned, is greater in Belgium than elsewhere – thus weighs down the aggregate productivity trend, and consequently the growth potential

too. As a result, it could be beneficial for the Belgian economy to reduce the number of zombie firms. There are two possible ways of doing this. On the one hand, these zombie firms can close down, which would enable their factors of production to be allocated elsewhere in the economy. On the other hand, they can restructure with a view to becoming economically viable again.

With a view to estimating the impact, in terms of productivity, of the closure or restructuring of part of these zombie firms, notably those whose performance is below the average for their branch of activity, two simulation exercises were conducted. For that purpose, one sub-group of firms was isolated from the sample. More precisely, these are companies that do not belong to a group, which have been zombies all the time from 2014 to 2016 (meaning that, for five years, their operating profits did not cover their financial expenses), and whose productivity in 2016 was below the average for their branch.

This group comprises 1 250 companies and accounts for 10 % of all zombie firms in 2016. Total employment in this group is 5 845 FTEs. Two scenarios were envisaged : the first involves purely and simply taking these firms out of the sample in 2016 and thus simulates their closure at the end of 2015, while the second involves cancelling out the productivity gap with the average for their branch in 2016.

The analysis reveals that the exit/restructuring of these firms would have inflated TFP growth by 0.1 to 0.2 of a percentage point in 2016. This increase may be considered as a minimum threshold, as it does not take account of the potential effects of redistributing resources among firms. This exercise thus confirms that the closure or restructuring of some zombie firms can have a positive effect on the aggregate productivity of the economy.

4.5 Portrait of productive firms and internal growth levers

Having flagged up the contributions that some sub-populations of firms have made to aggregate TFP growth, attention can now be turned to a range of conditions driving the increase in productivity levels. These include integration into world trade networks and investment in know-how, subjects on which the Bank's own databases provide some information. As there were no observations or not good enough quality records about the skills level of the labour force for the whole sample, the productivity determinant analysis period has been limited to the years 2007 to 2016.

First of all, it appears that there is a link between the company's age and its productivity. Since productivity levels are an important precondition for long-term survival, the group of firms aged over ten years should be relatively more productive than the group of younger firms (selection effect).

Among the companies that are less than five years old, it is the gazelles (i.e. young high-growth firms) that are estimated to have the highest level of productivity, ahead of young medium- or low-growth enterprises. This conclusion is quite obvious, given that the sample of young firms has been broken down largely on the basis of growth in their value added, which is logically reflected in high productivity. Since gazelles only account for around 3.5 % of all young firms (De Mulder *et al.*, 2017), the entire group of young firms should generally tend to post a lower level of productivity than the other two groups of more mature firms.

A high level of productivity would make it possible for a firm to trade directly with the rest of the world. In comparison with companies that neither import nor export, the level of productivity of importing or exporting firms would be respectively, 39 % and 10 % greater. Moreover, importing and exporting at the same time is something that is associated with an even higher level of productivity.

As mentioned in section 2, the existing literature is relatively divided as to the causality of the relationship. While there is a general consensus on the need to reach a certain level of productivity to get involved in trade, there is no clear evidence of any feedback effect from involvement in international trade, and especially in export, on productivity levels (learning by exporting). Earlier research work using Belgian data has generally not revealed any such effects.

Researchers nevertheless agree on the fact that diversifying sources of supply of material inputs by importing from several countries improves companies' performance. The multiplication of sources of supply would enable importing firms to benefit from the best inputs possible, which would boost their productive performance. In our sample, increasing the

TABLE 2 DETERMINANTS OF FIRMS' PRODUCTIVITY
(period 2007-2016)

Explanatory variables	Coefficients[1]	Standard deviation
Age (compared with firms at least 10 years old)		
Between five and ten years	–0.181***	(0.002)
Less than 5 years – Low growth[2]	–0.199***	(0.004)
Less than 5 years – Moderate growth[3]	–0.039***	(0.009)
Less than 5 years – High growth (gazelles)[4]	0.211***	(0.010)
Place in international trade[5] (compared with firms that neither import nor export)		
Exporting firms	0.104***	(0.010)
Importing firms	0.393***	(0.015)
Exporting and importing firms	0.316***	(0.016)
Intangible capital intensity	0.020***	(0.000)
Higher education (in % of total employment)	0.302***	(0.003)
Annual binary variables	Yes	
Sectoral binary variables	Yes	
R^2	0.3596	
Number of observations	859 125	

Source : NBB.
(1) A positive coefficient indicates a relatively higher productivity level than that of the reference group. All the coefficients mentioned are significant at the threshold of 1 % (indicated by ***).
(2) Firms which have registered average annualised growth of employment or turnover below 10 % over at least three consecutive years during their first five years in business.
(3) Firms which have registered average annualised growth of employment or turnover between 10 and 20 % over at least three consecutive years during their first five years in business.
(4) Firms which have registered average annualised growth of employment or turnover of at least 20 % over at least three consecutive years during their first five years in business.
(5) As individual figures for international trade in services are only available for a very small sample of firms, unlike data on trade in goods, the analysis of the relationship between productivity and international trade has been limited to manufacturing firms.

number of importing countries is actually favourable (raising the number of source countries by 1 % would push up productivity by 2 %).

Furthermore, the quality of human capital would also have an impact on firms' efficiency. The multivariate analysis reveals that, on average, when the proportion of highly-skilled jobs (workers with higher education qualifications) in total employment is raised by 1 percentage point, the productivity level goes up by 0.3 %.

Lastly, making more intensive use of intangible capital would boost the efficiency of firms, both in industry and market services. Intangible capital covers the whole range of development costs, concessions, patents and licences, know-how and goodwill. It can therefore be considered as a proxy for a firm's innovation level.

Conclusion

The analyses made as part of this study have led to some interesting findings about the trend in productivity in Belgium over the last 20 years.

Belgian firms are still among the most efficient in Europe. However, this positive element should not conceal the very wide heterogeneity among the population of Belgian companies. All the advanced economies, including Belgium, have seen a general slowdown in productivity growth since the start of the 2000s. But it has been more pronounced in Belgium than in the EU.

Over the period under analysis, TFP growth was higher in industry than in market services, which, given the shift in economic activity towards the services sector, weighs on aggregate productivity growth. Revitalising the economic fabric in that sector could therefore prompt a reallocation of resources more favourable to growth.

Moreover, it appears that productivity gains are almost entirely attributable to firms at the technological frontier, so they turn out to be very unequally distributed across the Belgian economy. Technological diffusion is inadequate.

So, what can be done to boost growth ? The wide variations in the performance of individual firms show that there is no single blueprint for generating high productivity levels. There are many factors which may influence a firm's efficiency, whether they be firm-specific or macroeconomic.

First of all, firms need to make use of all the internal growth levers. For example, apart from the aspects listed above, firms may become more efficient by investing in staff training (Konings and Vanormelingen, 2011). Greater integration in the domestic production network, particularly by outsourcing secondary tasks such as support activities, may similarly help to enhance productivity (Dhyne and Duprez, 2017). Setting up best managerial practices can likewise be a major source of productivity growth.

There are also other ways of boosting productivity : stimulating entrepreneurship, and especially the entry of new, high-potential firms and the exit of less efficient firms, is relevant to improving productivity. That is particularly important for market services, where there is less scope for internal growth.

Secondly, an appropriate regulatory framework is also important for facilitating the entry of potential competitors or the exit of inefficient firms, as well as to enable existing firms to develop and put in place favourable conditions for enhancing efficiency. More competition can be an additional incentive to innovate too, with a view to maintaining efficiency levels.

Overall, Belgium needs to keep its appeal, from an international point of view, in order to attract as much foreign direct investment as possible, a factor driving the spread of technology. High-quality infrastructure contributes to this attraction while enabling a more efficient allocation of resources within the Belgian economy. Likewise, efficient health care and education systems, guaranteeing a quality and healthy workforce, are still vital assets for the sustainable development of our economy. Last but not least, greater technological diffusion is the best guarantee of our long-term prosperity by avoiding polarisation of our society. All these various levers will have to be used simultaneously and in a complementary way to boost productivity and to keep Belgian firms at the forefront of the European business world.

Methodology

1. Data used

For the 1996-2016 period, the database provides data on Belgian companies that file annual accounts with the National Bank of Belgium (NBB). These were combined with information gleaned from VAT returns and figures for foreign trade (both imports and exports).

The basic annual account data do not always reflect a full calendar year and have been annualised where needed to arrive at data that capture the twelve-month period from 1 January up to and including 31 December, making them comparable between companies and from one year to the next. Where the time series was incomplete, a linear interpolation was carried out if the missing period did not exceed two years.

Our analysis focuses on private sector companies and has ignored NACE sectors 84 through 99 (non-market services). Other companies left out of the equation because of their special characteristics included those in sectors 01-03 (agriculture, forestry and fisheries), 05-09 (extractive sectors) and 64 (financial services). Too few observations made it impossible to arrive at sufficiently accurate total factor productivity (TFP) estimates for sectors 19 (coking and refining), 36 (water collection, treatment and distribution), 51 (air transport) and 65 (insurance) and these sectors were therefore also stripped out.

In addition, our analysis ignored observations related to companies that switched sectors in the NACE 64 classification, effective from the year of the switch. As noted above, the methodology involved applying a logarithm to the variables, and as logarithms can only be based on strictly positive values, the analysis also excluded observations with added values that were negative or nil, or where the workforce in FTEs was nil.

The adjustments required to estimate TFP at the level of individual companies also impact the broader economy's TFP. Whereas macroeconomic TFP estimates calculate the total added value (or employment) of all companies – i.e. also factor in negative or nil values – microeconomic TFP estimates do not, making for a slight overestimate in the case of the latter. And of course, ignoring certain sectors may also affect the aggregate TFP.

2. Estimating total factor productivity (TFP)

Total factor productivity (TFP) is a general measure of the efficiency of the economic production process. More specifically, TFP reflects how efficiently a number of production factors, such as labour and capital (equipment), are used to arrive at production. This measure may be calculated for the economy at large as well as for regions, sectors, groups of companies or individual companies.

Contrary to labour productivity, for instance, which can be calculated directly as the relationship between the added value achieved relative to the labour input – i.e. the number of workers or hours worked – TFP is not easily determined. Economic analyses typically calculate a production function, to which TFP is added. That is also the case in this article, which uses a Cobb-Douglas production function. For an individual company i operating in sector j in year t, the production function looks as follows:

$$Y_{it} = L_{it}^{a_j} . K_{it}^{b_j} . TFP_{it} \qquad (1)$$

Where Y = the added value (at constant prices)
L = labour input (number of hours worked or employment in FTEs)
K = capital input (capital stock, at constant prices)
a and b = output elasticity of labour and capital

A logarithm applied to this function renders the following linear equation for constructing the econometric estimate:

$$ln\,(Y_{it}) = a_j . ln\,(L_{it}) + b_j . ln\,(K_{it}) + ln\,(TFP_{it}) \qquad (2)$$

Data from company accounts make up Y_{it}, L_{it} and K_{it}. These data concern the added value (code 9800), the workforce in FTEs (code 9087) and the capital stock (codes 20-28) respectively. Added value and capital stock, which are reported in annual accounts at current prices, are deflated by the added value and the fixed capital formation respectively, available at sector level in the national accounts.

To arrive at an estimate of coefficients a_j and b_j, we use the instrumental variables method, an economic technique enabling a better estimate of the precise contribution of the various production factors. After all, the use of production factors labour and capital may also be linked to how efficient the production process is (in that case, the 'explanatory' factors on the right of the equation are connected to one another), which might distort the outcome of an estimate based on a simpler method (such as ordinary least squares).

As soon as a_j and b_j have been estimated (for all sectors and the entire period under review), TFP for each individual company is calculated as the residual of the equation below, derived from a rearrangement of equation (2):

$$ln\,(TFP_{it}) = ln\,(Y_{it}) - a_j \,.\, ln\,(L_{it}) - b_j \,.\, ln\,(K_{it}) \qquad (3)$$

For the individual TFP numbers so derived, we can calculate annual growth, which is then aggregated at, for instance, the level of groups of companies, sectors, regions, or the economy at large. To do so, we use as a weighting factor the share of each company in total added value.

3. Breaking down TFP growth

The year-on-year TFP change for the economy at large can be broken down into internal growth contributions on the one hand and external growth or reallocation change on the other (see for example Van Beveren and Vanormelingen, 2014). Internal growth reflects the more efficient use of production factors within an existing company; external growth is about productivity trends related to starting new companies and the closure of existing ones. Reallocation reflects the impact of shifts in production factors between existing companies, where an additional distinction can be made between companies in the same sector and shifts between sectors.

This can be captured as follows:

$$\begin{aligned}
\Delta\, PTF_t = & \sum_S \overline{w}_{St} \,.\, \sum_{i\in S, i\in C} \overline{w}_{it} \Delta p_{it} && \text{(internal growth)} \\
& + \sum_S \overline{w}_{St} \,.\, \sum_{i\in S, i\in C} \Delta w_{it} \,(\overline{p}_{it} - \overline{p}_{St}) && \text{(intrasectoral reallocation)} \\
& + \sum_S \Delta w_{St} \,.\, (\overline{p}_{St} - \overline{p}_t) && \text{(intrasectoral reallocation)} \\
& + \sum_S \overline{w}_{St} \,.\, \sum_{i\in S, i\in E} w_{it} \,(p_{it} - \overline{p}_{St}) && \text{(entry of new companies)} \\
& - \sum_S \overline{w}_{St-1} \,.\, \sum_{i\in S, i\in X} w_{it-1} \,(p_{it-1} - \overline{p}_{St-1}) && \text{(closure of existing companies)}
\end{aligned}$$

Where wi = the share of company i in the added value of sector S
w_S = the share of sector S in total added value
p_i, p_S = TFP of company i and sector S respectively
C, E and X = existing companies that continue their activities, new companies and existing companies that have closed
Δ = the change between year *t-1* and year *t*
$\overline{\ }$ = the average value for year *t* and year *t-1*

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