Special Analysis

Slowdown in labour productivity and forecasting employment in France

Mikael Beatriz
Département de la conjoncture

Anis Marrakchi
Sophie De Waroquier de Puel Parlan
Département de l'emploi et des revenus d'activité

From the beginning of the 1990s to the 2008-2009 crisis, labour productivity in France increased steadily, by around 1.3% per year. It then experienced an unprecedented fall during the crisis, losing 2.6% compared with its previous trend. From 2010, productivity started to grow once again, although at a slower pace than pre-crisis.

Labour productivity is linked to many factors. Traditionally, economic analysis has focused on the role of capital, which is complementary to the labour factor in the production process, and that of "total factor productivity", which describes how capital and labour contribute to production.

Many explanations have been put forward in the theoretical literature to attempt to account for the slowdown in labour productivity observed recently: a slump in investment and hence in the amount of capital due to the crisis, less efficient allocation of factors of production (capital and labour) between branches of activity or between enterprises, change in labour quality, etc.

An accounting breakdown of labour productivity gains, differentiating inter-branch and intra-branch contributions linked with capital and employment, identifies the determining factors of the slowdown in productivity post-crisis.

Average growth in labour productivity dropped from 1.3% per year for the 1990-2007 period to 0.9% during the 2010-2016 period. A less efficient capital allocation between branches post-crisis would probably be responsible for 0.2 points in this slowdown in labour productivity. A lower capital intensity would make a more moderate contribution to the slowdown, of around 0.1 points. The allocation of labour, on the other hand, appears not to play any part. Finally, total factor productivity appears to contribute 0.2 points to the slowdown, i.e. a significant contribution to the decline in pace.

Until now, the model used to forecast employment in the short term was based on a linear productivity trend, but this has now been challenged as a result of post-crisis developments. A new model has been built, using as a basis the previous accounting breakdown. The aim is to explain the slowdown in labour productivity in the long term by capital destruction both during and after the crisis, and the decline in efficiency of the reallocation of factors of production. The short-term employment forecast that is possible using this new model appears to be more accurate than with the tools used until now.

This new tool will now be used for forecasting employment in Conjoncture in France. According to the model, employment should increase at a slower pace in 2018 than in 2017 (+203,000 jobs over the year at the end of 2018 against +257,000 in 2017). Apart from employment policies, this slowdown is probably due essentially to the slowdown in value added in the non-agricultural market branches.

Slowdown in labour productivity and forecasting employment in France

The decline in labour productivity disrupts employment forecasts

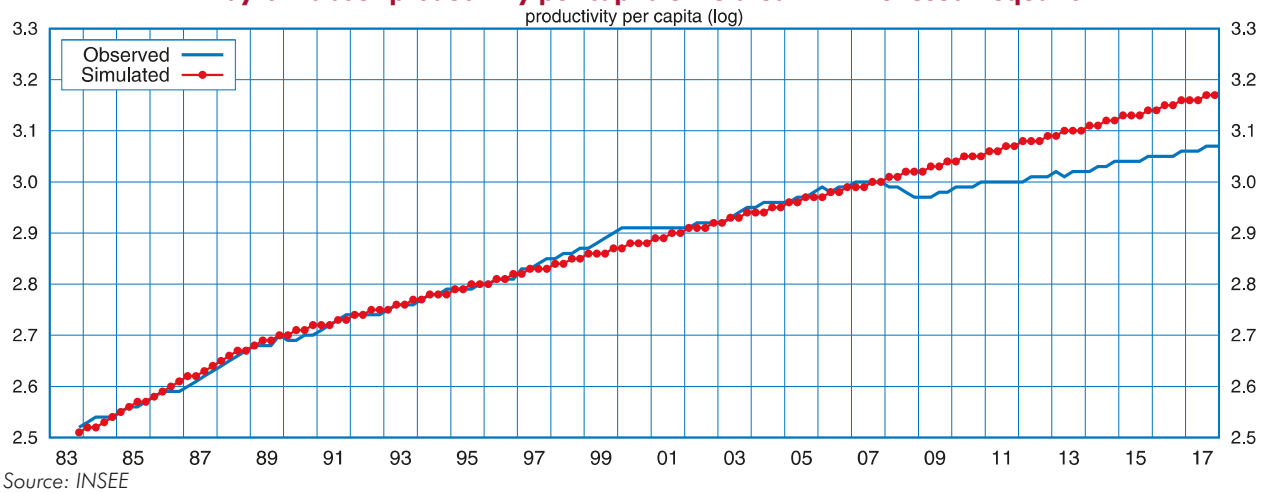
Payroll employment is forecast by estimating its adjustment to its long-term trend

In INSEE's Conjoncture in France, the adjustment of payroll employment to activity is usually modelled by correcting for the effect of employment policies and differentiating between short-term and long-term dynamics (Box 1). In the long term, the focus is on factors that determine per capita labour productivity, defined as the ratio of total value added to the employment of natural persons. Overall, it has increased in a linear fashion, apart for a decline during the 2008-2009 economic crisis. In the short term, the labour productivity cycle around its long-term trend reflects a non-instantaneous adjustment of employment to activity.

The labour productivity cycle is modelled using an error-correction model

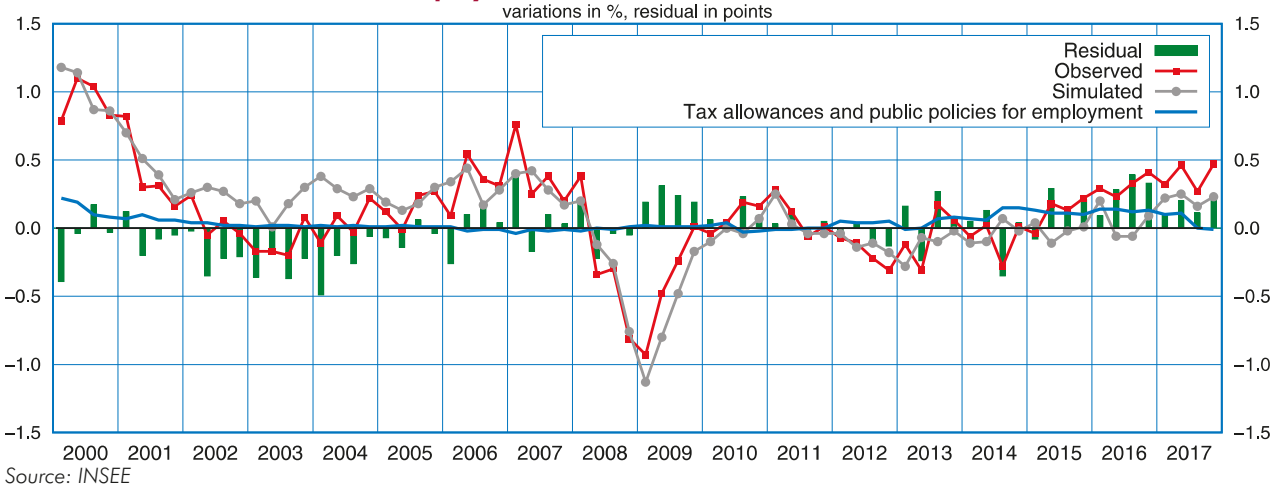
During an economic slowdown or even a recession, companies may need to reduce their production in order to cope with a drop in demand. They usually wait some time before reducing their workforce, for several reasons: uncertainty over the scale of the slowdown, holding onto workforce to avoid losing skills, redundancy costs, labour market legislation, etc. As a result, labour productivity declines temporarily. During periods of economic acceleration or recovery, job creations also lag behind the increase in activity because of uncertainty over the scale of the economic recovery, hiring costs, the time needed to recruit qualified staff, etc. In this case, labour productivity temporarily increases faster than its trend growth.

1 - Payroll labour productivity per capita simulated with the "usual" equation



Source: INSEE

2 - Variations in employment observed and sdimulated in the short term



Source: INSEE

In general, fluctuations in value added are on a bigger scale than fluctuations in employment, since corporate behaviour does not impact on all of these fluctuations immediately. The short-term model adopted shows how labour productivity adjusts gradually to its long-term trend.

Modelling is disrupted by the slowdown in labour productivity since the crisis

The employment equation used until now in *Conjoncture in France*, as described by Passeron and Perez-Duarte (2003) and updated by Argouarc'h *et al.* (2010), cannot easily account for the increase in payroll employment since 2008. The drop in labour productivity during the economic crisis, then its slowdown, disrupted the adjustment of the short-term dynamics to the long-term equation, which does not take into account the change in trend. This then results in a positive and persistent residual, which represents the gap between labour productivity simulated by the long-term equation and labour productivity actually observed (*Graph 1*). By anticipating the extent of these residuals, the "residual compensation" used in this equation was able to avoid excessive short-term forecasting errors (*Graph 2*). The aim of this analysis is to identify the causes of this trend change so that they can be modelled in a new equation.

Box 1 - Current equation for employment in mainly non-agricultural market sectors

The equation normally used to forecast employment in the medium term is an error-correction model which estimates the link between the number of people in employment at the end of the quarter and activity, i.e. the value added. This estimate is done in two stages: a long-term equation that describes the labour productivity trend and a short-term equation that describes the dynamics of employment adjusting to its long-term trend.

The equation includes public policies promoting employment growth

Public policies aimed at improving employment growth and targeting certain categories of workers must be differentiated. The reason is that since they lead to a relative increase in unskilled work, they may bring labour productivity down. The effects of three types of public policy are estimated:

- measures concerning specific audiences: alternance training contracts, exemptions and hiring premiums, etc.;
- measures for a general reduction in the cost of labour, general exemptions from employers' social contributions on low wages and tax credit for encouraging competitiveness and jobs;
- at the end of the 1990s and the beginning of the 2000s, measures to reduce working time which, in some cases increased gains in hourly labour productivity by reorganising work within enterprises and establishments, while still maintaining the current level of production.

These effects are estimated separately on an *ad hoc* basis then subtracted from the employment series used for the error-correction model. The aim is therefore to estimate a labour productivity trend that is independent of policies to improve employment growth. It could be possible to estimate the effect of labour policies on labour costs and working time without constraints, based on macroeconomic data. However, in practice it is difficult to model breaks in trends caused by these labour productivity variables as their effects are highly dependent on the choice of estimation period.

Long-term equation

The long-term equation accounts for the level of labour productivity through a linear trend, and represents the upward trend in labour productivity corrected for the effects on employment estimated previously from public policies (see above). The estimation period extends from Q1 1984 to Q4 2009. More precisely, the long-term equation used until now accounts for the level of employment using the level of value added in the non-agricultural market sectors and a linear elbow-curve trend in 1989 (see Argouarc'h *et al* (2010) for the statistical identification of this break in trend).

The long-term equation is written as follows:

$$\log(va_t) - \log(employment_t - pe_t) = \alpha + \beta trend_t^1 + \gamma.trend_t^2 + \varepsilon_t$$

where:
- *va* is the value added in the NAMS;
- *employment* is the number of employees expressed in natural persons in the NAMS;
- *pe* is the effect of employment policies;
- $trend^1$ and $trend^2$ are productivity gains before and after the break in Q4 1989.

Slowdown in labour productivity and forecasting employment in France

Short-term equation

The short-term equation reflects fluctuations in labour productivity around its long-term trend, i.e. the speed at which employment adjusts to variations in activity. In other words, this second equation seeks to reflect the time lag as employment adapts to fluctuations in activity. As with the long-term equation, the effects attributable to employment policies are imposed in the short-term equation. This equation is estimated as follows:

$$\Delta\log(employment_t - pe_t) = \eta + \lambda_1\Delta\log(employment_{t-1} - pe_{t-1}) + \lambda_2\Delta\log(va_t) + \delta\varepsilon_{t-1} + \xi_t$$

Where: :
- ε_{t-1} is the residual of the long-term relation.
- δ is the pull-back effect of employment towards the long-term relation, i.e. the speed at which employment adjusts to fluctuations in activity. ■

The 2008-2009 economic crisis resulted in a long-term fall in labour productivity

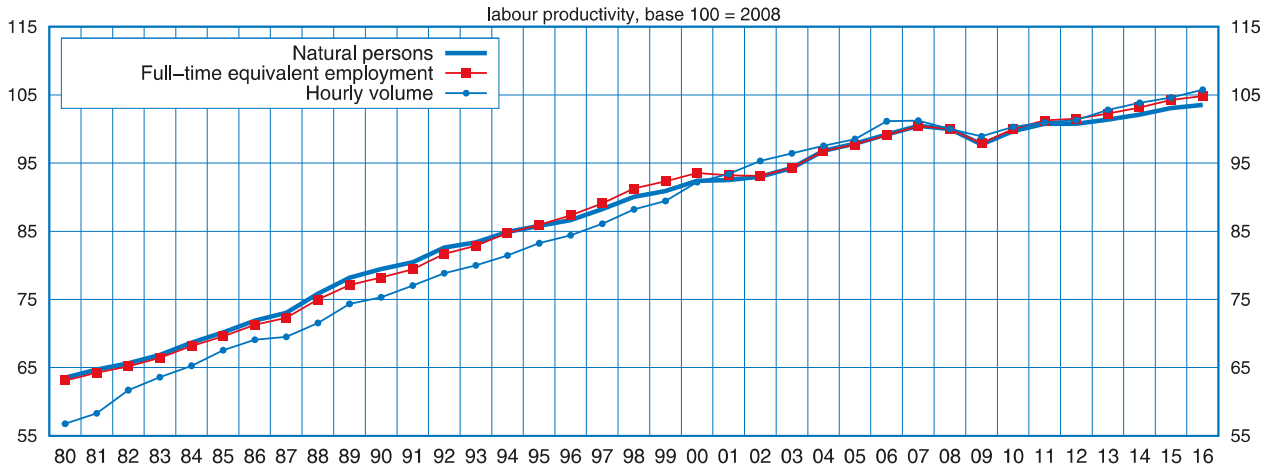
After the crisis, labour productivity slowed

Labour productivity can be defined in several different ways, according to the variable used to measure the labour factor: employment as number of natural persons, employment as people in full-time equivalent employment, or hourly volume. Irrespective of the measure used, labour productivity fell drastically during the 2008-2009 crisis (*Graph 3*), and has not regained its pre-crisis level or growth rate (*Graph 4*): between 1990 and 2007, the average annual labour productivity gain, measured as employment of natural persons, was +1.3%, whereas between 2010 and 2016, it was no more than +0.9%.

Labour productivity tumbled then slowed in all non-agricultural market sectors after the crisis but with different magnitudes.

The sharp fall in labour productivity in 2008-2009 was homogeneous between the different non-agricultural market sectors. Thus the contribution of industry to the change in total labour productivity fell by 1.3 points between 1990-2007 and 2008-2009, whereas the contribution of mainly market services dropped by 0.8 points over the same periods. The construction sector also made a negative contribution to the change in labour productivity and in significant proportions due to a sharp decline in productivity gains (*Table 1*). Post-crisis — over the 2010-2016 period — only industry's contribution to the change in labour productivity decreased significantly compared with the 1990-2007 period. Its contribution dropped by 0.4 points on average after the crisis with an average growth in labour productivity of less than 1.0 point, on average, in the pre-crisis period. Conversely, average growth in labour productivity of mainly market services was relatively stable both before and after the crisis (around 0.8 points). Finally, the contribution of the construction sector to the slowdown was marginal.

3 -Irrespective of the employment measure used, labour productivity within the scope of NAMS fell drastically



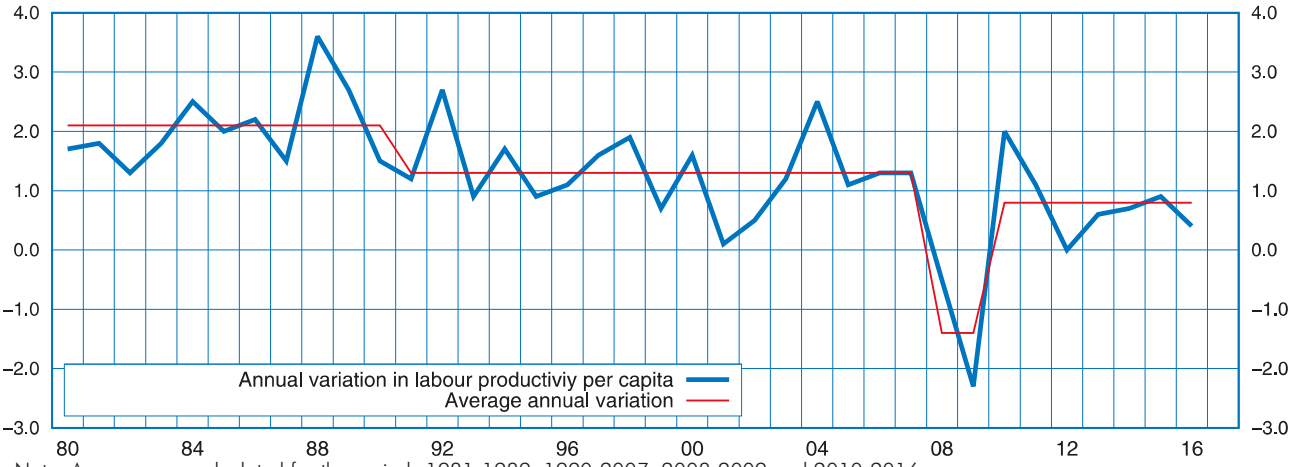
Scope: non-farm market sectors (NFMS)
Source: INSEE

Slowdown in labour productivity and forecasting employment in France

A similar phenomenon in other advanced economies

During the economic crisis, labour productivity also fell in all of Europe's advanced economies (*Graph 5*), with Germany and the United Kingdom experiencing the most severe declines (-5.9% and -3.9% respectively between 2007 and 2009). They did not recover their pre-crisis level until 2011 for Germany and 2014 for the United Kingdom. The Eurozone overall had a similar profile to France, despite a slightly more pronounced drop in productivity than France during the crisis. Lastly, the United States' profile was unusual: although annual labour productivity did not decline during the crisis, it slowed significantly over the 2010-2016 period (+1.0% on average per year against +1.7% on average between 1990 and 2007).

4 - Slowdown in labour productivity per capita after the crisis



Note: Averages are calculated for the periods 1981-1989, 1990-2007, 2008-2009 and 2010-2016.
Source: INSEE

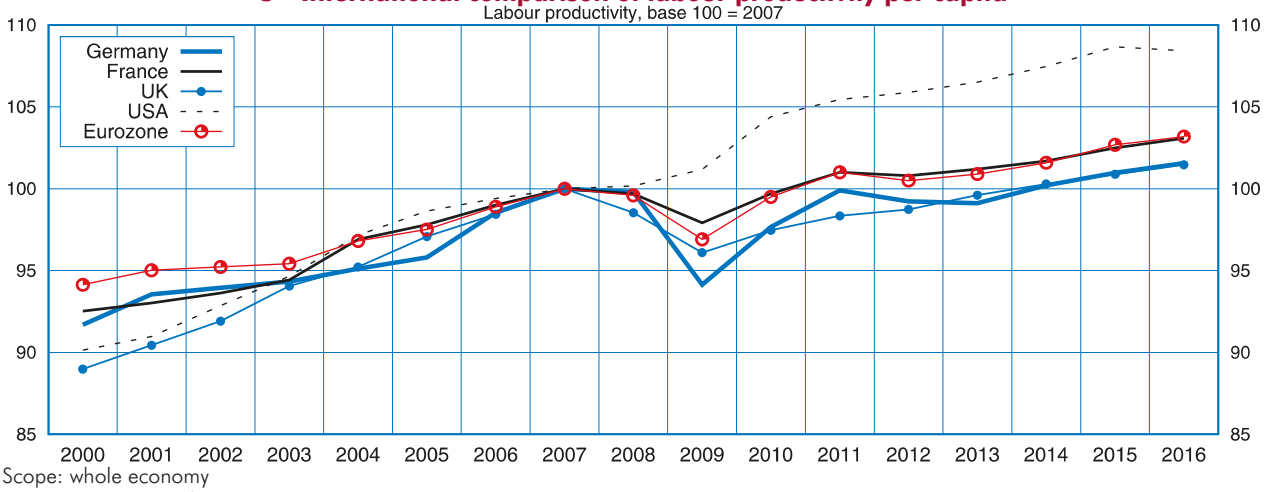
Table 1: Average annual variations in labour productivity and contributions from non-agricultural market sectors

Growth rate in % and contributions in points

	NFMS	Industry		Market services		Construction	
	productivity	*productivity*	*contribution*	*productivity*	*contribution*	*productivity*	*contribution*
1980-1989	2.1	3.3	0.9	1.4	1.0	1.7	0.2
1990-2007	1.3	3.4	0.8	0.8	0.5	0.5	0.1
2008-2009	–1.3	–2.2	–0.5	–0.4	–0.3	–5.1	–0.5
2010-2016	0.9	2.4	0.4	0.7	0.5	–0.9	0.0

N.B. productivities are calculated as the ratio of value-added in volume to internal employment for each sector.
How to read it: during the period 1980-1989, the average annual growth rate in labor productivity was 3.3% in industry . The contribution of this sector to NFMS productivity growth was 0.9 percentage points.
Source: INSEE, national accounts, base 2014

5 - International comparison of labour productivity per capita



Scope: whole economy
Sources: Eurostat and BEA-BLS

Slowdown in labour productivity and forecasting employment in France

A significant rise in the number of self-employed between 2010 and 2013

Throughout this analysis, the change in total employment is addressed, i.e. salaried employment (24.7 million people in France at the end of 2017) and the self-employed (2.9 million). The number of self-employed in the mainly non-farm market sectors (NFMS) has fallen back since the beginning of the 1980s, mainly due to the decline in the number of small shops, but it stabilised at the start of the 2000s. From 2009, the introduction of the "auto-entrepreneur" status in France paved the way for an influx of self-employed people. Whereas between 2000 and 2009 in the mainly non-agricultural market sectors, the number of self-employed increased by an average of only 1.0% per year, between 2010 and 2013 numbers rose by 4.4%, before stabilising between 2014 and 2017 (+0.1% per year). In the national accounts, it is not possible to determine specifically the value added attributable to employees and to the self-employed, and neither is it possible to calculate a figure for employee productivity, to compare with self-employed productivity. Note, however, that on average auto-entrepreneurs declare lower incomes than employees, so the increase in this form of employment may have helped to exacerbate the slowdown in labour productivity observed since the crisis, especially between 2010 and 2013.

Box 2: A theoretical framework to explain the slowdown in labour productivity since the crisis

Using a simple theoretical framework, labour productivity growth can be broken down into its main determinants. We can thus model a two-factor economyusing a production function of the Cobb-Douglas type with constant returns to scale,i.e. $\alpha_K + \alpha_L = 1$:

$$Y_t = A_t (S_{t,K})^{\alpha_K} (S_{t,L})^{\alpha_L}$$

where $S_{t,L} = Q_t^L L_t$ is labour services, or the product of a labour quality index and the number of jobs. Similarly, $S_{t_K} = Q_t^K K_t$, represents capital services, or the product of a capital quality index and capital stock. With these indices the structural effects of capital and labour can be assessed: capital (or labour) structure is deformed in favour of sectors with a greater marginal productivity of capital (or labour). In other words, they represent a measurement of capital allocation between branches. An increase in factor quality means that this factor is correctly allocatedto the branches where marginal productivityof this factor is stronger than elsewhere. Finally, A_t is the total factor productivity (TFP), also called the *Solow residual*. Thus total factor productivity incorporates a large number of phenomena: technological progress, competition, logistics, public infrastructure, climate, etc. This can be summarised as everything thatenables production to increase, assuming equal quantities and quality of labour and capital.
Moving on to logarithmic differentiation, the rate of total factor productivity growth is written thus:

$$\Delta \log A_t = \Delta \log Y_t - \alpha_K (\Delta \log(Q_t^K) + \Delta \log(K_t)) - \alpha_L (\Delta \log(Q_t^L) + \Delta \log(L_t))$$

where α_K and α_L are constants determined by the production processand are equal to the respective shares paid for thecapital and labour factors in the value addedif these factors areremunerated at their marginal cost and if companies maximise their profit under demand constraints. We can then break down therate ofapparent labour productivity growth, i.e. the growth rate of the ratio: $y = \frac{Y}{L}$:

$$\Delta \log(Y_t / L_t) = \Delta \log Y_t - \Delta \log L_t$$

$$= \underbrace{\alpha_K \Delta \log(K_t / L_t)}_{Capital} + \underbrace{\alpha_K \Delta \log(Q_t^K)}_{Capital\_reallocation}$$

$$+ \underbrace{\alpha_L \Delta \log(Q_t^L)}_{Labour\_reallocation} + \underbrace{\Delta \log A_t}_{TFPgrowth}$$

In order to calculate growth in the quality of labour and capital, it is assumed that capital services, measuring the instantaneous contribution (hence a flux) ofproductive capital to the growth of value added,are proportional to the stock offixed capital at a sufficiently detailed level of capital breakdown so that thebasic assets of which it is composed have their own marginal productivities(ortheir own

remunerations). We therefore consider that within each branch, the fixed capital stock has its own marginal productivityand that in a branch, the capital stock is proportional to the capital services. The same reasoning holds for the labour factor:

L_t^b designates employment, K_t^b capital stock, r_t^b capital remuneration, and w_t^b labour remuneration in branch b. We know that these quantities are additive, so that:

$$\sum_{b\in B} L_t^b = L_t \ , \ \sum_{b\in B} K_t^b = K_t \ , \ \sum_{b\in B} r_t^b = r_t \ , \sum_{b\in B} w_t^b = w_t$$

where L_t , K_t , r_t , w_t are employment,fixed capital stock, capital remuneration andlabour remuneration for the whole economy and B is all branches of the economy. It can also be broken down by branch:

$$\log(S_{t,L}) = \sum_{b\in B} \frac{w_t^b}{w_t} \log(S_{t,L}^b) \ , \ \log(S_{t,K}) = \sum_{b\in B} \frac{r_t^b}{r_t} \log(S_{t,K}^b)$$

where $S_{t\ L,}^b S_{t\ K}^b$ are capital services and labour in branch b. We can then model the change in services for the factors using a Törnqvistindex: the change in volume of capital (or labour) services between two dates is expressed as a change in stocks of fixed capital (or employment) by sectorweighted by the weight of the remuneration of the capital (or labour) service in the total remuneration of capital (or employment) services.

$$\Delta\log(S_{t,L}) = \sum_{b\in B} \frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right)\Delta\log(S_{t,L}^b)$$

$$\Delta\log(S_{t,K}) = \sum_{b\in B} \frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right)\Delta\log(S_{t,K}^b)$$

The proportionality hypothesis of labour services and capital services assumes that they grow in an identical fashionto their respective stocks:

$$\Delta\log(S_{t,L}^b) = \Delta\log(L_t^b), \ \ \Delta\log(S_{t,K}^b) = \Delta\log(K_t^b)$$

so that:

$$\Delta\log(S_{t,K}) = \sum_{b\in B} \frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right)\Delta\log(K_t^b)$$

$$= \Delta\log(K_t) + \sum_{b\in B} \frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right)\Delta\log\left(\frac{K_t^b}{K_t}\right)$$

$$\Delta\log(S_{t,L}) = \sum_{b\in B} \frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right)\Delta\log(L_t^b)$$

$$= \Delta\log(L_t) + \sum_{b\in B} \frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right)\Delta\log\left(\frac{L_t^b}{L_t}\right)$$

[1] The hypothesis is intuitive as the structure of capital or employment varies from one sector to another.For example, the marginal productivity of capital in industry is structurally different from that of services as the capital used in the production process is different (machine tools againstcomputers, for example). Similarly, the employment needed for production in industry (workers, technicians, engineers) is different from that in services (sales assistants, sales representatives, etc.),hence their own average marginal productivitiesare different.

We then define the capital and labourquality indices as the ratio of the services of the factor to the quantity of the factor in the economy, so that:

$$\Delta\log(Q_t^K) = \sum_{b\in B}\frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right)\Delta\log\left(\frac{K_t^b}{K_t}\right)$$

$$\Delta\log(Q_t^L) = \sum_{b\in B}\frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right)\Delta\log\left(\frac{L_t^b}{L_t}\right)$$

We can also note that:

$$\Delta\log(Q_t^K) = \sum_{b\in B}\left(\frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right) - \frac{1}{2}\left(\frac{K_{t-1}^b}{K_{t-1}} + \frac{K_t^b}{K_t}\right)\right)\Delta\log\left(\frac{K_t^b}{K_t}\right)$$

and $$\Delta\log(Q_t^L) = \sum_{b\in B}\left(\frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right) - \frac{1}{2}\left(\frac{L_{t-1}^b}{L_{t-1}} + \frac{L_t^b}{L_t}\right)\right)\Delta\log\left(\frac{L_t^b}{L_t}\right)$$

In fact:

$$\sum_{b\in B}\frac{1}{2}\left(\frac{K_{t-1}^b}{K_{t-1}} + \frac{K_t^b}{K_t}\right)\Delta\log\left(\frac{K_t^b}{K_t}\right) = \sum_{b\in B}\Delta\frac{K_t^b}{K_t} = \Delta\frac{\sum_{b\in B}K_t^b}{K_t} = 0$$

and $$\sum_{b\in B}\frac{1}{2}\left(\frac{L_{t-1}^b}{L_{t-1}} + \frac{L_t^b}{L_t}\right)\Delta\log\left(\frac{L_t^b}{L_t}\right) = \sum_{b\in B}\Delta\frac{L_t^b}{L_t} = \Delta\frac{\sum_{b\in B}L_t^b}{L_t} = 0$$

Thus the terms:

$$\left(\frac{1}{2}\left(\frac{r_{t-1}^b}{r_{t-1}} + \frac{r_t^b}{r_t}\right) - \frac{1}{2}\left(\frac{K_{t-1}^b}{K_{t-1}} + \frac{K_t^b}{K_t}\right)\right)\Delta\log\left(\frac{K_t^b}{K_t}\right)$$

and $$\left(\frac{1}{2}\left(\frac{w_{t-1}^b}{w_{t-1}} + \frac{w_t^b}{w_t}\right) - \frac{1}{2}\left(\frac{L_{t-1}^b}{L_{t-1}} + \frac{L_t^b}{L_t}\right)\right)\Delta\log\left(\frac{L_t^b}{L_t}\right)$$

can be interpreted as contributions from branch *b* to factor reallocation.

Several theoretical arguments can help explain the slowdown in labour productivity

Many hypotheses have been put forward to account for the slowdown in labour productivity after the crisis (*Box 3*).

Fall in investment rate during the crisis

Between 2008 and 2009 the investment rate of the French economy fell by 1.7 points in all sectors (Graph 6). Most notably, it lost 2.6 points in the manufacturing industry and in 2016 it had not recovered its pre-crisis level. This decline contributed to the slowdown in capital intensity (i.e. in the ratio of the capital stock to the number of people employed, or per capita capital), as the capital destroyed during the crisis had not been reconstituted sufficiently in relation to the change in employment. In the manufacturing industry especially, this has led to a substitution of labour for capital, which has a negative impact on labour productivity.

A misallocation or less efficient allocation of factors of production

Beyond the simple analysis of macroeconomic aggregates, the reallocation of factors of production helps to explain the change in total factor productivity (TFP; see *Box 2*). In particular, a misallocation of factors of production (where capital and/or labour do not go into the most productive enterprises or sectors) may have a negative effect on TFP and hence on labour productivity.

A misallocation of capital can manifest itself in many ways. Capital may be allocated to unprofitable or unproductive companies because of an accommodating monetary policy or business support measures, which enable them to remain in the market when there is a turnaround in the economic situation. Next, capital may not go to potentially very profitable companies (e.g. start-ups) because it is already allocated elsewhere, because companies have credit constraints or because the mood is too uncertain. The same observation can be made at sector level.

Concerning the labour factor, misallocation may be caused by labour market rigidities restricting employee mobility. As with capital, TFP and hence ultimately labour productivity may be affected by this. Enterprise creation may be slowed because of a lack of skilled labour, and some companies may be in difficulty because they are unable to let employees go.

Change in labour quality

Finally, one of the components of TFP is labour quality. In particular, an increase in the skills of people in employment also increases the aggregate labour productivity. In addition to this long-term consideration, changes in labour quality can also have a short-term effect through the workforce retention mechanism: when there is a drop in production, companies do not let their skilled workers go, so that they can avoid diminishing the skills within the company or losing the expenditure put into training their skilled workers. The higher the proportion of skilled workers, the more significant this mechanism may be, i.e., the temporary drop in labour productivity during a turnaround in the cycle may be stronger. Note also that the allocation of labour, described above, is also a measure of quality, which is analysed below.

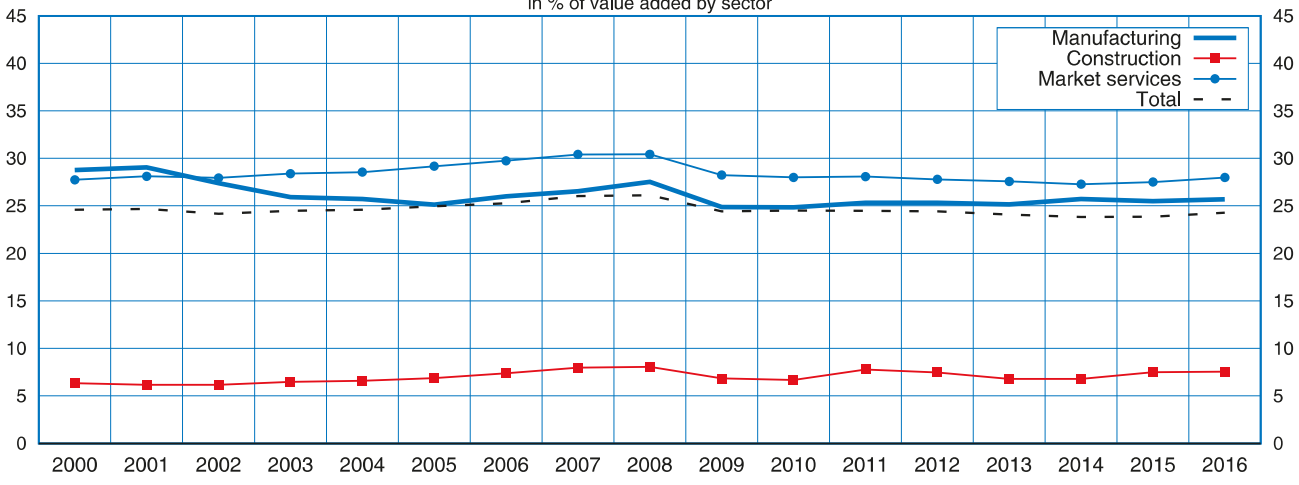
A breakdown of contributions to productivity gains from the branches deepens understanding of the drop in level and the slowdown of labour productivity

Labour productivity gains for the whole of the economy can be broken down into several inter-branch and intra-branch effects

The change in labour productivity gains for the whole of the economy can be broken down between the different branches of activity. An interpretation of a branch's contribution to labour productivity gains involves first distinguishing the structural effects, linked with quantitative variations in employment and capital in the branch (factor reallocation within the economy), effects that are intrinsic to each branch, linked with variations in capital intensity and total factor productivity (TFP). Box 2 shows a breakdown that differentiates these effects.

6 - Investment rate of non-agricultural market sectors

in % of value added by sector



Source: INSEE

Box 3 - Literature on the slowdown in productivity

In the economic literature, the slowdown in productivity that has been occurring for decades and which is common to most developed countries, has been widely documented. Putting to one side the debate between techno-pessimists on the one hand (Gordon 2016) and techno-optimists on the other (e.g. Mokyr 2015) on whether there has been a decline in technological progress, many economists have explored the macro- and microeconomic causes of this slowdown. By breaking down the growth in productivity (*Box 2*), four sets of assumptions can be defined.

Effects of capital intensity

Concerning the effects associated with capital intensity, the decline in the investment rate post-crisis is often cited as having a long-term effect on growth (see OECD 2017 or Ollivaud *et al.* 2016). In particular, Sode (2016) highlights the weakness of investment in ITC and in digital. Adler (2017) believes, for example, that investment in R&D is limited by the scarcity of available credit, the deterioration in the balance sheets of companies in difficulty, the weakness of aggregated demand and also the pervading economic and political uncertainty which limits risky investment.

Effect of labour quality

Several studies have looked at changes in labour quality. In particular, Askenazy (2016) points out that the number of skilled workers in the labour market affects the productivity cycle via a phenomenon of retention of skilled workforce: in periods when activity slows, companies do not part with their most highly-skilled employees as the cost of training or recruiting them was high. This phenomenon probably explains half of the slowdown in productivity. According to Askenazy, another quarter could be due to the increase in the number of short contracts and self-employed workers (temporary workers, auto-entrepreneurs). The last quarter is probably linked with changes in managerial practices. Similarly, Argouarc'h *et al.* (2010) suggest that employment recovered less strongly in 2010 than in other recovery phases, due specifically to a phenomenon of retention of the workforce during the crisis: adjustment of hourly volume by resorting to part-time work or the slack work system. Nevertheless, this short-term phenomenon only accounts for a small proportion of the recovery of employment in 2010. Finally, a trend break in productivity gains has also been mentioned, especially for industry. The reason may be a transformation in the way industries are organised or the use of sub-contractors.

Effect of factor allocation

The hypothesis of a poor reallocation of factors of production affecting the "creative destruction" of the economy has been hotly debated, but with no apparent consensus. The literature evokes a poor reallocation of the labour factor linked to rigidities concerning the labour market (mobility, wages) (Sode 2016, Cette *et al* 2017), or the capital factor (Gamberoni *et al* 2016). These last authors believe that, for France and other Eurozone countries, the reallocation of capital between firms deteriorated in the 2000s, but not that of employment which, although it certainly fell dramatically in 2009, nevertheless quickly returned to its previous level. To explain this, McGowan *et al.* (2017) suggest that zombie firms (with weak productivity and deteriorating financially) may monopolise part of the capital in the context of an accommodating monetary policy and business support measures. Nevertheless, Bellone (2017), when commenting on Cette *et al.* (2017), qualifies the role of factor reallocation in the dispersal of productivity gains and suggests an examination of inter-sectoral reallocations.

Other hypotheses

Microeconomic hypotheses can also be proposed. Andrews (2015) believes that companies at the frontier of global technology are always productive but that the gap between them and the rest has increased, giving rise to problems of spread within economies.

Lastly, questions are sometimes brought up about measurement in national accounting. On the one hand, the value added of certain ITC-intensive sectors is not necessarily to be found in sale prices (e.g. the development of apps on smartphones). On the other hand, the difficulty of incorporating changes in quality into the calculation of product deflators is one hypothesis that could be put forward. Nevertheless, Syverson (2017) highlights the absence of empirical checks, particularly as these measurement problems are neither recent, nor likely to explain the slowdown in productivity. Rather it is a difference in level in measuring labour productivity. ■

Different levels of aggregation can be analysed, each time adding together the contributions of the intrinsic and structural effects of the branches: at the level of the whole economy (here limited to the non-agricultural market branches), or at the level of each branch with variable levels of detail. The average annual variations in labour productivity are broken down by comparing four sub-periods: 1980-1989, 1990-2007, 2008-2009 and 2010-2016. The first corresponds to a period of lower labour productivity than in the "Glorious Thirty" (between 1945 and 1975) but which is still significant, before the 1989 break identified in Argouarch' et al. (2010). The second period stops before the start of the 2008 economic crisis. The third covers only the crisis, the biggest of the post-war period, and finally, the fourth covers the post-crisis period.

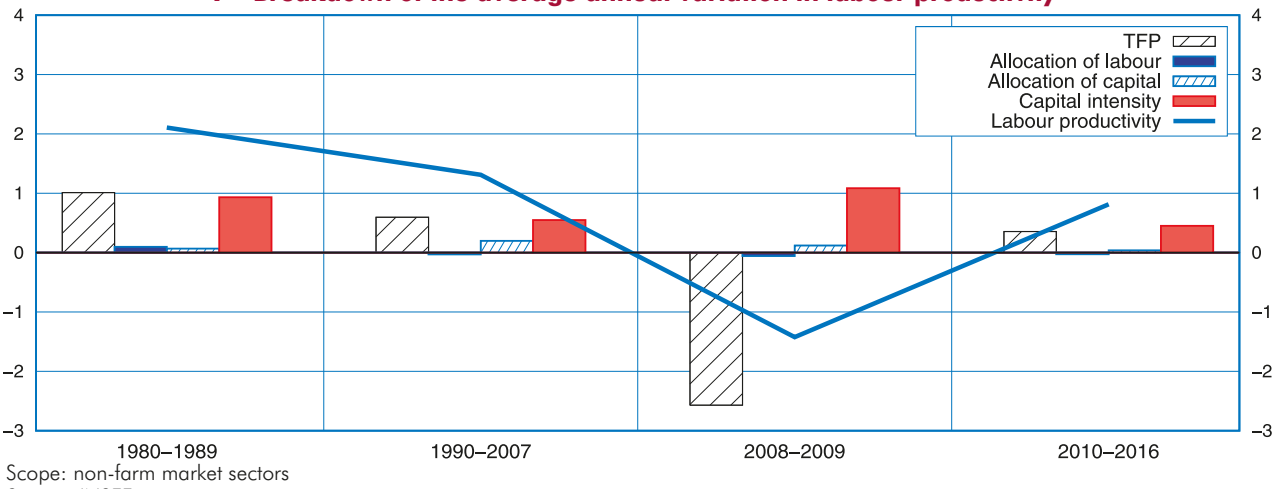
The fall in the level of labour productivity during the crisis is not explained by the dynamics of capital or labour

For all the market branches (excluding agriculture), labour productivity in 2008-2009 fell drastically, by an average of 1.3% per year (*Graph 7*). Compared to its pace between 1990 and 2007, this represents a slowdown of 2.6 points (*Table 2*). TFP accounts for almost all of this decline, contributing a downturn of -3.0 points. Conversely, capital intensity, which increased by 1.0% over the period, helped to accelerate labour productivity by 0.5 points and hence limited its decline. This acceleration compared with the 1990 – 2007 period can be explained, as employment adjusted more quickly to the return to the cycle than the fixed capital stock. Finally, the re-allocation of labour and of capital each contributed only -0.1 points to the drop in labour productivity.

All in all, the main contribution of the fall in labour productivity during the crisis, despite being slowed by the occasional rise in capital intensity, was TFP, the residual term of the breakdown. In other words, the fall was not explained by the variations in factor quality or in capital intensity. At the start of the crisis, it could therefore be interpreted as being cyclical in origin: the drop in demand led, in the short term, to a fall in value added, while the factors of production did not adjust so rapidly. For the capital factor, for example, this effect could be seen through the production capacity utilisation rate which measures the ratio of production capacity actually used for production to all the production capacities potentially available on a given date (*Graph 8*); for the labour factor, it can be seen through the ratio of hours worked per job (*Graph 9*). Both these ratios fell occasionally during the 2008-2009 period before picking up, indicating the very cyclical

1. The employment data used for this breakdown are taken from the national accounts, available by *branch of activity*. They differ slightly from the *Employment estimates*, also published by INSEE, which are presented by *sectors of activity*.
2. Note that a misallocation of factors of production can also operate between companies in the same branch. However, such a phenomenon is difficult to identify from national accounts data.

7 - Breakdown of the average annual variation in labour productivity



Scope: non-farm market sectors
Source: INSEE

nature of the decline in the use of available capacities over this period. On the other hand, in contrast to the indicators of capacity usage, productivity did not recover immediately after the crisis: the drop in level, which cannot be explained by the breakdown over the period 2008-2009, therefore appears to be more structural than cyclical.

The slowdown in labour productivity post-crisis is partly explained by a less efficient allocation of capital

By comparing periods 1990-2007 and 2010-2016 (*Table 2*), the origins of the slowdown in productivity can be examined and the bias caused by the drop in level in 2008-2009 can be avoided. Between these two periods, the average increase in productivity dropped from 1.3% to 0.9% per year. The contribution of TFP decreased from +0.6% to +0.4%, which was a considerable proportion of the decline in pace. Similarly, a less efficient allocation of capital between branches was responsible for 0.2 points of the slowdown in productivity. The contribution of capital intensity to the slowdown, at around 0.1 points, was more moderate. The allocation of labour was neutral in its effect on the slowdown.

The decline in labour productivity during the crisis was due mainly to industry

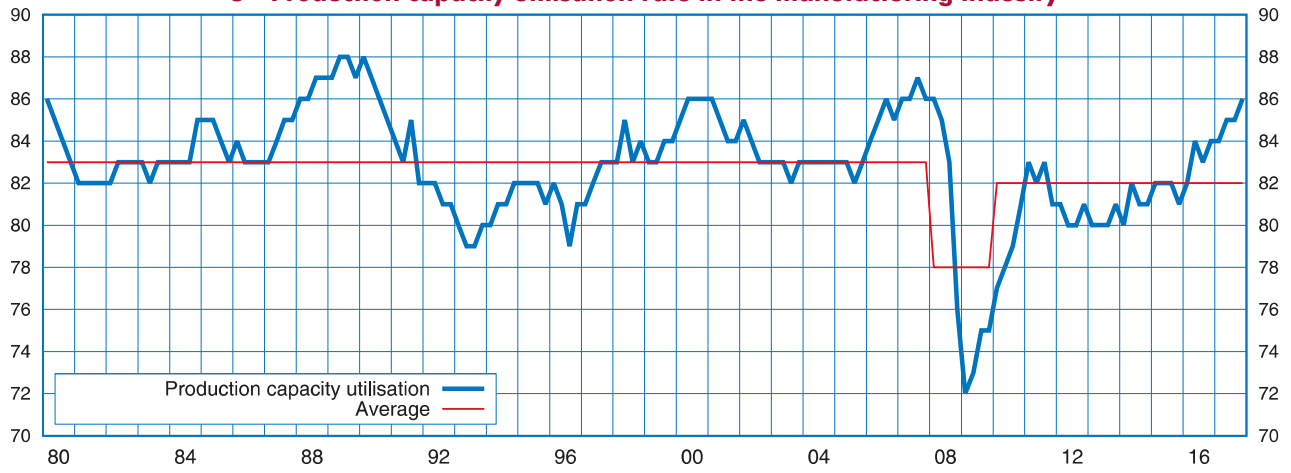
Now consider the contributions of each branch to the drop in level of labour productivity. The breakdown by branch across the non-agricultural market sector shows that the drop in the level of labour productivity in 2008-2009 was due mainly to industry: it was responsible for 48% of the decline although it represents only about 20% of the value added of the non-agricultural market branches. Meanwhile, the contribution of market services to the decline in productivity (31%) was much less than its contribution to the economy. Finally, construction accounts for the balance (20%), which is more than this sector's contribution to the economy.

Table 2: Average variations in labour productivity and contributions to the fall and the slowdown

	Average annual change (*in %*)			Change of pace (*percentage points*)	
	1990-2007 (1)	2008-2009 (2)	2010-2016 (3)	Drop in level (2)–(1)	Slowdown (3)–(1)
Labour productivity per capit	**1.3**	**–1.3**	**0.9**	**–2.6**	**–0.5**
including TFP	0.6	–2.3	0.4	–3.0	–0.2
Reallocation of labour	0.0	–0.1	0.0	–0.1	0.0
Reallocation of capital	0.2	0.1	0.0	–0.1	–0.2
Capital intensity	0.5	1.0	0.4	0.5	–0.1

Scope: NAMS
Source: INSEE

8 - Production capacity utilisation rate in the manufacturing industry



Note: Average over the periods 1980-2007, 2008-2010, 2011-2017
Source: Business tendency survey

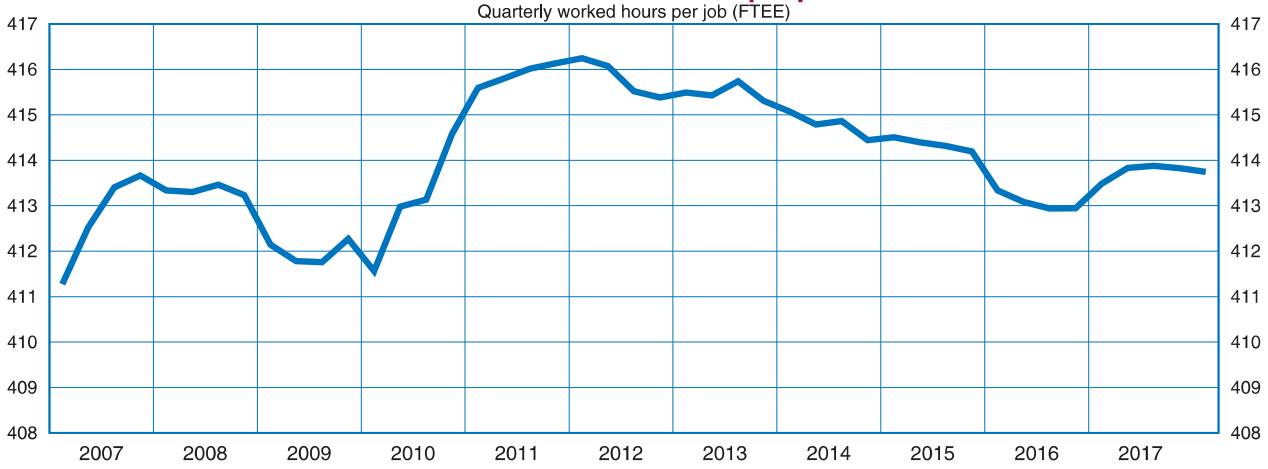
In addition, the fall in labour productivity in industry is linked almost exclusively with the drop in TFP, as the contributions from capital intensity and factor reallocations were zero. Conversely, the capital intensity of market services helped to limit the drop in productivity thanks to greater growth in fixed capital stock than in employment (*Graph 10*).

The slowdown after 2010 was also due mainly to the industrial branches

The contribution of the industrial branches to the annual change in labour productivity decreased by 0.4 points between 1990-2007 (contribution of +0.8 points) and 2010-2016 (contribution of +0.4 points). This dynamic accounts for almost 90% of the slowdown in post-crisis productivity. This contribution by industry is due mainly to TFP (0.3 points), and capital intensity (0.1 points). However, the quality of allocation of the two factors of production is negligible for this branch.

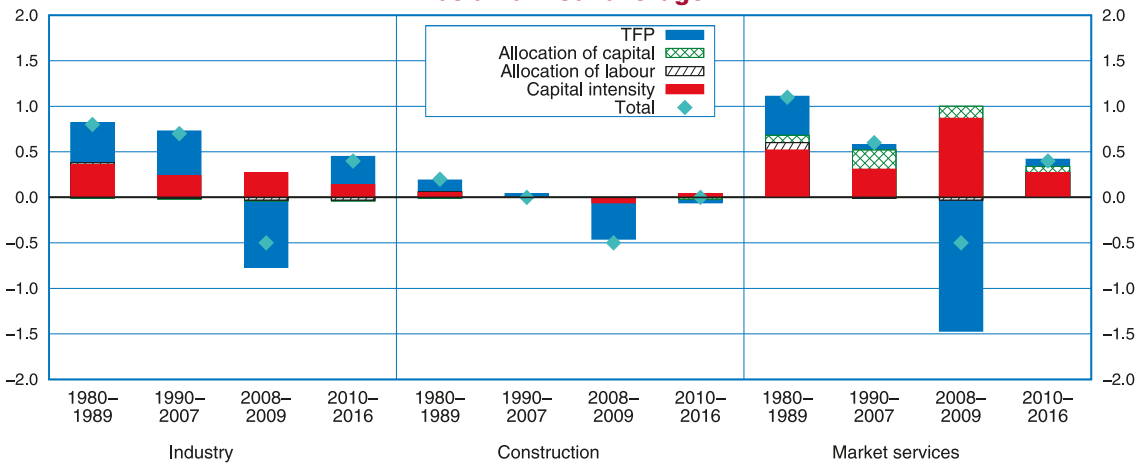
Construction and market services contributed only marginally to the overall slowdown. In market services, unlike industry, the contribution of TFP accelerated after the crisis (0.1 points) whereas the effects of capital intensity remained relatively stable. However, a less efficient allocation of capital adversely affected labour productivity (-0.1 points), which meant that the changes in these two items cancelled each other out in services.

9 - Ratio of hours worked per job



Scope: non-farm market sectors
Note: The indicator selected compares the hourly volume of the branches in question to numbers in full-time equivalent (FTE)
Source: INSEE

10 - Contributions by the branches to the growth of labour productivity in the economy as an annual average



Scope: non-farm market sectors
Source: INSEE

All in all, the slowdown in labour productivity in the non-agricultural market branches after the crisis can be explained essentially by three factors: (i) a lower TFP contribution in industry, (ii) a lower contribution from capital intensity in industry, and (iii) a less efficient capital allocation in services.

Within the manufacturing sectors the drop in post-crisis capital intensity is homogeneous

To check whether some sub-branches contributed more than others to these changes, the same breakdown was applied within a single branch. Within industry the contributions of the variation in capital intensity after the crisis derived entirely from the manufacturing branches. These contributions were fairly similar to the weightings of the different sub-branches in value added. Thus, 8% of the slowdown was due to agrifood industries (C1), 18% to capital goods (C3), 20% to transport equipment (C4) and 54% to "other industries" (C5). The drop in capital intensity in the manufacturing industry therefore had a relatively homogeneous effect on all the sub-branches.

In services, capital allocation was less efficient mainly in the branches representing the digital economy and innovation

After the crisis, the decline in the contribution of capital allocation in market services came primarily from information-communication (JZ), and services to businesses (MN), branches representing the digital economy and innovation. These two branches accounted for more than 55% of poor capital allocation (contribution from 0.08 points to 0.14 points of the slowdown in capital allocation in services), the remaining 45% were from business services, transport services, accommodation and food services on the one hand and property services on the other (23% each).

Finally, to test the robustness of the analysis, the same breakdown was applied to the non-agricultural market sectors, excluding property services, which have very high levels of capital and could skew the results. Nevertheless, it was observed that in this case, the least efficient allocation of capital still accounted for 0.2 points of the slowdown in labour productivity.

A new model of the long-term equation to trace the slowdown in productivity

A new long-term model to account for labour productivity

As a result of this analysis and the various slowdown factors identified, a new long-term equation was built to account for the slowdown in trend productivity gains (*Box 4*). Labour productivity per capita is attributed to four factors:

- The capital allocation indicator as defined in *Box 2*. Good capital allocation is a situation where capital is allocated to the most productive branches (in the sense of the remuneration of this factor). The contribution this variable makes to the change in productivity declines when the capital is less available in the branches that are most remunerative.
- The share of higher education diplomas among people in employment (Baccalaureate +2 years and more). This is a proxy variable for human capital which contributes to total factor productivity. The share of skilled workers, which is in theory more directly linked to productivity than the level of qualifications, was also tested, but its relation with productivity in the long term did not stand out so clearly.
- A dummy variable with a value of zero before 2009 and one after 2009. This dummy explains the drop in productivity level at the time of the crisis which, according to the breakdown carried out previously, is not explained by the capital factor nor by the labour factor.

The long-term equation no longer shows a persistent residual

This long-term model represents the trend break since 2008 better (*Graph 12*). By using the dummy, the drop in labour productivity due to the crisis can be represented. On the other hand, the measurement for efficient allocation of capital between branches explains the slowdown in post-crisis productivity. By studying the contributions to the change in labour productivity in the long term, it

can be noted that the contribution of capital allocation is positive across all periods, i.e. capital is allocated, on average, to the branches where it is best remunerated (*Graph 13*). However, while its contribution remained relatively steady during the 2008-2009 crisis (contributing +0.8 points against +0.6 points in 1990-2007), it declined substantially over the 2010-2016 period (+0.1 points). The share of highly qualified employees contributed positively to the change in labour productivity and remained relatively constant around +0.8 points on average both before and after the crisis. Lastly, the contribution made by employment policies remained constant (-0.2 points before and after the crisis) and was therefore unlikely to account for the slowdown.

Box 4: Revised employment equation for market sectors

Long-term equation

La nouvelle The new employment equation explains labour productivity per capitain the longterm as a combination of several integrated variables of order 1, derived from the analysis in this report.The long-term equation is written as follows:

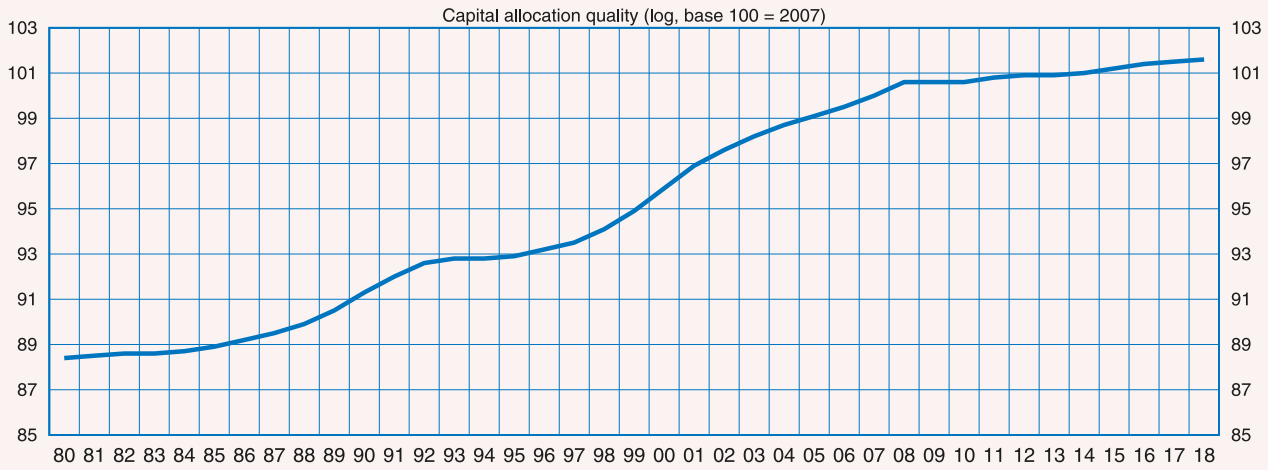
$$\log(va_t) - \log(employment_t - pe_t) = \alpha + \beta \log(a_t^K) + \gamma 1_{t \geq 2009T1}$$
$$+\lambda \log(diplomas_t) + \varepsilon_t$$

where:[1]

- a_t^K is a measurement of good capital allocation between sectors according to their respective remunerations and constructed on the basis of the breakdown in Box 2 (Graph 15).
- $1_{t \geq 2009T1}$ is a dummy equal to 1 if date *t* is later than Q1 2009. It measures the drop in the level of productivity that is not explained by our model. Q1 2009 was chosen as it was the quarter in which labour productivity reached its lowest level during the last economic crisis.
- *diplomas*$_t$ is the share of highly qualified people in employment. This is a proxy ratio for the increase in human capital in the economy, it is used to measuretrend gains in labour productivity (Graph16).

[1]These indicators are not immediately available for the production of a forecast. For the employment forecast 2018, the series stop in 2016. As a result, they are extended until 2018 by their average growth rate over the last five years.

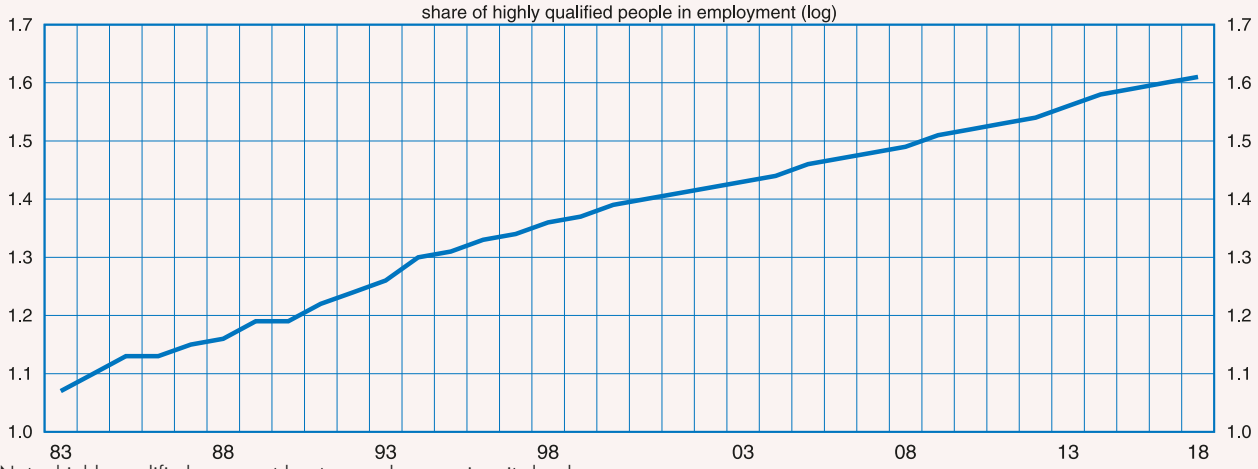
1 - Indicator for allocation of capital among branches



Scope: non-farm market sectors,
Source: INSEE

The estimated coefficients are all significant and have the expected positive signs. The residual of the equation is stationaryaccording to

2 - Share of highly qualified people in employment



Note: highly qualified means at least second-year university level.
Scope: non-farm market sector
Source: INSEE

the Philips-Perron and theAugmentedDickey-Fuller tests guaranteeing the validity of thecointegration relation.

The stationarity of the residual is robust using the Stock-Watson (1993) dynamic ordinary least squares (DOLS) method. Nevertheless, given the limited number of observations andthe number of significant time lags and advances to be included,[2]subsequently we shall use the estimation method in one.

Short-term equation:

The error-correction model is estimated in one step, as follows:

$$\Delta\log(employment_t - pe_t) = \alpha + \delta(\log(va_{t-1}) - \log(employment_{t-1} - pe_{t-1})) + \varsigma\log(a^K_{t-1})$$

$$+\lambda\log(certificates_{t-1}) + \gamma 1_{t-1\geq 2009T1}$$

$$+\kappa_1\Delta\log(va_t) + \kappa_2\Delta(\log(employment_{t-1} - pe_{t-1})) + \xi_t$$

Where *va is the value added of the non-agricultural market branches.*

The coefficient δ, *i.e.the "pull-back force", must be positive as employment appears with a negative sign in the endogenous variable* of the long-term equation. The estimated coefficients are given below. The Student's statistics are given in brackets. For d the statistic should be compared with the values in Ericsson & MacKinnon's table (2002), where the threshold value, in our case, for a significance levelof 5% (or 1%) is 3.5 (or 4.1). Finally, thelong-termexplanatory statistics do not follow a Student's lawand are therefore replaced by a *.

$$\Delta\log(employment_t - pe_t) = \underset{(-4,9)}{-0,22} + \underset{(4,5)}{0,11}(\log(va_{t-1}) - \log(employment_{t-1} - pe_{t-1}))$$

$$\underset{(*)}{-0,16}\log(a^K_{t-1}) - \underset{(*)}{0,02}\log(diplomas_{t-1}) + \underset{(*)}{3,2\%}1_{t-1\geq 2009T1}$$

$$\underset{(5,7)}{+0,20}\Delta\log(va_t) + \underset{(4,0)}{0,31}\Delta\log(employment_{t-1} - pe_{t-1})$$

$R^2_a = 0,78$, estimation period: 1990T1-2015T4

[2]This number is chosen in such a way that the residual is no longer autocorrelated according to the Ljung-Box test.

Robustness

Estimation period

By varying the end of the estimation period between 2009Q2 (i.e. one quarter after the start of the indicator) and 2015Q4 (i.e. the date from which the employment series used are no longer revised), the model presents a validcointegration relation and residuals that did not persist after the crisis. On the other hand, when the start of the estimation periodwas varied between 1984 and 1990, the model had difficulty showing the trend break in 1989. As suggested by Sode (2016), among others, the end ofcatching up the productivity gap with the United States, measured in part via TFP, may account for this break. As a result, it is necessary to include an elbow curve trendin order to obtain a satisfactory long-term model of labour productivity. By estimating the original model on the 1984-2015 period, enhanced by an elbow curve trendto replace the share of highly-qualified employees, the model is satisfactory from a statistical point of view and shows no persistent residual. Finally, the share ofqualified personnel can be replaced by the share of skilled employees in total employment without affecting the quality of the model.Nevertheless, we shall use only the model described at the top of the box as it has the least persistent residual outside the estimation period.

Employment-wage elasticity

A variable likely to affect employment in the short term is the cost of labour, here measured by theaverage wage per capitain the non-agricultural market sectors (AWPC-NAMS).By including variations in the AWPC-NAMS in the short-term explanatory variables, we can expect the estimated coefficient (or employment-wage elasticity) to be negative. The coefficient obtained is -0.07 but this is not significant (Student fs statistic equal to -1.4), while the coefficients estimatedfles do not vary. ■

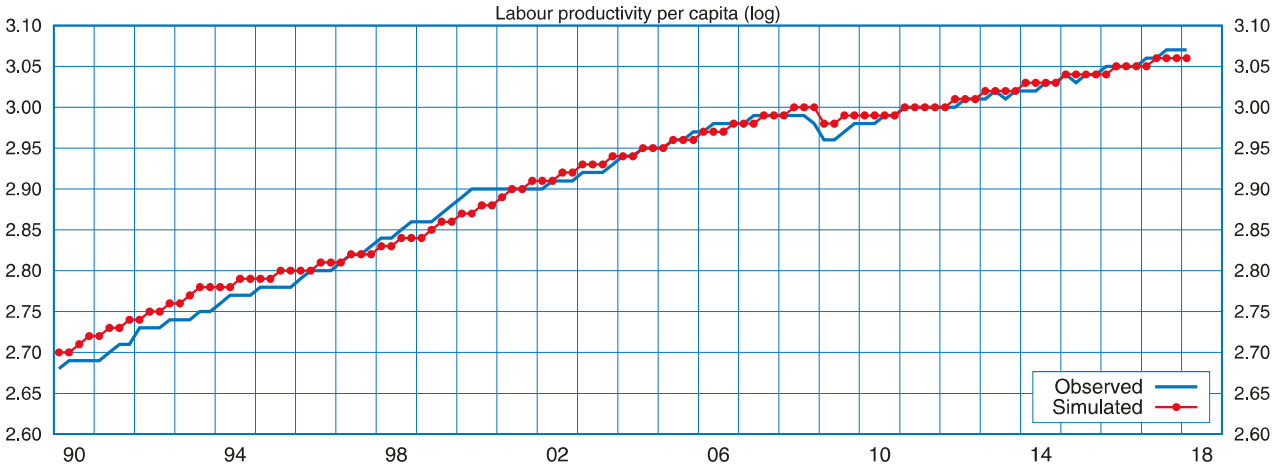
The 1990-2007 period can also be broken down into two sub-periods, 1990-1999 and 2000-2007, in order to isolate any possible decline in the capital allocation contribution prior to the crisis. Labour productivity may have slowed substantially between these two periods, but the slowdown was still not explained by the model.

The short-term equation gives a better employment forecast

Since the slowdown in productivity has been explained in the long term, the short-term equation is improved (*Graph 13*). The short-term fluctuations are explained on the one hand by the growth in contemporary value added and on the other by the lagged variations in employment. The short-term equation shows substantial residuals during the unexplained peaks and troughs of employment growth, as in Q3 2014. Apart from this it is successful in correctly presenting the recovery of employment from mid-2015, better than the model used previously (*Box 5*).

The ultimate aim of the equation described in this analysis is to forecast changes in payroll employment. As it is impossible to measure value added, and hence

11 - Comparison of long-term productivities modelled in the old and new equation



Scope: non-farm market sectors
Source: INSEE

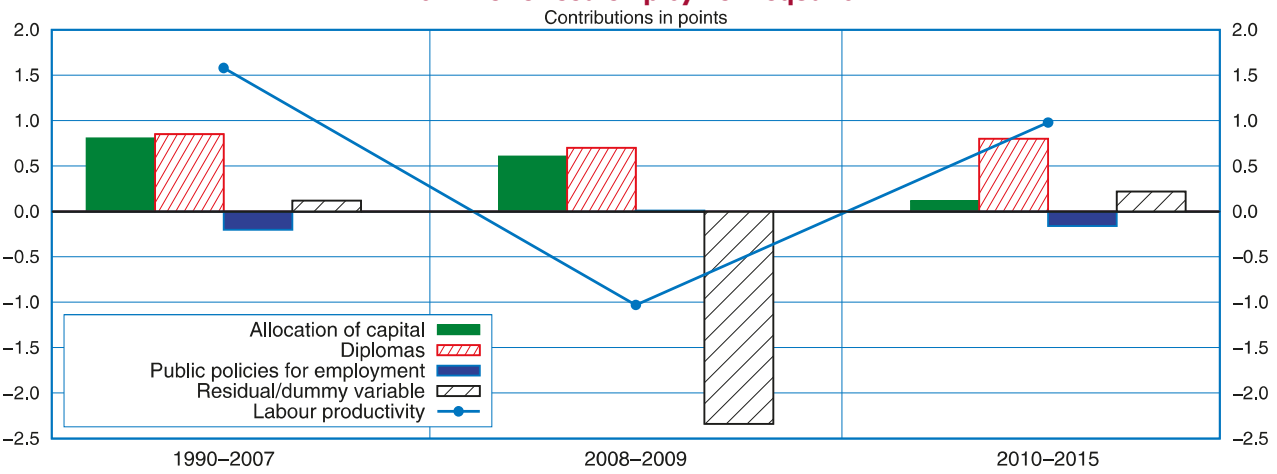
Slowdown in labour productivity and forecasting employment in France

productivity, linked specifically to employees (excluding the self-employed), the econometric model is based on a total employment series (employees and self-employed). The number of self-employed is forecast independently, and the number of employees is obtained from the balance from total employment and the self-employed (*Graph 14*, see Aubert & Coudin (2008) for a fuller description of the process of preparing the employment forecasts for Conjoncture in France).

Growth in non-agricultural market-sector employment is likely to be more moderate in 2018

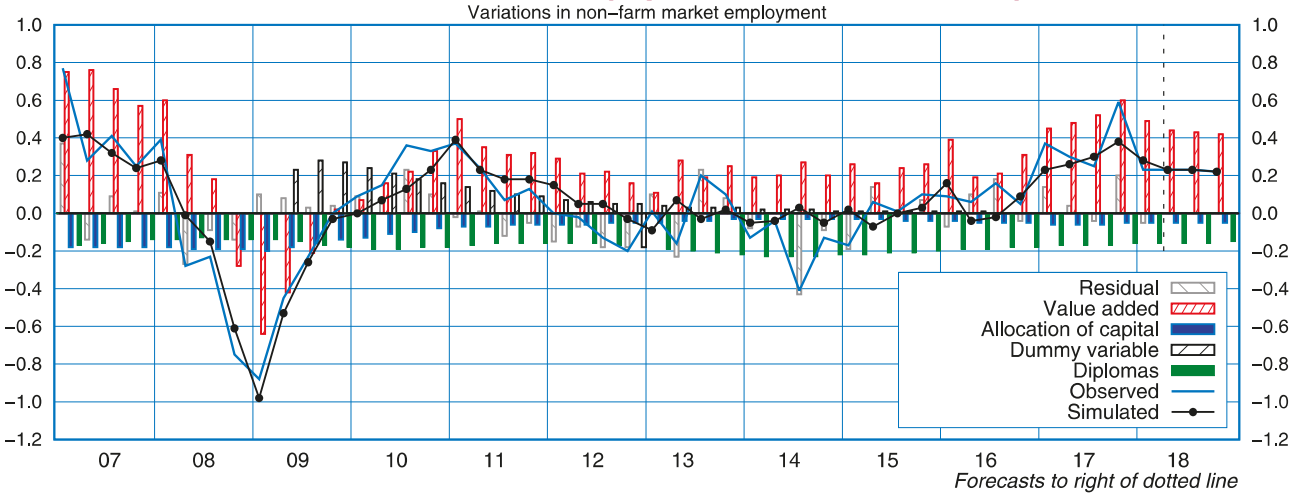
According to the forecast for 2018, the value added of the non-agricultural market sectors looks set to slow considerably compared with 2017 (+1.6% over the year, after +2.8% as an annual average). As a result, employment should also grow at a slightly slower pace: +203,000 jobs over the year by the end of 2018, after +257,000 in 2017 (see *Employment* sheet). This reduced momentum will probably be associated not only with bringing an end to the greater employment intensity of growth via employment policies, but also with slowing value added. ■

12 - Contributions to the annual average change in labour productivity per capita from the revised employment equation



Scope:non-farm market sector, source: INSEE

13 - Contributions to simulated employment based on the revised equation



Scope: non-farm market sectors, source: INSEE

Box 5 - Comparison of the new employment forecast with the one used currently

In order to check the effectiveness of the employment forecasting model which was eventually selected (*Box 4*), its predictive power must be compared with that of other existing models.

To do this, the first obvious task is to compare the root mean square error (RMSE) of each model. This is defined as the square root of the arithmetic mean of the squares of the differences between forecasts from the equation and the values observed on n dates outside or inside the estimation period:

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(simulated_t - observed_t)^2}$$

More simply, it is a measure of the quality of the estimate produced, which gives a composite measurement of total error in a single value. Thus the best estimator is the one that produces the lowest mean squared error. For each of the models used, the RMSE was calculated for 3 distinct periods: between 1990 and 2015, corresponding to an error calculated over the estimation period (RMSE *in sample*), between 2016 and 2018 leading to a squared error outside the sample (RMSE *out of sample*), and finally between 1990 and 2018, corresponding to total squared error (RMSE total).

The equations used for the forecast were the following:

- Present equation (1): presented in Box 1, this was used until now to forecast employment for *Conjoncture in France* and to explain the level of employment in the NAMS based on their level of value added and a linear elbow curve trend in 1989.

- Revised equation (2): this is the new employment equation presented in this analysis (*Box 4*).

The results are shown in the table below:

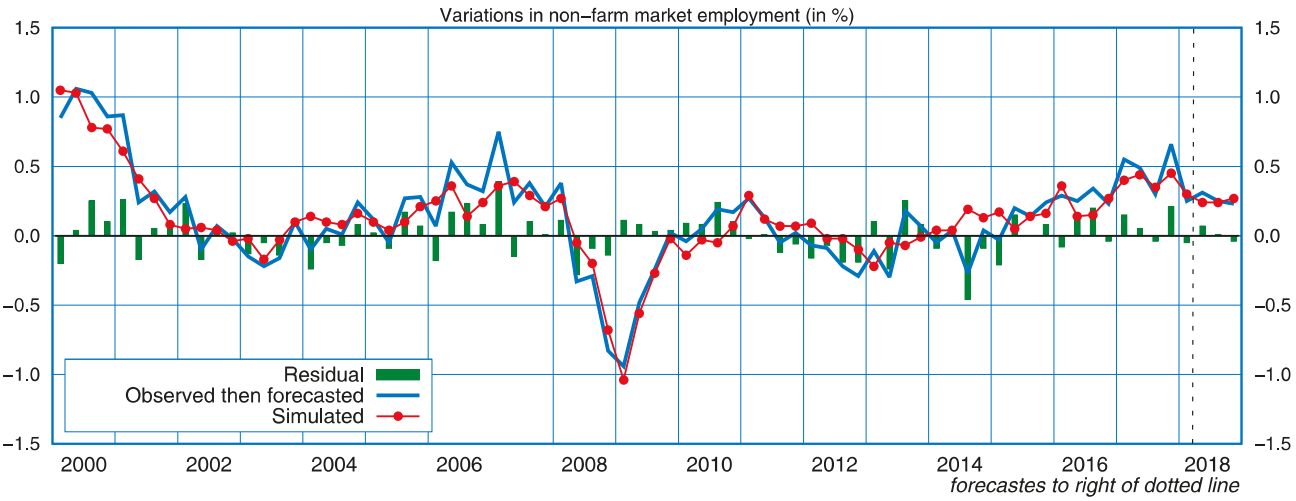
Table 3: Comparison of RMSE for the current equation and the revised equation

The squared error of the revised model was 0.2%, irrespective of the period chosen, whereas that of the traditional model was between 0.4% and 0.7%. The new equation was therefore preferred for the new employment forecasts in *Conjoncture in France*. ■

Comparison of RMSE for the current equation and the revised equation

	Old equation		Revised equation	
	RMSE	Period	RMSE	Period
over estimation period	0.4%	1984Q1-2009Q4	0.2%	1990Q1-2015Q4
out of estimation period	0.7%	2010Q1-2018Q1	0.2%	2016Q1-2018Q1
total	0.4%	1984Q1-2018Q1	0.2%	1990Q1-2018Q1

14 - Emploi salarié prévu avec l'équation révisée



Champ: non-farm market sectors, source: INSEE

Bibliography

Adler G., **Duval R. A.**, **Furceri D.**, **Kiliç Celik S.**, **Koloskova K.**, **Poplawski-Ribeiro M.** (2017), "Gone with the Headwinds : Global Productivity", *Staff discussion notes* n° 17/04, International Monetary Fund, April.

Andrews D., **Criscuolo C.** et **Gal P. N.** (2015), "Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries." OECD Publishing.

Argouarc'h J., **Debauche E.**, **Leblanc P.** et **Ourliac B.** (2010), "How to explain change in employment since the beginning of the crisis ?", *Conjoncture in France,* INSEE, December, p. 19-43.

Askenazy P., **Bellmann L.**, **Bryson A.** et **Galbis E. M.** (2016), "Productivity puzzles across Europe", Oxford University Press, November.

Aubert P. et **Coudin É.** (2008), "Employment, unemployment, activity: from observation to forecast", *Conjoncture in France*, INSEE, March, p. 29-45.

Bellone F. (2017), "Productivity slowdown and loss of allocative efficiency: A French disease?", *Economics and Statistics* n° 494-495-496.

Cette G., **Corde S.** et **Lecat R.** (2017), "Stagnation of productivity in France: a legacy of the crisis or a structural slowdown?", *Economics and Statistics* n° 494-495-496.

Duval R. A., **Hong G. H.** et **Timmer Y.** (2017), "Financial Frictions and the Great Productivity Slowdown", *IMF Working papers*, Fonds monétaire international, May.

Ericsson N. R. et **MacKinnon J. G.** (2002), "Distributions of error correction tests for cointegration", *The Econometrics Journal* volume 5, p. 285-318.

Gamberoni E., **Giordano C.** et **Lopez-Garcia P.** (2016), "Capital and Labour (Mis)Allocation in the Euro-Area: Some Stylized Facts and Determinants", *ECB Working Paper* n° 1981, November.

Gordon R. J. (2016), "The rise and fall of American growth : The US standard of living since the civil war", Princeton University Press.

McGowan M. A., **Andrews D.** et **Millot V.** (2017), "The walking dead? Zombie firms and productivity performance in OECD countries", *Economics Department Working Papers* n° 1372, OECD Publishing, January.

Mokyr J., **Vickers C.** et **Ziebarth N. L.** (2015), "The history of technological anxiety and the future of economic growth: Is this time different ?", *The Journal of Economic Perspectives* vol. 29 n° 3 , p. 31-50.

OCDE (2017), Perspectives économiques n° 102, *Technical Report*, OECD Publishing, November.

Ollivaud P., Guillemette Y. et Turner D. (2016), "Links between weak investment and the slowdown in productivity and potential output growth across the OECD**",** *OECD Economics Department Working Papers, June*.

Passeron V. et Perez-Duarte S. (2003), "Will the recovery be jobless?", *Conjoncture in France*, INSEE, December, p. 19-35.

Sode A. (2016), "Comprendre le ralentissement de la productivité en France", Note d'analyse de France Stratégie, January.

Stock J et Watson M. W. (1993), "A simple estimator of cointegrating vectors in higher-order integrated systems", *Econometrica : Journal of the Econometric Society vol. 61 n° 4, July p. 783-820.*

Syverson C. (2017), "Challenges to mismeasurement explanations for the US productivity slowdown", *NBER Working Paper n° 21974, February.* ■