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ASSET PRICE CHANGES AND MACROECONOMIC MEASUREMENT OF PROFITABILITY

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On the basis of national accounts data, this article compares two different measures for the profitability of non-financial corporations, between France and the United States over the last two decades. The two measures differ in the way they evaluate the various elements that are integrated in the profitability calculation. The first measure corresponds to the usual practice which ignores the holding gains and losses on assets concerning some components of the profit measurements. In contrast, the second takes full account of these holding gains and losses on assets in corporations' returns. The analysis highlights in particular the effects on profitability measures of the huge variations in asset prices observed in recent years in the two countries. The main finding is that taking holding gains and losses into account actually matters for the measurement of corporate profitability over time, this result being particularly clear over the recent period.

1. Introduction

The usual indicators of corporate profitability are ratios of current profits to a measure of capital stock. Computed from national accounts data, these ratios take into account in an asymmetric way the potential holding gains and losses on assets held by firms.[1] The latter are integrated into the measure of net capital stock—the value of capital stock in balance sheet accounts—listed in the denominator, whereas they are not in the measures of profits listed in the numerator. The latter convention is justified by the methodology used in national accounts according to which no holding gains, whether realized or potential, are regarded as production or revenue. From a practitioner's point of view, this convention may be at the root of a paradox: for instance, the decline in measures of profitability in line with improvements in firms' prospects regarding their own value (and vice versa)! Everything being equal, when firms enjoy better prospects, to the extent that they are reflected in an increase in the value of their assets, current profits in

Note: The views expressed in this paper are those of the authors and do not necessarily reflect those of the Banque de France.

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[1]See, for example, Bataille and Durant (2005), Deutsche Bundesbank (2003), Picart (2004), Plihon (2002), Sylvain (2001), and Walton and Citron (2002).

the numerator—which exclude holding gains and losses—do not change, while the value of the capital stock at replacement cost in the denominator—which takes into account holding gains and losses that includes expectations of better prospects—increases. The result is then a fall in the ratio, incorrectly signaling a deterioration in firms' profitability despite the improvement in their prospects. If these effects were substantial, it would be difficult to make a sound economic assessment on the basis of such indicators. The question is especially crucial in times of dramatic change in asset prices, as is currently the case. This study investigates what the impact of this asymmetry on profitability measures might be.

The method proposed here aims to compare the results of the usual practice with the ones derived from an alternative approach. Still at the macroeconomic level, and on the basis of national accounts data, the alternative approach consists of estimating the numerator of the profitability ratios in a more consistent way with the denominator, by taking into account not only current realized profits but also the holding gains and losses on financial and real assets. The two measures are computed for non-financial corporations (NFCs). A comparison of the results provided by the two approaches is carried out for France and the United States over the last two decades. This analysis is the extension of a number of studies carried out by the Banque de France in 2004–05.[2] It also updates the methodological framework developed by Levy-Garboua and Maarek (1985) on which these studies were based.

In Section 2, we define the profitability ratios used, describe the data and, more precisely, the methods used to compute the capital stock series and elaborate the series of holding gains and losses on non-financial assets. In Section 3 we compare the results obtained using various approaches, with a specific focus on the most recent period. Section 4 concludes.

2. Profitability Indicators

Two methods for computing the rate of return on equity (ROE) and the rate of return on capital employed (ROCE) are compared. These two methods are described in greater detail in Appendix 1. The first method—hereafter referred to as "unadjusted"—corresponds to the usual practice. Unadjusted ROE and ROCE are then computed as follows:

$$\text{ROE unadjusted} = \frac{\text{net disposable income}}{\text{net shareholder's equity}} \text{ and}$$

$$\text{ROCE unadjusted} = \frac{\text{net operating surplus}}{\text{net capital}}.$$

The second method—hereafter referred to as "adjusted"—adds to the net result the realized and potential holding gains and losses on non-financial assets for the ROCE, and the realized and potential holding gains and losses on both

[2]See Bataille and Durant (2005), Durant (2005), and Cordier and Durant (2004).

financial and non-financial assets and liabilities[3] for the ROE. The numerator is adjusted every year for the change in the denominator due to revaluation of the stock of asset during the said year. As a matter of consequence, numerator and denominator change coherently.

We then obtain the following relations:

$$\text{ROE adjusted} = \frac{\text{net disposable income} + \text{net holding gains and losses}}{\text{net shareholder's equity}}$$

$$\text{ROCE adjusted} = \frac{\text{net operating surplus} + \text{holding gains and losses on } \textit{capital}}{\text{net capital}}.$$

For all these indicators, the net operating surplus is defined before taking into account the intermediate consumption of financial services indirectly measured. In the case of France, this amounts to going back to the 1995 base year methodology of national accounts. In this respect, interest paid includes the financial services indirectly measured.

The adjusted indicators fit broadly with the current developments in private accounting. Indeed, taking into account asset price changes is one of the challenges of the accounting reform that has recently concerned firms at the international level. This reform has led to notable changes, especially in countries like France. The former approach, known as "prudent," had two consequences. On the one hand, income and charges were accounted for in the year they appeared. On the other hand, potential losses on assets were systematically accounted for, while potential profits were recorded only in exceptional cases. The new approach recommends revaluing, for each financial year, a much broader set of assets, in a symmetrical way, whether positive or negative, and even revaluing some liabilities at the price they could be realized at this time. Such holding gains and losses are recognized either directly in the profit and loss account or in equity. The International Accounting Standards Board (IASB) is thus defending a broad concept of profit ("comprehensive income"). This profit would not only include the net current profit, but also the variation in the value of the assets and liabilities recorded in shareholders' equity. As it is based on expectations, this approach adds to the measurement of corporate profit a source of variability that is difficult to interpret. Private accounting experts are thus trying to promote a profit concept based on a level of recurrent performance ("current operational profit").

Conversely, national accountants are reluctant to introduce holding gains and losses to build current accounts.[4] As a matter of fact, the latter hardly correspond to the production of a good or a service, except in the case of financial institutions, for which they are considered as trading margins in the new SNA. If they were considered as imputed property income, savings would increase, while the revenue is only potential and more than that, reversible. By ignoring holding gains and losses, however, national accounts omit the changes in asset prices that correspond

[3]Holding gains and losses on assets are net of holding gains and losses on liabilities.

[4]When realized, holding gains and losses impact on net lending/net borrowing requirements through the financial transactions.

to a change in the quality of the said asset or, in other words, to the potential generation of higher services by this asset. For example, an increase in the value of the stock of real estate may be caused by higher expected rents in the future, due to scarcity. By contrast, if the price of existing equipment falls due to an increase in the quality of new equipment, the holding losses acknowledge the fact that existing equipment will provide in the future poorer services than the new ones. Regarding financial assets, an increase in the share price of one identified company results from higher anticipated profits generated by this company in the future[5] and thus from higher property income to be received in the future in the form of dividends.

Such a debate regarding alternative definitions of income has not been taken on board in the SNA 2008 but has been included in its long-term research agenda. Clearly, national accounts cannot abandon such a debate to corporate accounting alone, as they have to play a major role in the assessment of the efficiency of national productive organization as well as in its financing. Indeed, national accounts add value to corporate accounts because they are exhaustive, time consistent, and internationally harmonized, while it is not the case for corporate accounts, despite the definition of international accounting standards (IAS). In France, IAS are implemented by quoted companies for their consolidated accounts, but other companies apply French Generally Accepted Accounting Principles (GAAPs). Both of these standards differ from U.S. GAAPs and the definition of holding gains and losses in the profit and loss accounts is a particularly notable reason for divergence, due to different proportions of potential holding gains. By contrast, while excluding holding gains and losses from the standard presentation, national accounts provide them in accumulation accounts, according to definitions that are similar in all countries. As a conclusion, the relevant series in order to compute and compare profitability ratios using alternative definitions of income are available in national accounts while they are scarcely available in corporate accounts.

Except for the volume and the value of capital stock, and consequently the consumption of fixed capital, the data used to compute the profitability indicators are taken directly from the national accounts, as described in Appendix 1. In particular, realized and potential holding gains and losses on financial assets are available within the financial accounts.

As regards the stock of fixed capital, national accounts methodologies vary between countries, making it difficult to draw any international comparisons of indicators involving these data. For this reason, capital stock is computed here using the same method for France and the United States (see Appendix 2). The Permanent Inventory Method (PIM) is used, assuming a geometric decay. For each capital product, a specific scrapping rate is used, assumed to be the same in the two countries.[6] In this way, the homogeneity across countries is guaranteed. Five capital components are distinguished (buildings, non-ICT equipment, com-

[5]This idiosyncratic change in the value of one share compared to the market is usually referred to as the β of the share.

[6]We use the expression "scrapping rate" here, instead of the usual expression "depreciation rate" to make clear that we focus exclusively at this stage on the retirement pattern of the capital stock, excluding all kind of change in value that may be taken into account when it comes to depreciation in a general sense.

TABLE 1
HYPOTHESES OF ANNUAL SCRAPPING RATES FOR THE VARIOUS COMPONENTS OF CAPITAL STOCK

		ICT		
Buildings	Non- ICT Equipment	Computer Equipment	Communication Equipment	Software
5%	15%	30%	15%	30%

puter equipment, communications equipment, and software). Given this distinction, under certain assumptions (see, for instance, OECD, 2001), the scrapping and depreciation rates are the same, and consequently gross capital and net capital at constant price are identical. Table 1 presents the scrapping rates by product. These data stem from Cette *et al.* (2006).

For each one of the five products, the stock of capital at constant price varies as a function of the accumulation of investment flows at constant price (Gross Fixed Capital Formation, GFCF) and of the scrapping rate. At current price, there is a valuation effect and the dynamics of capital stock are not only related to GFCF at current price and to the consumption of fixed capital (CFC), but also to changes in net worth due to nominal holding gains or losses (HGL).

By aggregation, changes in the total capital stock depend on its structure by product. Hence, the price/volume breakdown of the components matters.

In this domain, the breakdown of capital expenditure according to volume and price in the national accounts is based on methodological choices that vary from one country to another (see Cette *et al.*, 2000). These different choices may be called into question, in particular as regards capital goods, since it may be argued that this type of product is likely to be rather similar across developed countries. Hence, in order to be able to assess the possible impact of such different choices on profitability measures, we have adopted the following strategy for the purpose of comparison: we take as given the price/volume breakdown as it is presented in the U.S. national accounts and use two sets of equipment deflators for France. The first one is directly based on the deflators of the French national accounts. The second one is computed according to the method put forward by Colecchia and Schreyer (2001), whereby the equipment deflators for France vary in relation to the French value added deflator, in the same way as in the United States.

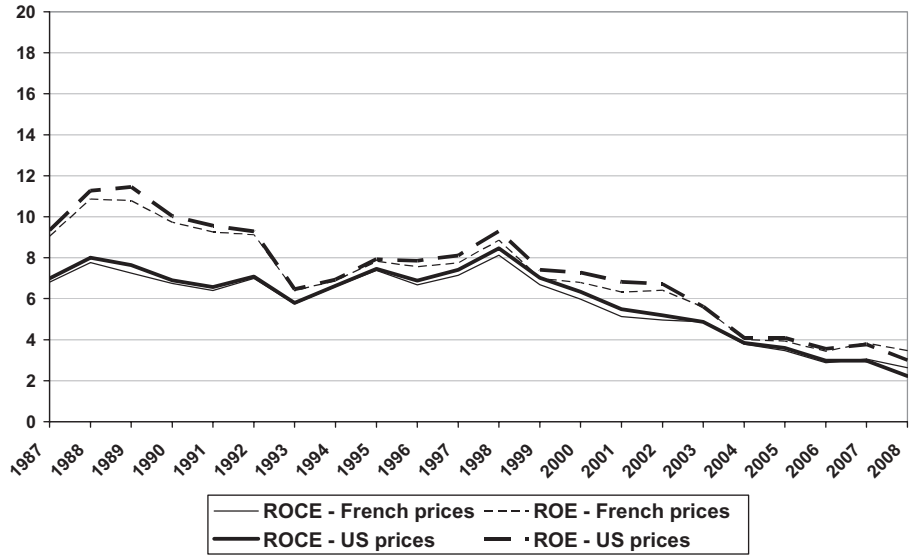
Conversely, as regards buildings, the deflators have not been corrected, relying only on national sources. Indeed, the discrepancies between the two countries are supposed to be more legitimate. The deflator used is the implicit revaluation index (see Appendix 2). Holding gains and losses added to the numerator of adjusted ROE and ROCE are directly computed from these different deflators.

3. MAIN RESULTS

Deflators

Deflators are presented in Figure 1. First, for France, the method put forward by Colecchia and Schreyer (2001) for correcting the equipment deflators for

(A) Unadjusted Ratios



(B) Adjusted Ratios

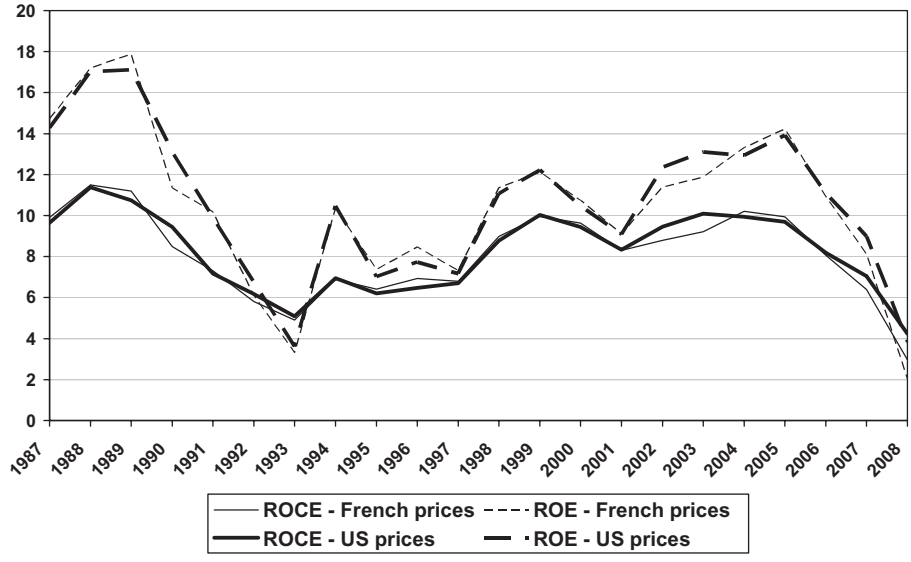


Figure 1. Indicators of NFC Profitability for France, Comparison of French and American Deflators (in %)

Source: Calculations by the authors using national accounts data.

France slightly increases the measured profitability of firms, with either adjusted or unadjusted indicators, but the impact of this correction remains of second order when compared with the United States.

Adjustment of Profitability Measures

Profitability measures are presented in Figure 2. Although the unadjusted ratios appear more stable in the United States than in France, two different periods may be identified in the case of the United States: an upward trend between the mid-1980s and the mid-1990s, and a downward trend after that. In France, the trend is downward sloping for the ROE over the entire period under review; it is more stable at the beginning of the sample for the ROCE, but also downward sloping as from the end of the 1990s.

Taking into account holding gains and losses changes the picture for the two countries. The common downward trend that starts in the 1990s disappears with the adjusted ratios. Conversely, an upward trend is noticeable in both countries until 2005.

On the whole, the unadjusted ratios fail to actually reflect the current financial conditions but somehow reflect the underlying trend, as it is often argued that asset prices incorporate forward looking elements. Given that their assets are constantly revalued, NFCs have to be more profitable in order to earn a return on this more expensive capital. Hence, the trend in profitability would be more accurately reflected by unadjusted measures.

The variability of the adjusted ratios is also markedly different from that of the unadjusted ratios. These differences may be explained by various effects caused by business cycle fluctuations. In particular, the decline in asset values increases the magnitude of the fall in the downturn of 1992 in the case of the United States and of 1993 in the case of France, as well as that in 2008 in both countries.

Comparison between France and the United States

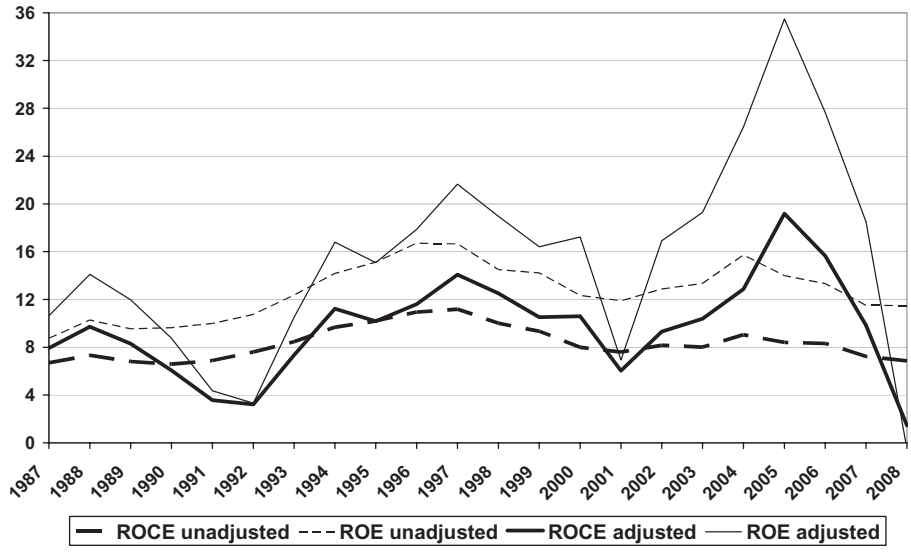
A comparison between France and the United States is presented in Figure 3. With unadjusted indicators, firms' profitability in France was similar to that in the United States at the end of the 1980s. But from the mid-1990s profitability appears definitely lower in France than in the United States, by 2–4 percentage points as regards the ROCE, and 6–15 percentage points as regards the ROE. With adjusted indicators, the discrepancy is much more volatile, but basically fluctuates around what is measured by the unadjusted ratios.[7]

Such a persistent discrepancy in favor of the United States is difficult to interpret since, conceptually, it should not persist with capital mobility. At this stage, one may venture that this discrepancy is due to differences in financial behavior across countries,[8] differences in regulation, especially with regard to

[7]The use of series from the 2000 database and series adjusted for the United States changes the results described by Durant (2005) and Cordier and Durant (2004).

[8]The return on financial assets is far higher in the United States than in France. That reduces the cost of net debt and thus increases the return on equity in the former country compared to the latter.

(A) United States



(B) France

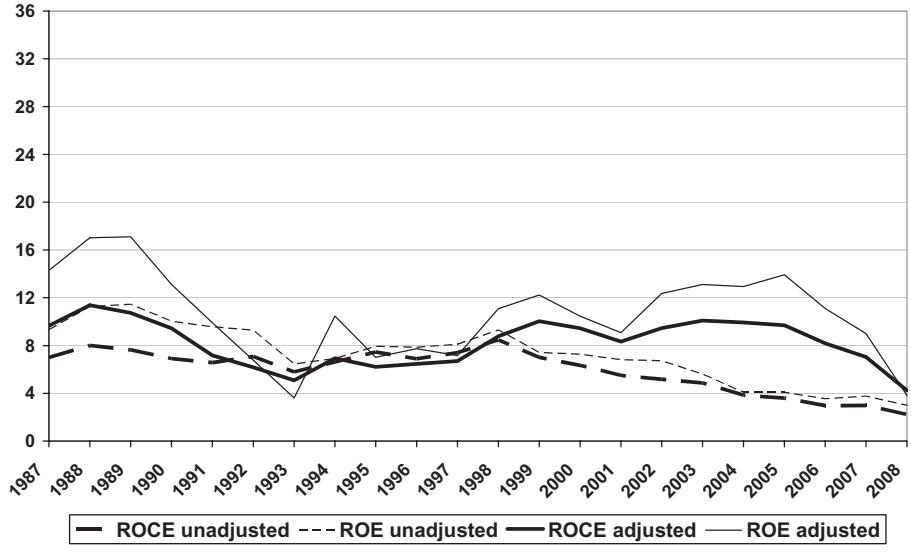


Figure 2. Indicators of NFC profitability, unadjusted and adjusted (in %)
Source: Calculations by the authors using national accounts data.

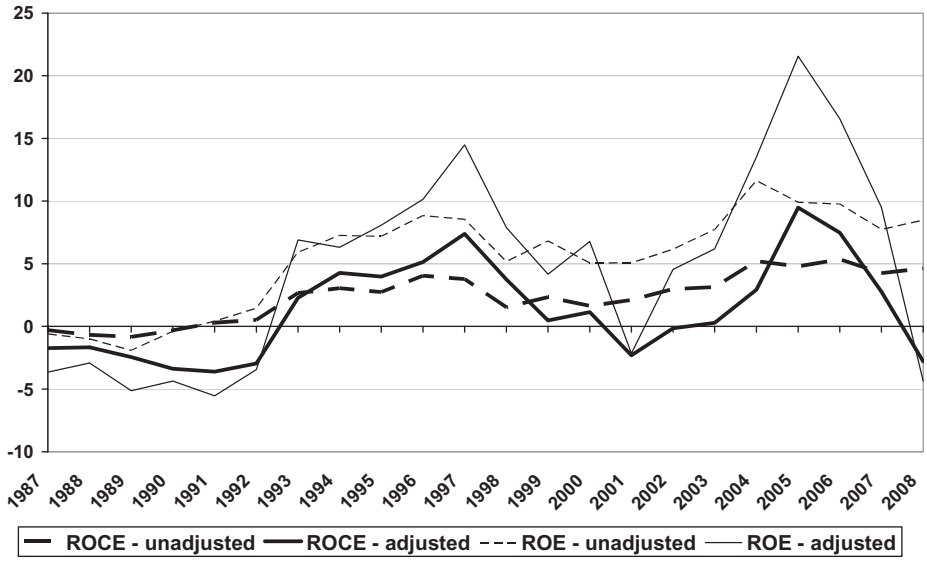


Figure 3. Gap between Rates of NFC Profitability (United States–France)

Note: American prices are taken into account as regards France; expressed in points.
Source: Calculations by the authors using national accounts data.

taxation,[9] and statistical differences, especially with regard to valuation of buildings. This discrepancy in favor of the United States does not appear at the end of the 1980s and, for adjusted indicators, in 2008. This could suggest that the high profitability of U.S. non-financial corporations was not sustainable. But it will only be possible to test this explanation in a few years.

Economic Analysis

Although the financial crisis has accelerated the phenomenon, the downward adjustment in the adjusted measures of profitability dates back to 2006, one year before the commonly accepted start of the financial turmoil. In 2008, these measures were of the same order of magnitude as those recorded during the 2002–03 recession in the United States and France.

The rise and fall of real estate prices thus clearly appears in our adjusted measures, especially in the United States, but also to some extent in France. Indeed, in the United States, the indicators are pushed downward to zero in 2008 due to holding losses on financial assets and real estate prices that exceed a somewhat depressed net operating surplus. In France, non-financial corporations only experience a decrease in holding gains in 2008, which adds to a reduced net operating surplus compared to 2007.

[9]The calculated apparent tax rate used in this study is higher in France than in the United States, while the hierarchy is reversed as far as nominal tax rates are concerned (in 2007, 40 percent in the United States and 33.4 percent in France). This may be due to differences in the tax base or in derogation opportunities. A thorough analysis of such an effect does not come within the scope of this study.

4. Concluding Remarks

The main result of this analysis is that taking into account holding gains and losses on assets has an important effect on the assessment that may be made of the developments in corporate profitability. This effect appears both in France and in the United States. The discrepancies between the two types of indicators, adjusted and unadjusted, have been very substantial since the end of the 1990s. The declining trend in French corporate profitability, which appears to have lasted almost ten years as regards unadjusted indicators, is less clear if one looks at adjusted indicators. In the United States, the economic downturn of 2008 is not captured in unadjusted indicators compared to 2007, as the fall in net operating surplus in the numerator is offset by the fall in real estate values in the denominator. However, with adjusted indicators, which correct the paradoxically positive effect of the fall in asset prices, corporate profitability decreases markedly between 2005 and 2008 and even becomes negative in 2008.

Nevertheless, this analysis remains incomplete. In particular, we do not explain why corporate profitability is almost always (since the early 1990s, except in 2001 and 2008) higher in the United States than in France. This gap could be explained by differences in financial and taxation structures or in statistical measurements from national accounts. It may also be noted that this gap does not appear at the end of the 1980s and, with adjusted indicators, in 2008. This could mean that the high profitability of U.S. non-financial corporations was not sustainable. But it will only be possible to test this explanation in a few years.

In 2009, given that real estate prices are likely to continue falling, quite substantially in the United States and to a lesser extent in France, the adjusted indicators should continue to decrease in the two countries and possibly even remain negative in the United States. They would remain positive in France. But, contrary to the results observed in the long term, the unadjusted ratios would provide, this year, a more positive view of the underlying profitability of firms due to the fall in the price of capital.

Appendix 1: Two Methods for Computing the Rate of Return on Equity (ROE) and the Rate of Return on Capital Employed (ROCE)

In the following, the variables are:

R_f:	ROE
R_e:	ROCE
π:	inflation rate
K:	capital = productive fixed assets + inventories + net trade credit + net receivables
DN:	net debt = issued debt securities + loans incurred – deposits held – loans granted – securities other than shares and mutual fund shares held
FP:	net shareholder's equity = shares issued – shares held + net worth = K – DN
ENE:	net operating surplus
INP:	net interest paid, before FISIM being imputed

T: tax other than taxes on products
AdjRel: holding gains and losses on capital, not taxed in the model, imputed to the numerator of ROCE
AdjFin: net holding gains and losses on financial assets minus liabilities, not taxed in the model, imputed to the numerator of ROE

The general formula is: $R_f = R_e + (R_e - r) \times \frac{DN}{FP}$.

r is the after-tax real apparent cost of net debt: $r = \frac{(1-\tau) \times INP - \pi DN}{DN}$.

It is after tax because it takes into account the tax savings achieved by using debt financing rather than equity financing, since interest is tax-deductible in every country. It is real because it is adjusted by the amount corresponding to the devaluation of debt due to inflation. It is apparent because it is obtained from the ratio of net interest actually paid over the period to net debt. It is net because it is calculated as the ratio of net interest to debt net of financial assets such as deposits, loans, securities other than shares and mutual fund shares.

τ is the apparent tax rate $\tau = \frac{T}{ENE - INP}$.

As regards unadjusted ratios:

$$R_f = \frac{ENE - INP - T + \pi DN}{FP} \text{ and } R_e = \frac{(1-\tau) \times ENE}{K}.$$

These definitions are consistent with the general formula as demonstrated below.

$$\begin{aligned}
R_f &= \frac{ENE - INP - T + \pi DN}{FP} \\
&= \frac{ENE - INP - \tau(ENE - INP) + \pi DN}{FP} \\
&= \frac{(1-\tau) \times ENE - (1-\tau) \times INP + \pi DN}{FP} \\
&= \frac{(1-\tau) \times ENE}{K} \times \frac{K}{FP} - \frac{(1-\tau) \times INP - \pi DN}{DN} \times \frac{DN}{FP} \\
&= \frac{(1-\tau) \times ENE}{K} \times \frac{FP + DN}{FP} - \frac{(1-\tau) \times INP - \pi DN}{DN} \times \frac{DN}{FP} \\
&= \frac{(1-\tau) \times ENE}{K} + \left[\frac{(1-\tau) \times ENE}{K} - \frac{(1-\tau) \times INP - \pi DN}{DN} \right] \times \frac{DN}{FP} \\
&= R_e + (R_e - r) \times \frac{DN}{FP}
\end{aligned}$$

As regard adjusted ratios:

$$R_f = \frac{ENE + Adj\,\mathrm{Re}l - INP - T + \pi DN + AdjFin}{FP} \text{ and } R_e = \frac{(1-\tau) \times ENE + Adj\,\mathrm{Re}l}{K}.$$

These definitions are consistent with the general formula:

$$
\begin{aligned}
R_f &= \frac{ENE + Adj\,\mathrm{Re}l - INP - T + \pi DN + AdjFin}{FP} \\
&= \frac{ENE + Adj\,\mathrm{Re}l - INP - \tau(ENE - INP) + \pi DN + AdjFin}{FP} \\
&= \frac{(1-\tau)\times ENE + Adj\,\mathrm{Re}l - (1-\tau)\times INP + \pi DN}{FP} + \frac{AdjFin}{FP} \\
&= \frac{(1-\tau)\times ENE + Adj\,\mathrm{Re}l}{K} \times \frac{K}{FP} - \frac{(1-\tau)\times INP - \pi DN}{DN} \times \frac{DN}{FP} + \frac{AdjFin}{FP} \\
&= \frac{(1-\tau)\times ENE + Adj\,\mathrm{Re}l}{K} \times \frac{FP + DN}{FP} - \frac{(1-\tau)\times INP - \pi DN}{DN} \times \frac{DN}{FP} + \frac{AdjFin}{FP} \\
&= \frac{(1-\tau)\times ENE + Adj\,\mathrm{Re}l}{K} + \left[\frac{(1-\tau)\times ENE + Adj\,\mathrm{Re}l}{K} - \frac{(1-\tau)\times INP - \pi DN}{DN}\right] \\
&\quad \times \frac{DN}{FP} + \frac{AdjFin}{FP} \\
&= R_e + (R_e - r)\times \frac{DN}{FP} + \frac{AdjFin}{FP}
\end{aligned}
$$

Appendix 2: Capital Stock

A2.1. *Formulae*

i denotes a given product, which may be buildings, computers, communication equipment, software, or non-ICT equipment.

On the basis of a fixed scrapping rate δ_i, specific to each product (see Table 1), capital stock at constant prices is assumed to show a geometric decline:

$$K_t^i = (1-\delta_i)\cdot K_{t-1}^i + I_t^i. \tag{A2.1}$$

On the basis of this equation, we take as given the fact that the conditions are such that the scrapping rate and the depreciation rates are the same (see, for instance, OECD, 2001). Then, using a valuation index p_t^i, the capital stock of product i at current price is consistently:

$$p_t^i \cdot K_t^i = p_{t-1}^i \cdot K_{t-1}^i + \underbrace{p_t^i \cdot I_t^i}_{\text{GFCF}} \underbrace{- p_t^i \cdot \delta_i \cdot K_{t-1}^i}_{\text{CFC}} + \underbrace{\Delta p_t^i \cdot K_{t-1}^i}_{\text{HGL}} \tag{A2.2}$$

and, by summation over the five products, total capital stock is:

– at constant prices:

$$\begin{cases} K_t^S = \sum_{i=1}^{5} K_t^i \\ \text{hence:} \\ K_t^S = \left(1 - \sum_{i=1}^{5} \frac{K_{t-1}^i}{K_{t-1}^S} \cdot \delta_i\right) \cdot K_{t-1}^S + I_t, \quad \text{with: } I_t = \sum_{i=1}^{5} I_t^i. \end{cases} \tag{A2.3}$$

The second equation in (A2.3) shows that the scrapping rate of total capital stock, $\left(\sum_{i=1}^{5}\frac{K_{t-1}^{i}}{K_{t-1}^{S}}\cdot\delta_i\right)$, is a weighted average of the scrapping rates by product δ_i, the weights being given by the structure of the capital stock by product.

– at current prices:

$$p_t^i\cdot K_t^S=\left(\sum_{i=1}^{5}\frac{K_{t-1}^{i}}{K_{t-1}^{S}}\cdot p_{t-1}^{i}\right)\cdot K_{t-1}^{S}\underbrace{+p_t\cdot I_t}_{\text{GFCF}}\underbrace{-\left(\sum_{i=1}^{5}\frac{K_{t-1}^{i}}{K_{t-1}^{S}}\cdot\delta_i\cdot p_t^i\right)\cdot K_{t-1}^{S}}_{\text{CFC}}+\underbrace{\left(\sum_{i=1}^{5}\frac{K_{t-1}^{i}}{K_{t-1}^{S}}\cdot\Delta p_t^i\right)\cdot K_{t-1}^{S}}_{\text{HGL}}. \tag{A2.4}$$

This formula again shows the role of the structure of capital stock by product at the aggregate level, in each of the components, except the gross fixed capital formation.

A2.2. *Initial Conditions*

In order to use an equation like (A2.1), an initial condition K_1 is needed for K. We will write it as: $K_1 = k + I_1$, where k is unknown.

From:

$$K_t=(1-\delta)K_{t-1}+I_t \tag{A2.5}$$

we may write, solving recursively from date $t = 1$:

$$\begin{aligned}K_t&=(1-\delta)^{t-1}(I_1+k)+\sum_{j=0}^{t-2}(1-\delta)^j I_{t-j}\\&=k(1-\delta)^{t-1}+\sum_{j=0}^{t-1}(1-\delta)^j I_{t-j}.\end{aligned} \tag{A2.6}$$

In addition, on a steady state growth path, where K and I would grow at the same constant rate g, the following relation would hold:

$$\frac{K}{I}=\frac{1+g}{g+\delta}. \tag{A2.7}$$

We then choose to fix the value of k so that the average value of $\frac{K_t}{I_t}$ over the sample is equal to $\frac{1+\bar{g}}{\bar{g}+\delta}$, where $\bar{g}$ is the average growth rate of investment over the same sample of observations, in other words, k such that:

$$\frac{1}{T}\sum_{t=1}^{T}\frac{K_t}{I_t}=\frac{1+\bar{g}}{\bar{g}+\delta}. \tag{A2.8}$$

From which we have:

$$k = \frac{T\dfrac{1+\bar{g}}{\bar{g}+\delta} - \displaystyle\sum_{t=1}^{T} \frac{\displaystyle\sum_{j=0}^{t-1}(1-\delta)^{j} I_{t-j}}{I_t}}{\displaystyle\sum_{t=1}^{T} \frac{(1-\delta)^{t-1}}{I_t}}. \tag{A2.9}$$

A2.3. *Deflators*

For Equipment

For the United States, we use for each type of equipment the GFCF deflators from the national accounts, denoted p_{US}. For France, we first use the GFCF deflators from the French national accounts (p_{FR}). We then correct these deflators in such a way that the corrected deflators (denoted $\tilde{p}_{FR}$) vary in relation to the French value added deflator (pq_{FR}) in the same way that the corresponding GFCF deflator for the Unites States moves in relation to the value added deflator (pq_{US}). Then:

$$\tilde{p}_{FR} = p_{US}\frac{pq_{FR}}{pq_{US}}. \tag{A2.10}$$

For Buildings

For both the United States and France, we use the implicit revaluation index computed in the following way.

If the value of an asset at the end of period t, A_t, may be broken down on the basis of its value at time $t-1$, A_{t-1}, net flows F_t and a revaluation R_t, as:

$$A_t = A_{t-1} + F_t + R_t.$$

Then, the growth rate of the implicit revaluation index p_t may be approximated by:[10]

$$\dot{p}_t = \frac{2R_t}{A_t + A_{t-1} - R_t}. \tag{A2.11}$$

One may then recover the revaluation index p_t under the convention that $p_{2000} = 1$.

[10]For details on this formula, see "Les comptes de patrimoine et de variation de patrimoine base 2000," système français de comptabilité nationale, Insee, Banque de France, Trésor Public, No. 10, January 2008, A3, pp. 108–9. http://www.insee.fr/fr/indicateurs/cnat_annu/base_2000/documentation/methodologie/nb10.pdf

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