Why and How Should Human Capital be Measured in National Accounts?

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Abstract – There is currently a significant divergence in the way in which education expenditure is perceived in economic theory and in national accounting: the former treats it as investment, the latter as consumption. In fact, the accounting framework is still structured around two major production factors (labour and physical capital), whereas human capital appears to be essential if certain current phenomena are to be perceived accurately, notably the resurgence of inequality in certain countries. This paper presents the work undertaken to incorporate human capital into national accounts and explores the two main methods used: that based on costs (inputs) and that based on income (output). We go on to use the inputs method to estimate the savings rate of USA, French and British households when education and health expenditure is transferred to investment. Only the inclusion of health expenditure would enable the USA savings rate to be redressed significantly.

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Although "human capital" was first evoked by Adam Smith (1776), the articles of Schultz (1961, 1962) and Becker (1962) have contributed decisively to the inclusion of this concept in modern economic theory. In the view of these authors, agents' education expenditure is an investment with a view to the accumulation of a stock of knowledge, namely human capital. Conversely, in national accounting, the education expenditure of the various institutional sectors (households, public administrations) is a consumption expenditure: agents consume (and therefore destroy) an education service, meaning that this operation does not give rise to the accumulation of any assets: human capital does not appear in the accounts of the agents' assets or, *a fortiori*, in the national accounts.

In fact, this conceptual divergence between the national accounting framework and the economics theoretical framework seems to be particularly salient in certain ongoing economic debates. Two important points should be mentioned in this regard:

- The dualism of the labour market, particularly the consequences it can generate in terms of income inequality. Many studies carried out in recent years seem to suggest that capital income is of secondary importance in the resurgence of income inequality in recent decades and that human capital now plays a much more central role in the genesis of such inequality. Other analyses indicate, conversely, that human capital at best only explains some of the inequalities currently being observed. In fact, the (international) accounting framework, which is still founded today on a productive model based on two factors, labour and physical capital, fails to support the economic theory with empirical data, which is nonetheless crucial to these issues.

- Currently, the accounting framework still adopts a fairly narrow definition of household investment, which is limited to the household's acquisition of immovable property. Extending the scope of household investment expenditure to education or health would in fact have a direct impact on the estimation of household savings. However, household saving behaviour (as well as these factors) is, again, at the centre of numerous macroeconomic debates of recent decades, whether considering the regular fall in savings rates of USA households since 1980 or, conversely, the notably high level of savings rates of Chinese households (Chamon & Prasad, 2010), which is probably largely responsible for the "saving glut" identified in 2005 by Bernanke (2005).

This paper focuses on all of these issues, exploring in particular how national accounting could incorporate human capital into its accounts. The first section sets out an overview of the research studies relating to the resurgence of income inequality over the past thirty years or so in numerous developed countries, placing human capital at the heart of this key economic debate. After having briefly looked at the way in which human capital is perceived by economic theory (section 2), we set out the empirical studies undertaken over several decades, with a view to estimating human capital accounting series, exploring in particular the two principal methods – costs (or input) method and income (or output) method – used in these studies. These two approaches generally result in substantially different estimates. As the output method is very cumbersome to implement, we set out certain results of recent studies which produced human capital series using this method, notably for the USA. The final section focuses on the input method to construct alternative indicators to the savings rate of USA, French and British households, once their education and then health expenditure is deducted from consumption. While such an approach seems to have an impact on savings rate levels, the effect on changes to those levels appears modest, education expenditure having remained relatively stable (as a percentage of gross domestic product – GDP) in the countries under consideration.

1. The Role of Human Capital in the Resurgence of Income Inequality

Following the seminal paper of Solow (1956) on economic growth, human capital rapidly came to be considered as an essential contributing factor to growth. Denison (1962) establishes a positive correlation between the Solow residual and education, thereby paving the way for an extension of economic growth factors and for the first attempts to estimate human capital and its returns. These studies concluded with the analysis of Mankiw *et al.* (1992), who offer an extended version (incorporating human capital) of Solow's model, which they then estimate for an international cross-section, valuing human capital using secondary school enrolment rates in the countries under consideration.

Human capital also plays a key role in the analysis of inequality. The resurgence of significant income inequality in certain developed countries since 1980 has therefore resulted in various academic studies in recent years. Indeed, the resurgence of inequality in

numerous English-speaking countries over the past three decades has led to challenges to the idea, illustrated in the "Kuznets curve", that the relationship between development and inequality is bell-shaped.[1]

Historically, and rather simplistically, it could be said that the national accounting framework lent itself perfectly to the analysis of inequality, given that such inequality was based principally on the distinction between a minority of the population, drawing its wealth from capital income (capital income characteristically being highly concentrated at that time) and the rest of the population, receiving income from labour. In these circumstances, income inequality remained closely linked to primary income distribution, and therefore entirely in line with the national accounting framework. The fall in inequality observed in most developed countries during the first half of the twentieth century is due to the spectacular fall in the income held by this small minority at the top end of the income scale, which Piketty (2001), following Keynes, classes as euthanasia of the rentiers (there are multiple causes: war, the 1929 crisis, increasing use of progressive taxation). While capital income has represented a relatively stable share of income throughout the twentieth century, it is now distributed across a much wider spectrum of the population: it is substantially "diluted" across a relatively sizeable middle class.

As of 1970, inequality resurfaces but does not in any way seem to be connected (at least until recently) to a revival of rentiers. The factors behind this resurgence are now fairly clear, with two principal explanations generally given. Firstly, globalisation: following the Hekscher-Ohlin-Samuelson (HOS) model, international specialisation is based on the factors available to the different economies; accordingly, rich countries, having substantial physical and human capital available, will specialise in goods intensive in these factors (high technology sectors, etc.) whereas developing countries specialise in sectors intensive in unskilled labour. This rise in inequality in developed countries (to which this section is devoted) can nevertheless be combined with a reduction in inequality at a global level, resulting from a fall in inequality between developed countries and developing countries (Bourguignon, 2015). Secondly, technical progress: new information and communication technology is produced by qualified workers (IT professionals, engineers, etc.) and replaces unskilled labour – as well as, increasingly, the routine tasks of intermediary professions (see Autor *et al*., 2008) in production chains. Technical progress is therefore biased in favour of skilled labour (Acemoglu, 2002).

Until recently, most academic studies concluded that biased technical progress was, by far, the principal factor explaining the increase in inequality (Berman *et al.*, 1994). However, recent studies are more nuanced and show the growing influence of globalisation on income inequality in countries, notably in the USA (Acemoglu *et al*., 2016). In fact, the two factors put forward are based on the same market mechanisms: the increase in inequality in developed countries results from the fall in demand for unskilled labour and the corresponding increase in demand for skilled labour (the curves move in a similar way in both explanations, but the causes of the "shocks" differ). Therefore, it is clear that the inequality trends are now occurring even within the sphere of labour earnings alone and that, whatever explanation is adopted, they are caused by differing trends in the demand for unskilled labour (simple labour) and skilled labour (human capital). However the national accounting framework in force is founded implicitly on a production function based on two major factors: labour and physical capital. It is therefore less suited to the analysis of the interaction at play within the domain of labour earnings itself, between skilled and unskilled labour. Furthermore, this framework is all the more outdated given that the boundary between pay for labour and pay from capital now appears to be increasingly blurred, shareholders seeking, within a principal-agent relationship, to bring managers' interests in line with their own: performance-related bonuses, stock-options, etc.

According to Goldin & Katz (2010), the resurgence of inequality can only be accurately perceived by focusing exclusively on company demand for human capital: the supply of human capital, which partially depends on the level of investment in education by the public authorities, must also be taken into consideration. While the skill biased technical change theory focuses on the specific features of ICT, affecting the demand for skilled and unskilled labour in different ways for the past thirty years or so, Goldin and Katz argue that, conversely, the

1. According to this curve, economic expansion is initially associated with an increase in inequality (between those instigating the expansion and benefiting from it fully and the rest of the population). Subsequently, this inequality narrows, the entire population ultimately benefiting from the economic development in terms of both productivity and pay, through diffusion and generalisation.

increase in demand for human capital is not recent: the difference between the 1950-1980 and 1980-2010 periods is due primarily to changes in the supply of human capital: regular growth until 1980 (in the case of the USA) therefore occurred alongside the increase in supply, but was followed by stabilisation. It is therefore the "race between education and technology" which explains the increase in inequality, demand for skilled labour growing more rapidly than the stock of human capital since 1980. According to Verdugo (2014), this analysis also explains the trajectory of income inequality in France since 1950: inequality effectively widened until 1965 and then narrowed, remaining relatively stable after 1980. Unlike in the USA, however, the investment effort in education was relatively late in France and took place primarily in the 1950s and 1960s; there was a delayed impact on the supply of human capital, which explains the growth in income inequality during the so-called "thirty glorious years". Conversely, and contrary to the USA, the investment effort in education continued in the 1980s and 1990s, which may explain why France was spared the return of inequality in recent decades.

The study undertaken by Autor (2014) confirms very clearly that in the United States, the speed of the rise in real incomes is closely linked to the level of study, notably since the start of the 1980s, which confirms the role of human capital in the widening of inequality. Piketty (2013), on the other hand, points out that, in the USA, the upper percentile of employees, that of super-managers or managers of large groups, has monopolised a very substantial share of the increases in the national wage bill for the past thirty years. Other interpretations of inequality have therefore been put forward: according to Gabaix & Landier (2008) in particular, the increase in Chief executive officers' (CEOs) remunerations can be explained by large groups competing to recruit the most talented individuals, as only they are able to respond to a constantly changing, increasingly unstable environment. However, not everyone agrees with this analysis: Bertrand & Mullainathan (2001) demonstrate that managers' pay is governed more by luck than by their performance (companies benefiting from noticeable positive shocks which are entirely distinct from managers' strategy pay those managers better than companies which do not have the benefit of such shocks). For these authors, the asymmetric information relationship between shareholders and managers enables managers to determine their own pay in many situations. More generally, authors such as Piketty (2013) and Krugman (2007) consider the institutional, or "sociological", dimension, which encouraged both the surge in income for super-managers and the decline in income at the lower end of the distribution of earnings (particularly in the USA): fall in the real minimum wage (Lee, 1999), erosion of the power of trade unions (Lemieux, 2008), capacity of the current economic elites to modify, to their advantage, social norms (on this point, see Akerlof, 1980) which were put in place long ago, notably during the second world war, the time of the great compression (see Goldin & Margo, 1992) and in the immediate post-war era, to limit wage dispersion.

Lastly, certain authors have placed human capital at the heart of inequality, whilst others downplay its explanatory power in the current era, when other factors seem to play an equally essential part: talent, luck, social norms. Human capital is therefore undoubtedly at the heart of the inequality debate, but measuring it often remains problematical. This is also one of the principal criticisms made by Weil (2015a) of Piketty's book "Capital in the Twenty-First Century": the analysis in the book is based on an empirical study which is most impressive, but never seeks to develop human capital series.

Before moving on to the question of the valuation of human capital within the framework of national accounting, the following section briefly explains how it is perceived in economic theory.

2. Human Capital in Economic Theory

The introduction of human capital into the marginalist framework of economic theory goes back to the work of Schultz (1961, 1962) and Becker (1962, 1964): the individual adopts maximising behaviour to determine the optimal level of education (schooling) he or she should attain. The marginal return to human capital is assumed to be decreasing or (which means the same thing) its marginal cost is increasing[2]: the stock of knowledge which can be acquired through education is limited (at least at a given point in time); the closer the individual gets to the "frontier' of knowledge, the harder it is to acquire marginal knowledge and the greater the (intellectual) effort required. Assuming (which

2. It should be noted that several important contributions to the theory of endogenous growth (for example Lucas, 1988 or Romer, 1990) advance a theoretical framework combining reducing human capital returns at a private (or microeconomic) level and constant, or increasing, returns at a social (or macroeconomic) level, as a result of the existence of a positive externality relating to the stock of human capital.

is highly theoretical) that human capital is a discrete "variable" – that is, it can be divided into distinct units which can be accumulated – the acquisition of each additional unit requires more time to be spent on training than the previous unit, which results in an increasing marginal cost (of human capital). Added to this principle is the fact that the marginal financing of education is also generally increasing: often free or subsidised in the initial years, higher education has to be paid for in many countries and can also require the agent to incur debt, etc. It is important to include in the costs of education the additional costs of transport or accommodation associated with education (notably higher education) and not to overlook its opportunity cost, notably foregone earnings as a result of the decision to continue to study, therefore delaying entry into the labour market; consideration can also be given to the time devoted by parents to their children's educational success.

Moreover, and although investment in human capital is generally reduced to education expenditure, Becker notes that for it to be effective, human capital needs to be "carried" by individuals in good health: a broad vision of investment expenditure should therefore incorporate health expenditure and even agents' expenditure on food (health expenditure notably enables agents' life expectancy and therefore, presumably, their intertemporal utility would be increased). In a first step, the analysis is limited to education expenditure.

In human capital theory, earnings reflect both unskilled labour (which would be achieved without any qualification) and the human capital acquired by the agent, namely the premium associated with qualification, or skill-premium. Here again, it may be assumed, on a highly theoretical basis, that the market will set a "skill-premium rate" representing pay for a unit of human capital. In other words (although this is one of several possible models), the earnings w received by an employee can be broken down as follows:

$$w = w_L + h.w_H \quad (1)$$

where w_L is the earnings rate for unskilled labour, w_H is the "skill-premium rate" and h is the number of units of human capital accumulated by the agent.

The agent will therefore seek to determine the optimal number h of units of human capital which he/she must accumulate considering as a given the skill-premium rate w_H and assuming an increasing marginal cost of this human capital. Using a marginalist calculation, the agent can therefore compare the cost and income associated with any additional unit of human capital which he/she may obtain. To determine this income, the fact that the associated gain $\partial h.w_H$ will be received by the agent throughout his/her working life must of course also be taken into consideration: it is therefore necessary to compare cost and the discounted amount of additional income generated by this additional cost.

The agent pursues his/her studies for as long as the (discounted) marginal income exceeds the marginal cost. At the point of equilibrium, marginal cost and marginal income are equal but average income is clearly quite likely to exceed average cost. In theory, however, the gain associated with the acquisition of human capital therefore encourages new (young) agents to accumulate human capital: this additional supply (of human capital) on the qualified labour market ultimately causes a fall in w_H, meaning that in terms of dynamics, the gain associated with human capital will reduce, or even disappear altogether: in the long term equilibrium, average cost and average revenue (and therefore ultimately total cost and revenue) are equal.

In theory, therefore, the value of the human capital accumulated by the agent can be estimated by valuing either the costs of education he/she pays, or (since the result should be the same) the discounted income flows generated by his/her level of education. The first approach represents a costs-based valuation of human capital (input method), the second an income-based valuation (output method).

Of course, in reality, all agents do not have the same capacity to access human capital, for reasons which are potentially very varied: different cultural baggage inherited from parents, different personal predispositions, or the existence of an imperfect financial market, making funding impossible for certain people. Moreover, the risk associated with investment in human capital (notably failure at school) may dissuade certain risk-averse agents from undertaking study, unless this risk is offset by a high premium (Abraham, 2010). All of these factors reduce the aggregated investment volume and explain the continued discrepancy between marginal return and marginal cost at the equilibrium. In these circumstances, the discounted average income from the human capital exceeds

its average cost at the equilibrium, meaning that these two approaches give different results, the output method therefore giving an estimate of human capital which is higher than for the inputs method.

3. Attempts to Value the Investment in Human Capital and Its Stock

The inputs method consists of valuing the stock of capital acquired by agents using the overall cost of the studies pursued by agents. This overall cost represents the sum of the production cost of non-market education services supplied by the public sector and the value of the market production of education sold by private entities. To estimate the stock of capital in the economy, it is then necessary to construct an investment time series and then aggregate this time series data, determining a depreciation rate for human capital.

A first difficulty associated with this method relates to the fact that the cost of study must also include the opportunity cost associated with pursued training, namely the total discounted earnings foregone by agents in order to pursue their studies. The time spent by parents helping their children with their school work must also be valued. One of the first studies carried out using this method was conducted by Kendrick (1976), who estimates that opportunity cost represents at least half of the total education costs. Another difficulty associated with this method is the distinction between price effect and volume effect (as is often the case in services): what share of the increase in production costs over time is attributable to an improvement in the "quality" of the education system? Notwithstanding these difficulties, this method has the benefit of being relatively easy to implement. The estimation of the stock of human capital is based, in this method, on a prior valuation of the investment for successive periods. However, this method requires a rate of depreciation of human capital to be determined.

The income approach (discounted lifetime income approach) is far more technical. It was first proposed and applied to the USA economy by Jorgenson & Fraumeni (1989), then it was refined in numerous subsequent studies, and now features in this context in the System of National Accounts 2008 (European Commission *et al.*, 2009) or in the very comprehensive United Nations Guide on Measuring Human Capital (UNECE, 2016). This method is based on determining the value at which an individual could resell, at any time, the human capital he/she has accumulated if it was not "embodied" in the person. The method of valuing human capital is therefore identical to that applied to a financial asset. In these circumstances, this method starts by valuing the stock of human capital in the economy for successive periods. Gross investment in human capital corresponds to the additional discounted future income received by all agents undertaking a further year of studies during the period under consideration.

Assuming that agents can work for a maximum of N periods (it is assumed here that agents reach age 1 when they are at working age) but that they can decide to initially dedicate between 0 and n (from N) periods ($n < N$) to training. n is an integer and the level of human capital attained is given by the number of years of study undertaken: $h = 0,1,2\ldots n$.

In theory – and making the simplified assumption that continuous training during working life is impossible – computing at a date t the value of the stock of capital of an agent who has already entered working life (having finished studying), aged a and having a level of training h involves estimating future income earned throughout his/her remaining working life:

$$KH_{A,a,h,t} = \sum_{i=0}^{N-a} \frac{h.\left(w_h\right)_{t+i,a+i}}{\left(1+r\right)^i} \qquad (2)$$

where $KH_{A,a,h,t}$ is the discounted value (in t) of the stock of human capital of a working individual (A), aged a and having a level of training $h \leq n$, $\left(w_h\right)_{t,a}$ is the annual skill-premium in period t of an agent aged a having accumulated h units of human capital during his/her training; r is the discount rate and N is the end of the agent's working life (retirement). It is immediately clear that the older an individual, the more his/her future income flow is reduced, thus decreasing the value of his/her human capital which depreciates over time, falling to nil when the individual reaches retirement age. Accordingly, net investment in human capital in t is deduced by the difference between the stocks of human capital estimated in (t+1) and the stocks estimated in t (Christian, 2010; McGrattan, 2010).

In practice, the current income in t of the older cohorts will be used to value all future income of agents (Figure I): to calculate, for example, $\left(w_h\right)_{t+1,a+1}$, the data available in t will therefore be used, that is $\left(w_h\right)_{t,a+1}$. It is simply assumed that, for a given level of training, the earnings

(or skill-premium) of an individual aged a increase at the constant rate g over time, so that $(w_h)_{t+1,a} = (1+g)(w_h)_{t,a} \ \forall t$

In these circumstances, equation (2) above can be rewritten as follows:

$$KH_{A,a,h,t} = h.(w_h)_{t,a} + \sum_{i=1}^{N-a} \frac{h.(w_h)_{t+i,a+i}}{(1+r)^i} = h.(w_h)_{t,a} + \sum_{i=0}^{N-(a+1)} \frac{h.(w_h)_{t+1+i,a+1+i}}{(1+r)^{i+1}} \quad \forall a < N$$

$$KH_{A,a,h,t} = h.(w_h)_{t,a} + \sum_{i=0}^{N-(a+1)} \frac{h.(w_h)_{t+i,a+1+i}(1+g)}{(1+r)^{i+1}} \quad \forall a < N$$

Finally, we have:

$$KH_{A,a,h,t} = h.(w_h)_{t,a} + \frac{1+g}{1+r} \sum_{i=0}^{N-(a+1)} \frac{h.(w_h)_{t+i,a+1+i}}{(1+r)^i} = h.(w_h)_{t,a} + \frac{1+g}{1+r} KH_{A,a+1,h,t} \ \forall a < N \quad (3)$$

It should be noted that, in this theoretical model, an agent who does not pursue any training ($h = 0$) has a stock of human capital of nil which will not prevent him/her from receiving earnings income w_L as payment for the unskilled labour undertaken throughout his/her life (according to (1)).

Calculating the value of the stock of capital in t of an agent undertaking his/her studies in theory involves determining the maximum level of training that he/she wishes to or will attain and then estimating, as for assets, his/her future income once he/she starts working life, which will be received throughout his/her professional career:

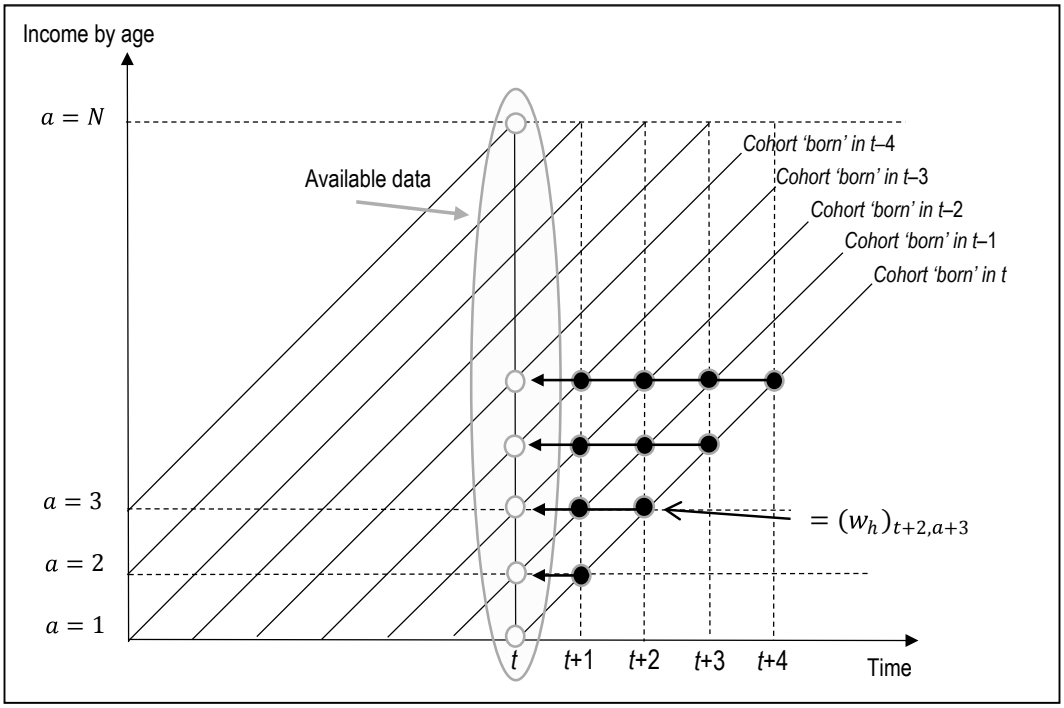
$$KH_{E,a,h,t} = \sum_{i=0}^{N-a} \frac{h.(w_h)_{t+h-a+1+i,h+1+i}}{(1+r)^{h-a+1+i}} \quad (4)$$

where $KH_{E,a,h,t}$ is the discounted value of the stock of human capital of an individual undertaking study (E), aged a (in t) and having an expected final level of training of $h \leq n$.

Furthermore, contrary to what has been stated above, agents will not necessarily live for N working periods and reach retirement age because they may die during their working life. It is therefore also necessary to calculate the one-year survival rates of agents of different ages. The one-year survival rate of an agent aged a is therefore recorded as $s_{a,a+1}$ ($a < N$). Agents may also become unemployed or decide to withdraw from the labour market. It is therefore necessary to keep account of the rates of employment $e_{a,h}$ for each group under consideration (by age and level of training).

Another empirical difficulty relates to the determination of the optimal level of training of an agent undertaking study in the period t under consideration. Here again, the statistics for previous generations will be used to estimate the

Figure I – **The methodology of the income-based method: Reconstitution of a fictional cohort**



likelihood enr_{y+1} that students already having y years of study ($y < n$) will continue their studies for one further year.

Lastly, it is assumed that the survival rates at each age as well as the likelihood of study being continued at each level of training are constant over time: therefore, the available data on past cohorts can be used to estimate these future values.

Empirically, equation (3) is therefore written as:

$$KH_{A,a,h,t} = e_{a,h} h.\left(w_h\right)_{t,a} + s_{a,a+1}.\frac{1+g}{1+r}.KH_{A,a+1,h,t} \quad (5)$$

Similarly, it can easily be shown that (4) is written:

$$KH_{E,a,h,t} = s_{a,a+1}\left[enr_{h+1}.\frac{1+g}{1+r}.KH_{E,a+1,h+1,t} + \left(1-enr_{h+1}\right).\frac{1+g}{1+r}.KH_{A,a+1,h,t}\right]$$

Lastly, the aggregate human capital equates to:

$$KH_t = \sum_{a=1}^{N}\sum_{h=0}^{n}\left(KH_{E,a,h,t} + KH_{A,a,h,t}\right)$$

Note also that separate stocks of human capital are generally constructed for each gender.

In their 1989 paper, using data constructed using this method, Jorgenson & Fraumeni assert that investment in human capital represents four times the gross fixed capital formation (GFCF) appearing in the national USA accounts. The value of human capital is also likely to correspond to at least seven times the value of the stock of "traditional", non-human capital, again estimated in the national accounts. The study undertaken by Liu (2014) in fifteen OECD countries shows that, in most countries, the ratio of the value of human capital (estimated using this method) to nominal GDP varies between nine and eleven; the value of human capital represents between four and seven times that of non-human capital. Liu (2014) also shows that this method enables an index for the volume of capital to be determined, based in particular on structural effects and their progression in each population group considered: changes in the percentage of the population attaining each level of study, structure by age, employment rate, and structure by gender within each group.

Additionally, this method allows for a comparison of stocks of capital for each level of qualification in each country: the growing divergences observed in certain countries are explained by an increase in the earnings differential but, in certain cases, the divergence also results from the growing numbers of people accessing higher levels of study.

A number of difficulties associated with this method of estimation can nevertheless be identified. A first important criticism addressed by Weil (2015b) is that Jorgenson & Fraumeni (1989) ultimately reduce to two (or rather, maintain at two) the number of factors in the economy's production function: physical capital and human capital. "Unskilled", unqualified labour has disappeared altogether, to the extent that the authors use the entire earnings received by agents in calculating the discounted income flows. With the notation used in this paper, Jorgenson and Fraumeni estimate $w = w_L + h.w_H$, without restricting payment for human capital to the sole component $h.w_H$. This approach can be justified in "our" developed economies where schooling is compulsory in childhood and no individual is now entirely devoid of human capital. This observation, however, sits uncomfortably with a reality in which the productivity of young people leaving the education system early stands at a low level. It may prove relevant to retain the distinction between unskilled labour and human capital, notably to analyse income inequality, although measuring pay for unskilled labour can be problematic: how can the threshold between unskilled labour and skilled labour be determined? Weil (2015b) is of the view that pay for unskilled labour currently represents around half of global pay for labour (unskilled and skilled).

Abraham (2010) offers a detailed analysis of the difficulties associated with the technique used by Jorgenson & Fraumeni. Four essential aspects must be mentioned:

i) Use of a reconstituted fictional cohort: in this method, the income at the age of 60 of a young person aged 20 today is estimated using the current income of persons currently aged 60 (with the same level of education) to which a growth trend is applied (associated with gains in productivity), being constant over 40 years. This hypothesis assumes that returns on education are constant (or increase in a constant manner) over time, which is far from certain: the quality of teaching provided may change (or may have changed) over time; moreover, this hypothesis does not take into consideration the potential dynamic effects: for example, high returns to human capital today could increase the desire of young generations to seek further training, which will reduce the returns on education in future.

ii) No stock of capital is determined for children aged under 15. Any agent capable of working at the time of the valuation is effectively considered to carry human capital. However, such an assumption is open to debate, the discounted future income being capable of valuation (as expected income) as of the individual's date of birth (Christian, 2017). Similarly, any person who leaves the labour market, even temporarily, reduces the stock of human capital in the economy, which is far from satisfactory.

iii) The results are affected (primarily in terms of level rather than in terms of progression) by estimates of the discount rate r and growth rate g for wages (Liu, 2014). In fact, there is no reason for g to be constant over time or, most importantly, to systematically have the same effect across the entire wage (or qualifications) structure: technical progress may, at certain times, further increase the productivity of skilled or unskilled workers.

iv) Even more fundamentally, the income-based approach treats any increase in wages as growth in the value of human capital. Any wage differential based on the levels of training attained is explained entirely by the human capital differential. The relevance of this hypothesis is certainly open to question and one might wonder in particular what wage would be earned by qualified workers if they had not pursued any studies: when the wages of individuals having different levels of training are compared, selection bias can exist in the constitution of samples of both skilled and unskilled individuals. Is it not the case that certain individuals have individual attributes (personal talent, "cultural" or "social" capital inherited from parents) explaining why it is easier for them to pursue studies but also why they receive a higher level of pay than the rest of the population if they decide not to pursue their studies? If these individuals are more skilled, part of the wage differential could certainly be explained by their individual attributes. The studies of Gabaix & Landier (2008) may be referred to again here: in a relatively stable economic environment, it is not always necessary to discriminate between "talented" skilled persons and "untalented" skilled persons; in a fast-changing world where a company's success depends on its constant capacity to be innovative or flexible, qualification is not enough and companies will look for "talent" at least as much as "skills": wages will rise, but it is the payment for individual attributes which increases, not payment for human capital; in some aspects, this reasoning may bring to mind the signalling theory of Spence (1973), according to which investment in human capital is simply used to signify the intrinsic attributes of agents, without substantially increasing their productivity. Similar reasoning can undoubtedly be applied to the changes to wages norms for the super-managers referred to by Piketty in his book (2013): the spectacular increase in very high earnings is due more to the ability of a small minority (sometimes also highly qualified) to monopolise a very substantial share of the income from innovation than to a true increase in the intrinsic productivity of their human capital. From this perspective, the most emblematic empirical case is the finding that, at given level of human capital, the value of the capital stock of men is higher than that of women (Liu, 2014)! While part of this differential seems to be explained by women's lower participation rates, a significant part remains attributable to wage differentiation, which is difficult to explain by purely economic mechanisms.

Lastly, and to mitigate this final comment, everything depends on the definition attributed to human capital. The OECD (2011), for example, advances a fairly wide definition, incorporating both skills acquired as well as individual attributes, whether innate or inherited (UNECE, 2016). The method of Jorgensen & Fraumeni (1989) may therefore offer the opportunity to reveal the differentials in returns on human capital between sub-groups of the population (which remains, moreover, to be explained). Conversely, with a narrower definition of human capital, the fundamental question is to establish whether earnings reveal the productivity associated with human capital. The earnings differential between two individuals having the same level of education should not therefore be attributed to human capital. These two representations can, however, be reconciled if we consider that the alternative factors explaining increases in wages (talent, capacity to monopolise a profit, etc.) are often complementary to human capital, on which they rely in order to operate fully.

Accordingly, each of the two methods (input and output) offers advantages and disadvantages: the output method certainly enables focus to be placed on national trends, and potential divergences in returns between different sub-groups of the population to be analysed; the inputs method is undoubtedly easier to implement, requiring a smaller amount of data (primarily national accounting data), which facilitates international, or regional, comparisons. In

fact, estimates using the discounted income method lead to far higher valuations of the stock of human capital. This divergence may be explained, at least in part, by factors already referred to in the previous section (imperfections in the financial market, agents' risk aversion, etc.). But it certainly reveals the valuation difficulties which continue to affect both these methods: likely under-estimation of the inputs in the former (notably due to the existence of opportunity costs which are difficult to measure), likely over-valuation of the output associated with human capital in the latter (high sensitivity of the result to the discount rate, over-valuation of the skill-premium, etc., see Abraham, 2010; Fraumeni, 2011; UNECE, 2016).

4. How Should Education and Health Expenditure Be Allocated to the Gross Fixed (Human) Capital Formation for the Purposes of National Accounting?

The final part of this paper is dedicated to an analysis of the effect on the savings rate of the reallocation of certain items of consumption expenditure to investment expenditure. In fact, there are many alternative ways of measuring the savings rate, depending on whether or not durable goods (motor vehicles, large domestic appliances, etc.) are included in consumption, whether or not capital gains taxes are deducted from disposable income or non-redistributed company profits are paid back to individuals (Reinsdorf, 2007). Moreover, it has been established (Galiana *et al.*, 2017) that the household savings rate is affected by institutional factors such as the retirement regime (distribution *vs.* capitalisation) or taxation (direct *vs.* indirect). We do not attempt here to set out exhaustively the various empirical definitions and measurements of savings, but rather it aims to focus on the specific impact of human capital expenditure.

The introduction of human capital into a national accounting framework *via* a satellite account is explained by the United Nations Economic Commission for Europe (UNECE, 2016). In this satellite account, two alternative methods are proposed: it is assumed either that the institutional sectors meet the costs of education produced by human capital, or that households produce this capital themselves. To do this, they accordingly invest "intermediate goods for the production of human capital", which are primarily produced by other institutional sectors and used by households as intermediate consumption in their production activity. In the first case, the agents (public administrations, companies, etc.) no longer produce an education service (effectively consumed by households) but instead produce human capital directly, which is subsequently purchased in the form of investment (GFCF) by households – whereas, within the accounting framework defined by the System of National Accounts 2008 (European Commission, 2009), education expenditure is systematically recorded under consumption expenditure of the institutional sectors. In this case, the portion of this (household) investment expense which is imputed is funded by a resource of the same amount which is itself imputed (primarily from the public sector), recorded as a transfer of capital. In the second method, the production of human capital is imputed in the household account, estimated at its production cost, such cost including the "intermediate inputs" (for the production of human capital) produced by the other institutional sectors, and the time devoted by students to pursuing their studies (opportunity cost, recorded in uses in the household account under the form of mixed income). The intermediate consumption imputed (appearing under uses in the household production account) is the subject of a social transfer in kind (for an identical amount) from the sector which produced these "inputs" (principally public administrations). Households' market spending on education is transferred from their final consumption expenditure to intermediate consumption, as it is now associated with their human capital production activity. The time devoted to study increases households' disposable income and savings. The entire production of human capital (for its own account) is ultimately a GFCF household expense. In the first method, the resource imputed is a transfer of capital, which does not therefore affect either the household's disposable income, or savings (this transfer effectively takes place "downstream", in the capital account). In the second method, the resource imputed is a social transfer in kind (representing the amount of the intermediate inputs "purchased" from other institutional sectors), which increases both households' disposable income and savings. In aggregate terms, both methods therefore result in the same volume of national savings, but the first method increases the administrations' savings, unlike the second, which increases households' savings.

The next part focuses on the impact of education (and then health) expenditure on the savings rates of households alone, relying on the second

method of the satellite account for human capital presented above.[3] We also make a simplified estimation of the production value of human capital, which does not take account of the opportunity costs of education (similar methodology on this point to that of Kokkinen, 2008). This assumes that production of human capital and the associated intermediate consumption are of the same value, meaning that households' disposable income and savings are only increased by the amount of social transfers in kind (associated with education) from the public sector (and in no circumstances by an increase in mixed household income). It therefore suffices to transfer the (actual) consumption expenditure on education to households' GFCF, with a significant impact on the volume of their savings.

This type of analysis is especially interesting for countries where the household savings rate has varied significantly in recent decades. This is the case in particular for the USA, where the savings rate has fallen markedly since the early 1980s. We therefore concentrate firstly on the USA situation. Subsequently, estimates for two major European countries, Great Britain and France, are presented.

4.1. The USA Case

The fall in the savings rate in the USA is generally explained by wealth effects (Bostic *et al*., 2009), households' ease of access to credit, or imitation phenomena causing a large proportion of the American middle classes to increase its expenditure to attain a lifestyle akin to that of the most well-off, whose income has increased far more quickly than average (Barba & Pivetti, 2009), although most of these points seem to fail to entirely resolve the "puzzle" of USA savings (Guidolin & La Jeunesse, 2007).

In the next section, we return to Becker's "wide" definition of investment expenditure in human capital: therefore, firstly (market) education expenditure (narrow definition of human capital) is added to household savings followed, secondly, by health expenditure (wider definition).[4]

In the household account of the USA National Income and Product Accounts (NIPA), available household income includes the social benefits in kind represented by the Medicare and Medicaid public health schemes; moreover, this income is calculated prior to payment of contributions (including employer contributions) to private health insurance. These contributions are recorded, net of payments received, as consumption expenditure, under "health insurance". Consumption expenditure on health appearing in the household account therefore incorporates all "actual" household expenditure, except for that received on a non-market basis by the public health authorities.

Analysis of the household account alone shows that household education expenditure, albeit low, has grown significantly, from 0.6% of GDP in 1960 to 1.5% in 2017, having therefore increased 2.4 times. However (Figure II), this progression is not sufficiently marked to significantly modify their savings rate and, notably, to alter its course, the divergence between 1960 and 2018 nevertheless falling from 3.4 points to 2.3 percentage points (the divergence therefore narrowed by a third between these two dates).

It may be interesting at this stage to compare these results with the series for human capital and net investment in human capital recently constructed by Christian (2016)[5], using the output method on USA data. The author distinguishes "market" human capital from "non-market" capital (valuation of the opportunity cost of education). He also values the capital stock of persons aged over fifteen (active human capital) and that of children (nascent human capital). Irrespective of the coverage of the study, the data constructed by the author shows that net investment in human capital declined slightly (as a percentage of GDP) between 1975 and 2013 (Figure III). The national USA accounts conversely show that total (gross) expenditure associated with education compared with GDP has increased by around 0.5 percentage points during the same period (further, the portion of this expenditure met directly by households has increased slightly). However, Christian's estimates principally confirm that the non-market portion of this investment is on average over twice as high as the market portion, although it is true to say that this component is defined by the author very widely as household domestic production.

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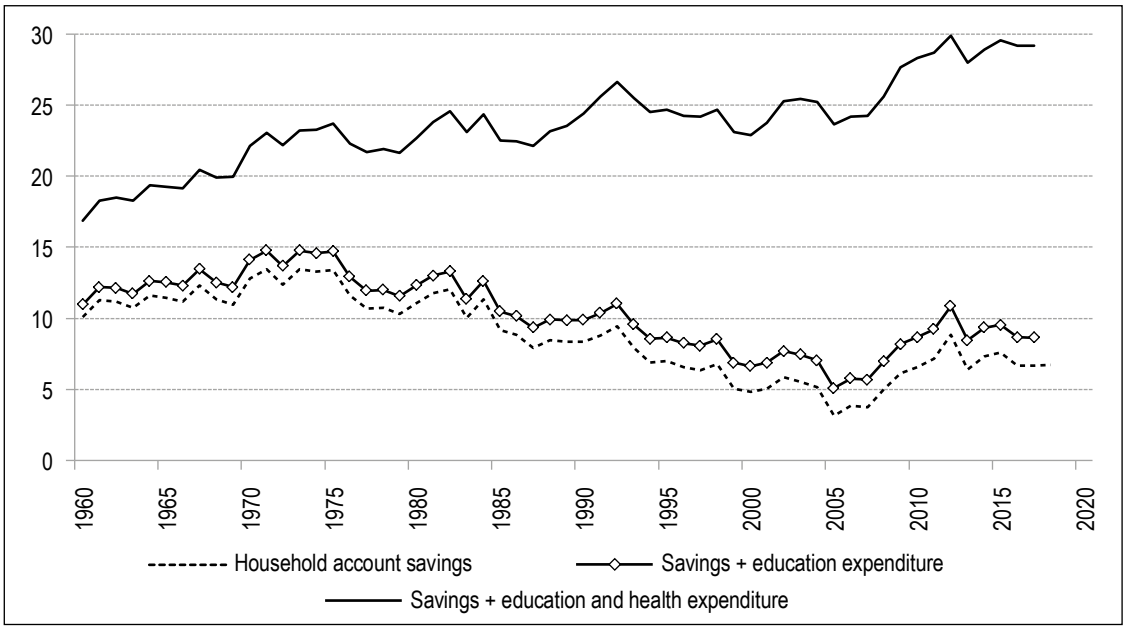
3. In this paper we only deal with education expenditure, ignoring the treatment of vocational training expenses incurred by businesses.

4. Up to this point, we have of course adopted a narrow definition (limited to education expenses), or a very narrow definition (excluding from human capital cultural capital which is difficult to acquire during studies, and attributes specific to agents). Moving to a wide definition of human capital at this stage, although this is suggested by Becker, therefore represents one of the limitations associated with this "exercise".

5. The values estimated by Christian (2016) are net rather than gross, unlike for Jorgenson & Fraumeni (1989); according to the author, the calculation of net values explains the significant differences in level obtained in the series produced, by comparison with those of Jorgensen & Fraumeni (1989).

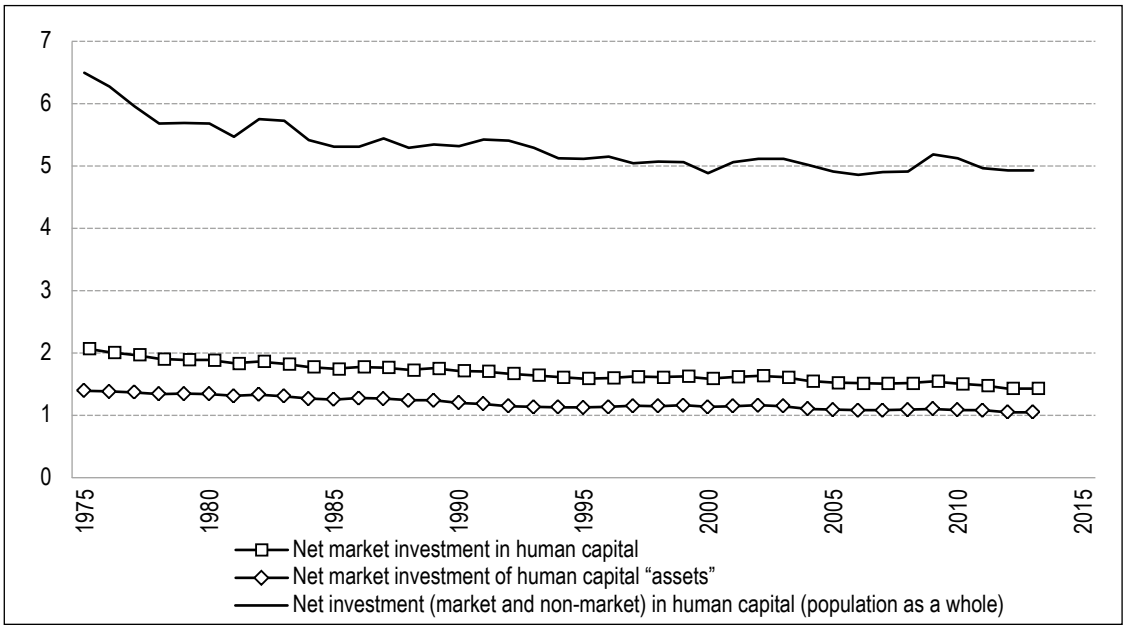
Figure II – **Calculations of savings rate (as a percentage of gross disposable income) for different definitions of savings, using the USA household account only, 1960-2018**



Sources: Bureau of Economic Analysis. NIPA. Author's calculations.

It should be noted that, in figure II, education expenditure does not include the opportunity costs associated with the pursuit of studies. If, like Kendrick (1976), we assume that these costs are proportionate to the "actual" expenditure, the impact of this omission on the progression of the savings rate remains modest. In the estimations made by Christian (2016) using the inputs method, the burden of this imputed expenditure (in total household education expenditure) has reduced; but in his estimates using the output method, this burden increases

Figure III – **Different indicators of net investment in human capital (Christian, 2016) as a percentage of GDP (NIPA), 1975-2013**



Sources: Christian (2016) and Bureau of Economic Analysis, NIPA. Author's calculations.

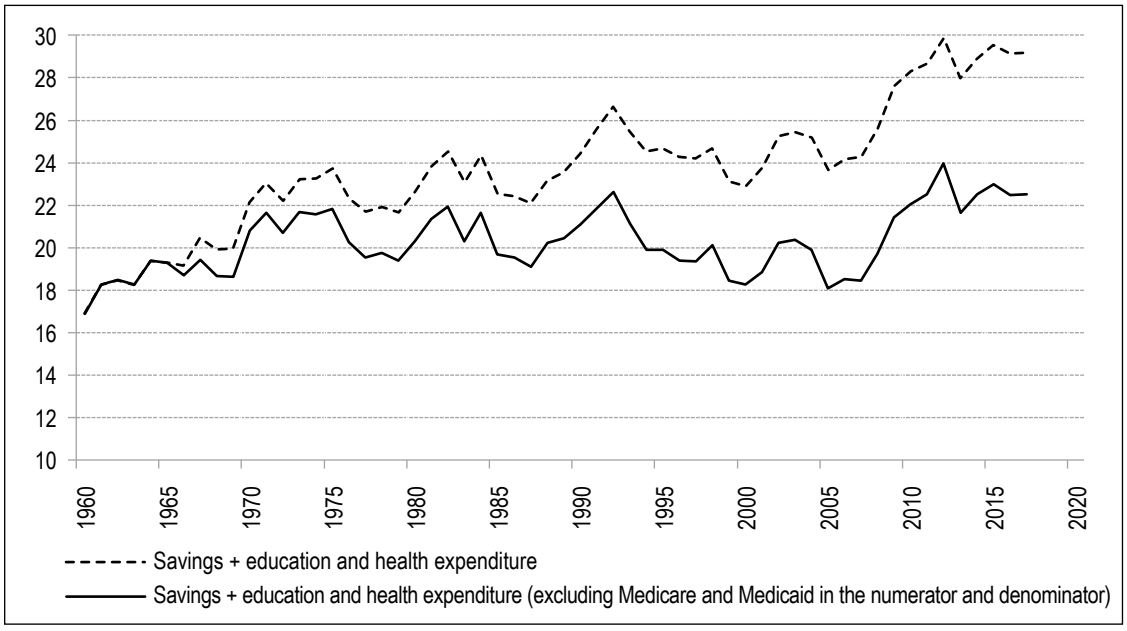
slightly. Moreover, the data provided by UNECE (2016) for Canada demonstrates that the portion of this expenditure imputed (in total education expenditure of Canadian households) has seen a spectacular increase, rising to as much as 11% of Canadian GDP in 2010, compared with only 2.2% in 1981 (on the situation in Canada, see in particular Gu & Wong, 2015). Accordingly, it is not entirely impossible that a refined estimation of the opportunity costs associated with education would, if taken into account, further adjust the savings rate of USA households (by the input method). The perception that, during recent decades, parents have attached growing importance to their children's educational success and have therefore "invested" more (primarily in non-monetary terms) in their "education" increases the likelihood of this happening.

The addition of health expenditure to savings, which undeniably reflects a far wider definition of human capital than that adopted so far in this paper, adjusts and even marginally reverses the trend in savings rates. The savings rate has also been computed excluding the Medicare and Medicaid schemes set up in 1965 from both the numerator and the denominator (Figure IV); this is therefore closer to the definition of gross disposable income (GDI) according to the European system of accounts, given that these schemes are social transfers in kind, which are included in adjusted gross disposable income (AGDI) but not in disposable income. The result is that this indicator is much more stable (around 20%) over a long period.

Conversely, households' "actual final consumption" of education and health can be calculated by adding the consumption expenditure of the public sector for these two items to theirs. In the accounts of the public administrations, final consumption expenditure (FCE) and investment expenditure (GFCF) per function are effectively available. It is therefore easy to access the education and health FCE of these public administrations.

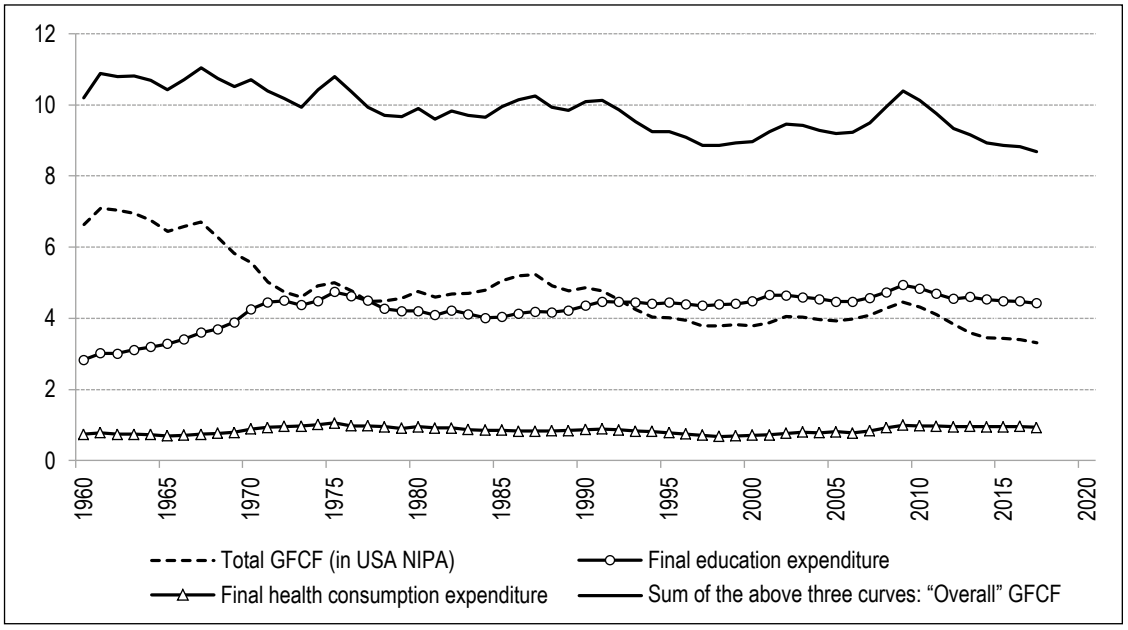
On the basis of the General government's accounts, it is possible, in the first instance, to estimate a "global" investment indicator for General government (related to GDP), by including their education and health FCE in their GFCF (Figure V). The ratio of (GFCF General government) / GDP provided by the NIPA shows a declining trend: since 1960, it has fallen by 3.3 percentage points. At the same time, consumption expenditure on education of General government (compared with GDP) has risen by 1.6 points, primarily between 1960 and 1970. Their health FCE has increased marginally (+0.2 points of GDP). Lastly, with this new measurement of the investment of General government, the declining trend is clearly less pronounced: only -1.5 points.

Figure IV – **Medicare and Medicaid included/not included in household health expenditure, 1960-2017**



Sources: Bureau of Economic Analysis, NIPA. Author's calculations.

Figure V – **GFCF expenditure of USA General government, as a percentage of GDP, 1960-2017**

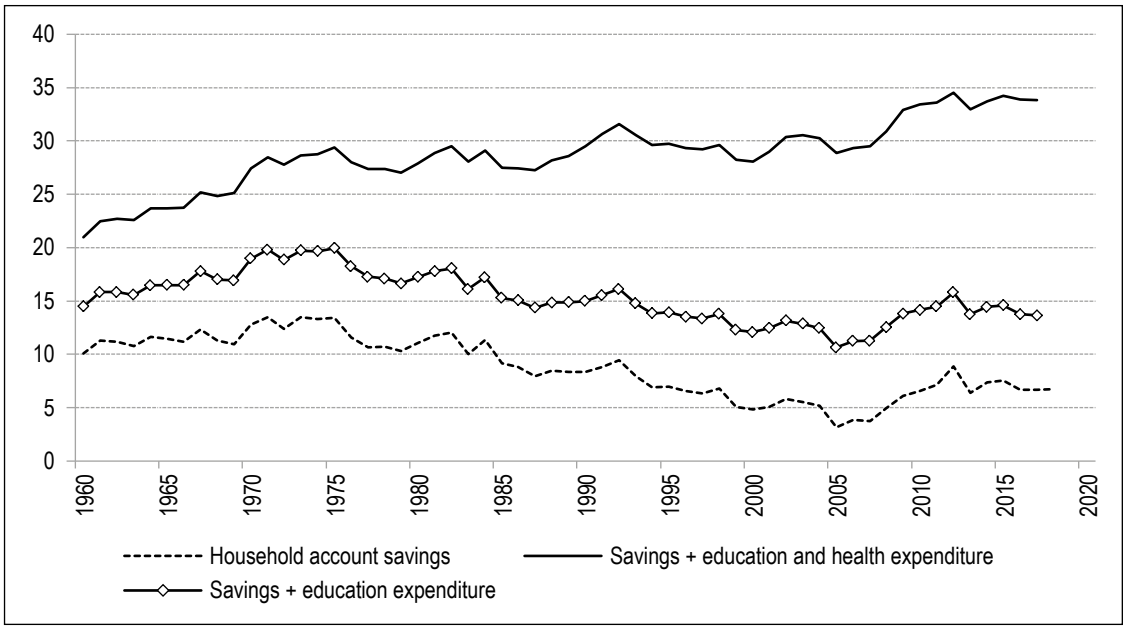


Sources: Bureau of Economic Analysis, NIPA. Author's calculations.

At this stage, household savings rates can therefore be calculated on the basis of their AGDI, by moving (by means of social transfers in kind added to their disposable income) all education and then health FCE of the public sector to the household account (Figure VI). The results obtained are quite similar, in terms of trends, to those computed using gross disposable income, although it is worth noting that the savings rate including household actual final consumption (AFC) on education practically returned to its 1960 level (14.5%) in 2017 (13.6%).

To conclude this section, the savings rate of USA households is only modestly redressed by the

Figure VI – **Different calculations of household savings rate (as a percentage of the "adjusted" GDI) using the accounts of USA households and General government, 1960-2018**



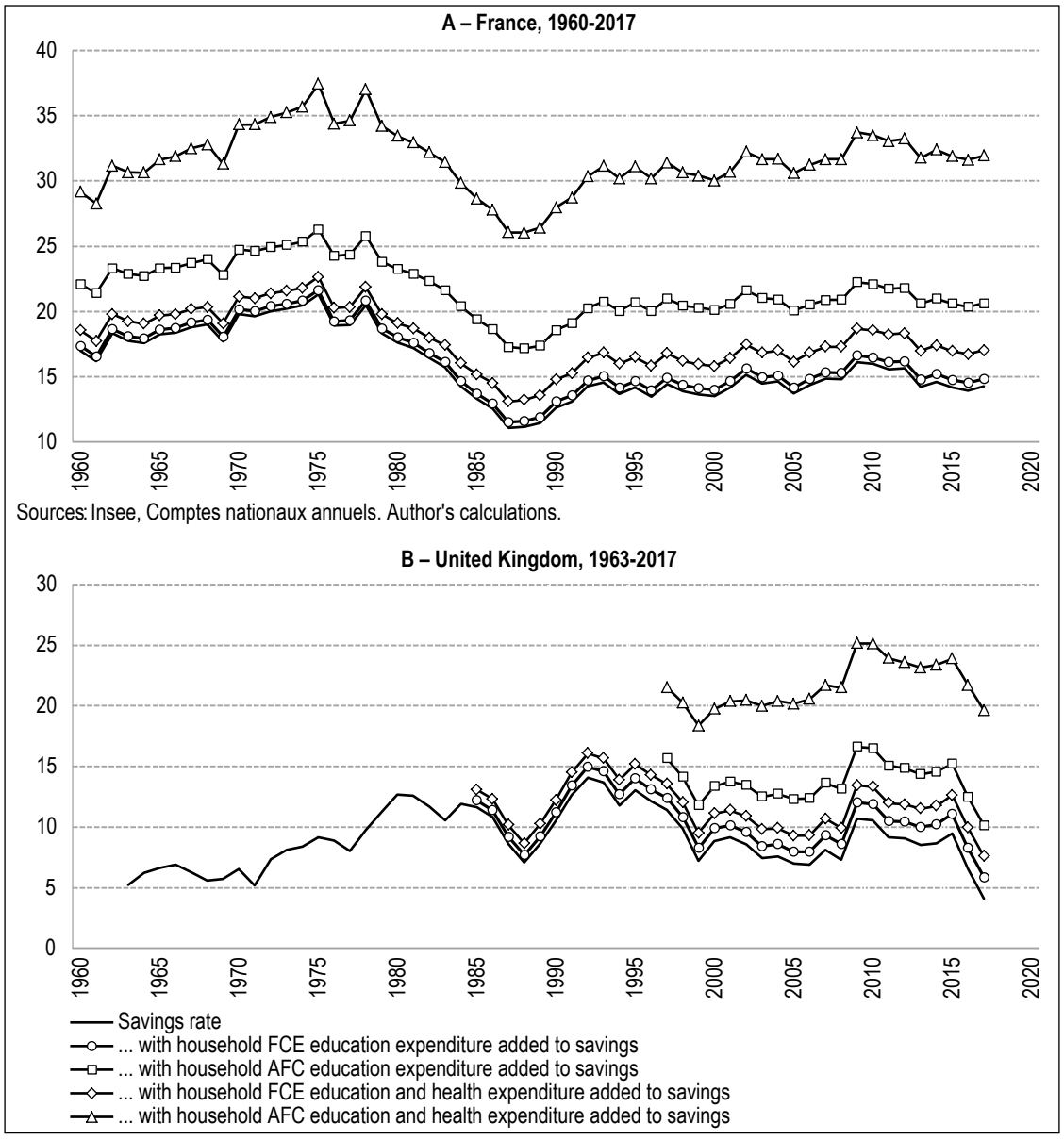
Sources: Bureau of Economic Analysis, NIPA. Author's calculations.

transfer solely of the education FCE to investment expenditure; the adjustment is improved for the indicator transferring education AFC rather than the FCE, but, in any event, the fall in the savings rate between 1980 and 2008 remains significant. This "restrictive" definition of investment in human capital does not in any circumstances explain the fall in the savings rate of USA households over almost 40 years. If, however, health expenditure is also added to investment, this savings rate is redressed significantly, therefore remaining relatively stable between 1960 and 2016.

4.2. The Case of Two European Countries: Great Britain and France

This final section sets out, still using the input method, alternative indicators for savings rates, once education (and then health) expenditure has been incorporated into the savings of French and British households. In both these countries, the household savings rate has seen no significant fall in recent decades, although the French rate experienced some fairly dramatic changes between 1975 and 1990; the rate for Britain is certainly fairly cyclical, but has remained stable

Figure VII – **Different calculations of savings rate (as a percentage of GDI and of AGDI) using the accounts of households and General government, 1960-2017**



Sources: Office for National Statistics, UK National Accounts. Author's calculations.

overall since 1963. The savings rate is computed, firstly, in the same way as for the USA, using the household account only, "transferring" their education and then health FCE to their savings; secondly, we proceed in a similar way but firstly construct a household AGDI, restricting social transfers in kind (from the public sector) solely to education and then health expenditure.

In the case of France, as national education expenditure has been very stable (around 4.5% of GDP) for several decades (and the portion of this expenditure paid by households has itself been both low and relatively stable), the alternative indicators have progressed in very similar ways to the "standard" savings rate (the curve incorporating education FCE into savings is in fact almost identical to the savings rate in the national accounts). With regard to health expenditure, household AFC has increased from 2.4% of GDP in 1960 to 6.8% in 2017, household FCE having increased far less rapidly (increasing from 0.9% to 1.3% during the same period): only the savings rate compared with the adjusted income (including actual health consumption) is therefore marginally redressed (Figure VII-A).

For Great Britain, data are only available on household education and health FCE since 1985 and on household AFC since 1997. The results obtained, however, appear similar to those obtained for France, the impact of alternative measures relating essentially to the indicator levels (Figure VII-B).

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While economic theory considers education expenditure as an investment, it is treated as consumption expenditure in the national accounting framework. This paper emphasises the point that for a long time economic work have been undertaken with a view to bringing the human capital factor into national accounts, some by adopting the input method (estimation of a stock based on investment expenditure incurred), others the output method (discounted income flows generated by the constitution of a stock). It is important to unerline in this conclusion how difficult this evaluation is, whichever method is adopted, which undoubtedly explains in part why, notwithstanding the attempts presented in this paper, national accountants have until now chosen not to take this step. Nevertheless, it seems that such an approach would enable national accounting frameworks to become more aligned with certain key debates between economists and would, undoubtedly, contribute to these debates and perhaps enable some areas of controversy to be resolved.

The construction of data on human capital clearly demonstrates that this is a production factor at least as important today as physical capital, and that this factor must be taken into account if we are to properly understand the productive dynamics of developed economies. We have used what is known as the input method to estimate a savings rate for USA, French and British households where education and health expenditure are considered as investment expenditure. The savings rate of USA households, which fell between 1980 and 2008, is only modestly redressed when only education FCE is transferred to investment expenditure (reduction of one third of the decline observed between 1960 and 2018). This may be explained, at least partially, by the fact that imputed education expenditure is not taken into consideration in the method adopted in this paper. Lastly, it emerges that health expenditure must be incorporated into investment in human capital if this savings rate is to be significantly redressed (and stabilised). For the two European countries considered, Great Britain and France, the alternative indicators have an impact on the savings levels, but not on their evolutions. □

BIBLIOGRAPHY

Abraham, K. G. (2010). Accounting for Investments in Formal Education. *Survey of Current Business*, 90(6), 42–53. https://fraser.stlouisfed.org/files/docs/publications/SCB/2010-19/scb_201006.pdf.

Akerlof, G. A. (1980). A Theory of Social Custom, of Which Unemployment May be One Consequence. *The Quarterly Journal of Economics*, 94(4), 749–775. https://doi.org/10.2307/1885667

Acemoglu, D. (2002). Directed Technical Change. *The Review of Economic Studies*, 69(4), 781–809. https://doi.org/10.1111/1467-937x.00226

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H. & Price, B. (2016). Import Competition and the Great US Employment Sag of the 2000s. *Journal of Labor Economics*, 34(1), 141–198. https://doi.org/10.1086/682384

Autor, D. H., Katz, L. F. & Kearney, M. L. (2008). Trends in U.S. Wage Inequality: Revising the Revisionists. *Review of Economics and Statistics*, 90(2), 300–323. https://doi.org/10.1162/rest.90.2.300

Autor, D. H. (2014). Skills, Education, and the Rise of Earnings Inequality Among the 'Other 99 Percent. *Science*, 344(6186), 843–851. https://doi.org/10.1126/science.1251868

Barba, A. & Pivetti, M. (2009). Rising household debt: Its causes and macroeconomic implications—a long-period analysis. *Cambridge Journal of Economics*, 33(1), 113–137. https://doi.org/10.1093/cje/ben030

Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy*, 70(5), 9–49. https://doi.org/10.1086/258724

Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago: University of Chicago Press.

Berman, E., Bound, J. & Griliches, Z. (1994). Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufacturers. *The Quarterly Journal of Economics*, 109(2), 367–397. https://doi.org/10.3386/w4255

Bernanke, B. (2005). The Global Saving Glut and the U.S. Current Account Deficit, *The Federal Reserve Board,* Remarks by Governor Ben S. Bernanke at the Sandridge Lecture, Virginia Association of Economists Richmond, Virginie. https://www.federalreserve.gov/boarddocs/speeches/2005/200503102/

Bertrand, M. & Mullainathan, S. (2001). Are CEOs Rewarded for Luck? The Ones Without Principals Are. *The Quarterly Journal of Economics*, 116(3), 901–932. https://doi.org/10.1162/00335530152466269

Bostic, R., Gabriel, S. & Painter, G. (2009). Housing wealth, financial wealth, and consumption: New evidence from micro data. *Regional Science and Urban Economics*, 39(1), 79–89. https://doi.org/10.1016/j.regsciurbeco.2008.06.002

Bourguignon, F. (2015). *The Globalization of Inequality*. Princeton: Princeton University Press.

Chamon, M. & Prasad, E. S. (2010). Why Are Saving Rates of Urban Households in China Rising? *American Economic Journal: Macroeconomics*, 2(1), 93–130. https://doi.org/10.1257/mac.2.1.93

Christian, M. S. (2010). Human Capital Accounting in the United States, 1994–2006. *Survey of Current Business*, 90(6), 31–36. https://fraser.stlouisfed.org/files/docs/publications/SCB/2010-19/scb_201006.pdf, p. 31.

Christian, M. S. (2016). Net Investment and Stocks of Human Capital in the United States, 1975-2013. *BEA Working Paper*.
https://www.bea.gov/research/papers/2016/net-investment-and-stocks-human-capital-united-states-1975-2013

Christian, M. S. (2017). Net Investment and Stocks of Human Capital in the United States, 1975-2013. CSLS, *International Productivity Monitor,* 33, 128–149. http://www.csls.ca/ipm/33/Christian.pdf

Denison, E. F. (1962). *The Sources of Economic Growth in the United States and the Alternatives before Us*. Committee for Economic Development. New York.

European Commission, IMF, OECD, United Nations & World Bank (2009). *System of National Accounts 2008*. New York. https://unstats.un.org/unsd/nationalaccount/docs/sna2008.pdf

Fraumeni, B. M. (2011). Human Capital Accounts: Choice of Rates and Construction of Volume Indices. NBER, *Working Paper* N° 16895. https://doi.org/10.3386/w16895

Gabaix, X. & Landier, A. (2008). Why has CEO Pay Increased So Much? *The Quarterly Journal of Economics*, 123(1), 49–100. https://doi.org/10.1162/qjec.2008.123.1.49

Galiana, L., Lafféter, Q. & Simon, O. (2017). Les taux d'épargne dans la zone euro : comment les comparer, comment les expliquer ? *In:* Insee (Eds), *Insee références, L'économie française - Comptes et dossiers édition 2017*, pp. 97–114. https://www.insee.fr/fr/statistiques/2894030?sommaire=2894036

Goldin, C. & Katz, L. F. (2010). *The Race between Education and Technology*. Cambridge: Harvard University Press.

Goldin, C. & Margo, R. A. (1992). The Great Compression: The U.S. Wage Structure at Mid-Century. *The Quarterly Journal of Economics*, 107(1), 1–34. https://doi.org/10.2307/2118322

Guidolin, M. & La Jeunesse, E. A. (2007). The Decline in the U.S. Personal Saving Rate: Is It Real and Is It a Puzzle? *Federal Reserve Bank of St. Louis Review*, 89(6), 491–514. https://doi.org/10.20955/r.89.491-514

Gu, W. & Wong, A. (2015). Productivity and Economic Output of the Education Sector. *Journal of Productivity Analysis* 43(2), 165–182. https://doi.org/10.1007/s11123-014-0414-y

Jorgenson, D. W. & Fraumeni, B. M. (1989). The Accumulation of Human and Nonhuman Capital, 1948-84. In: R. E. Lipsey and H. Stone Tice (Eds), *The Measurement of Saving, Investment and Wealth*, pp. 227–285. Chicago: University of Chicago Press. https://www.nber.org/chapters/c8121.pdf

Kendrick, J. W. (1976). *The Formation and Stocks of Total Capital*. New York: Columbia University for NBER. https://www.nber.org/books/kend76-1

Kokkinen, A. (2008). Human Capital and Finland's Economic Growth in 1910–2000. *30th General Conference of The International Association for Research in Income and Wealth* (IARIW). http://www.iariw.org/papers/2008/kokkinen.pdf

Krugman, P. (2007). *The Conscience of a Liberal*. New York and London: W. W. Norton & Company.

Lucas, R. E., Jr. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7

Lee, D. (1999). Wage Inequality in the United States During the 1980s: Rising Dispersion or Falling Minimum Wage? *The Quarterly Journal of Economics*, 114(3), 977–1023. https://doi.org/10.1162/003355399556197

Lemieux, T. (2008). The changing nature of wage inequality. *Journal of Population Economics*, 21(1), 21–48. https://doi.org/10.1007/s00148-007-0169-0

Liu, G. (2014). Measuring the Stock of Human Capital for International and Intertemporal Comparisons. *In:* D. W. Jorgenson, J. Steven Landefeld, & P. Schreyer (Eds), *Measuring Economic Sustainability and Progress*, pp. 493–544. Chicago: University of Chicago Press.

Mankiw, G., Romer, D. & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2), 407–437. https://doi.org/10.2307/2118477

McGrattan, E. R. (2010). Comment on Michael Christian's "Human Capital Accounting in the United States, 1994–2006". *Survey of Current Business*, 90(6), 37–41. https://fraser.stlouisfed.org/files/docs/publications/SCB/2010-19/scb_201006.pdf, p. 37.

Mira, M. & Liu, G. (2010). The OECD Human Capital Project: Progress Report. *31st General Conference of The International Association for Research in Income and Wealth* (IARIW). http://www.iariw.org/papers/2010/5Mira.pdf

OECD (2010). *The OECD Human Capital Project: Progress Report*. Paris.

Piketty, T. (2001). *Les Hauts revenus en France au 20e siècle : inégalités et redistribution, 1901-1998*. Paris: Grasset.

Piketty, T. (2013). *Le capital au XXIe siècle*. Paris : Seuil. English edition, 2014: *Capital in the Twenty-First Century*. Harvard University Press.

Reinsdorf, M. B. (2007). Alternative Measures of Personal Saving. *Survey of Current Business*, 87(2), 7–13. https://apps.bea.gov/scb/pdf/2007/02%20February/0207_saving.pdf

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98(5), 71–102. https://doi.org/10.1086/261725

Schultz, T. W. (1961). Investment in Human Capital. *American Economic Review,* 51(1), 1–17. http://la.utexas.edu/users/hcleaver/330T/350kPEESchultzInvestmentHumanCapital.pdf

Schultz, T. W. (1962). Reflections on Investment in Man. *Journal of Political Economy*, 70(5), 1–8. https://doi.org/10.1086/258723

Smith, A. (1776). Recherches sur la nature et les causes de la richesse des nations. Paris. Flammarion.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1), 65-94. https://doi.org/10.2307/1884513

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics*, 87(3), 355–374. https://doi.org/10.2307/1882010

UNECE - United Nations Economic Commission for Europe (2016). *Guide on Measuring Human Capital*. Task Force on Measuring Human Capital. New York, Geneva: United Nations. https://www.unece.org/fileadmin/DAM/stats/publications/2016/ECECESSTAT20166_E.pdf

Verdugo, G. (2014). The Great Compression of the French Wage Structure, 1969-2008. *Labour Economics*, 28, 131–144. https://doi.org/10.1016/j.labeco.2014.04.009

Weil, D. N. (2015a). Capital and Wealth in the 21st Century. *The American Economic Review*, 105(5), 34–37. https://doi.org/10.1257/aer.p20151057

Weil, D. N. (2015b). Capital and Wealth in the 21st Century. NBER, *Working Paper* N° 20 919. https://doi.org/10.3386/w20919