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A COHORT ANALYSIS OF WEALTH–AGE PROFILES GENERATED BY A SIMULATION MODEL IN FRANCE (1949–75)*

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During the last decade, increased interest has been paid to the role of the age factor in the dynamic process of household (or individual) wealth accumulation. Although it was not bound to be so, this question has been closely connected with the issue of the adequacy of the life-cycle hypothesis (referred to in the following as L.C.H.) as a model of wealth-accumulation behaviour. This theory predicts a hump-shaped pattern for the wealth–age profile with maximum at retirement age and – at least in its elementary version – nil value upon death (see Modigliani, 1975). Studies of this age–wealth relationship have used up to now two different kinds of data.

The first are based on household sample survey statistics and specify age effects on wealth in an econometric form derived more or less directly from the L.C.H. (Blinder *et al.* 1980; Mirer, 1979; Wolff, 1980 for the United States; King and Dicks-Mireaux, 1982 for Canada). In particular the last two studies mentioned lead to comparable results. First, there is a significant age effect in wealth-holding patterns. Second, on cross-sections at least, this age effect implies an inverted U-shaped curve, in agreement with L.C.H., although the decline in old age is less pronounced than expected. But third, even accounting for differences of lifetime earnings (Wolff) or permanent incomes (King and Dicks-Mireaux), life-cycle factors can only explain a minor part of wealth variations among households. Moreover the two papers reach comparable conclusions: there are several models of wealth-accumulation behaviour and a hump-shaped pattern grossly compatible with L.C.H. predictions is valid only for the intermediate two-thirds or three-quarters of the households that exclude the richest and the poorest.[1]

The second set of studies, using individual estate tax statistics, generally conclude that observed wealth is an increasing function of age (Atkinson, 1971;

* This study stems from team work and especially from a long-lasting collaboration with Dominique Strauss-Kahn. A first draft of the paper was presented at the Conference on Analysis of Panel Data on Incomes, London, in June 1982, organised by Tony Atkinson and Frank Cowell for the I.C.E.R.D. Through subsequent revisions of the paper I greatly benefited from the helpful suggestions and comments of two anonymous referees and the advice and stimulation of Denis Kessler. Finally, Franco Modigliani's remarks allowed several noticeable improvements of the paper.

[1] Age–wealth relations obtained for truncated samples must however be cautiously interpreted: for instance, as a referee pointed out to us, eliminating outliers reduces predicted wealth for the aged if, in the absence of truncation, (*a*) predicted mean wealth rises with age and (*b*) sample variation around predicted wealth does not decline with age. Attention must also be paid to the accuracy of the truncation: King and Dicks-Mireaux delete from their sample all the low or negative (net) wealth holders, although this group contains heavily indebted young households who are only temporarily 'poor' and whose behaviour may be consistent with the assumptions of life-cycle models. (See Burbidge and Robb (1983), pp. 19–20.)

Atkinson and Harrison, 1977; Shorrocks, 1975), a result contradicting the hump-shaped pattern obtained from sample surveys. Shorrocks rightly remarks that 'the most likely explanation is that the two data surveys are representative of different sets of people'. Estate-duty statistics are relative to more affluent individuals who are found, here also, to depart from the accumulation behaviour predicted by a (no-bequest) life-cycle model.

Interpreting these age–wealth variations as individual accumulation behaviour over time encounters a serious difficulty, however: cross-section data, even if corrected to take into account secular growth, are often poor proxies for longitudinal profiles. Using British estate-duty statistics covering sixty years, Shorrocks thus obtains mortality-adjusted[1] cohort profiles, in constant prices, which show the desired hump pattern, although more pronounced for the less wealthy.[2]

Our paper studies the behaviour of wealth-holdings according to age for French households during the post-war period (1949–75). It relies upon longitudinal data for several cohorts split into eight occupational groups.[3] Indeed, a systematic cohort analysis is necessary to detect common underlying features in the accumulation process of different cohorts of a given group. These invariants can then be interpreted as stable long-term age effects.

In Section I we argue that lifetime profiles cannot be inferred from a single cross-section since important vintage effects have occurred during the post-war period. Lacking longitudinal direct information we use in Section II a simulation accounting model that allows us to reconcile and complete available statistics relative to wealth and its variation so as to reconstitute synthetic wealth cohort profiles.

In Section III, to derive long-term age effects from these historical profiles, two alternative methods are used: the first one tries to disentangle age effects from period or cohort effects while bringing to light the most significant changes for wealth that have occurred since the war, whereas the second aims at a direct determination of age effects while deriving a steady state for the simulation model, that is supposed to capture the structural features of the post-war period. In Section IV, results show that one can find every possibility: instability (small-scale self-employed), stability but no hump shape (wealthy self-employed) and two different hump-shaped stable profiles among wage earners.

In Section V it is shown that a non-voluntary bequest version of the L.C.H. allowing for uncertainty of death in an imperfect capital market can broadly 'explain' the results obtained for the wage-earning groups.

[1] The rich living longer, an adjustment for differential mortality has to be introduced.

[2] Shorrocks' results however need further qualification. There is for instance the problem of consistency over time (relative position of the exemption level, changes in legislation, etc.). Also, Shorrocks neglects another correction for demographic change: considering the minimum wealth of the top 10%, he posits that they form a stable cohort. This is true only if there is no *intra-cohort wealth mobility*, an unlikely assumption when compared with the high intra-cohort mobility of income revealed by recent studies.

[3] To infer accumulation behaviour one must then consider the incidence of inter-group mobility over time. On the other hand, Shorrocks' demographic composition adjustment is considerably reduced within occupational groups; moreover, *household* wealth variations in old age are influenced by an offsetting effect due to the increased number of widowed persons having 'lost' already bequeathed assets.

I. CROSS-SECTION PITFALLS

The possibility of inferring longitudinal profiles from a single cross-sectional age distribution depends on the stability over time of this relationship.

If this age distribution is time invariant, all measures being in constant prices, all cohort profiles coincide with it. Longitudinal profiles can still be easily inferred from a cross-section distribution when time effects do not change its

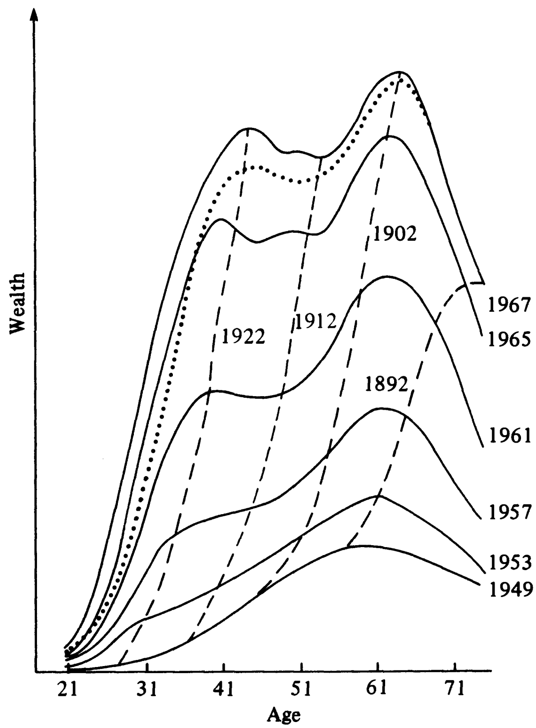

Fig. 1. Wage-earners' age–wealth cross-sections and cohort profiles.
—— Gross wealth cross-sections; – – – gross wealth cohort profiles (generation born in 1922, 1912...); ..... 1967 net wealth cross-section.
Sources: *1967 cross-section*: I.N.S.E.E. savings survey. *1949 cross-section*: generated by the EPHEBE model, the simulation being run backwards up to that year (see beginning of Section II). This reconstituted distribution has been checked against existing data: the average level of wealth in 1949 comes from various methods (permanent inventory, estate multiplier method, etc.); the age–wealth pattern in 1949, derived from estate duty statistics, appears quite robust under various assumptions relative to the exemption level, differentials in mortality multipliers according to occupation and mating patterns (to obtain wealth per household). *Intermediate cross-sections and longitudinal profiles*: simulated by the EPHEBE model (see Section II).

shape. The only admitted time effect is then a *uniform* real growth of wealth (Mirer, 1979).

The French data, as Fig. 1 shows, do not confirm this assumption: time effects (either cohort specific or calendar time specific) have considerably altered the age distribution for wage earners, from a single hump shape in 1949 to a double-peaked curve in 1967. We thus find for wealth the result obtained for earnings (Weiss and Lillard, 1978): growth is not uniform or neutral. In this case, 'there is no simple mechanical method by which lifetime profiles can be inferred from a single cross-section data' or equivalently, by which the intermediate cross-sections between 1949 and 1967 can be generated.

There would nevertheless be one way out, if these awkward non-neutral time effects on wealth growth could be attributed to similar non-stationarities affecting the growth of income, or better, permanent income. In this case, a longitudinal direct interpretation of cross-sections relative to the ratio of wealth to permanent income would be legitimate. The variation of this ratio with age has been studied cross-sectionally by King and Dicks-Mireaux (1982). They justify the choice of that variable essentially by the fact that the L.C.H. hump-shaped pattern concerns a wealth–age relationship controlled for the effect of differences in permanent income. From an econometric analysis of a sample survey for Canada in 1977, they draw an age-profile for the ratio of wealth to permanent income which is rather like the French wage-earner wealth–age curve in 1967. In fact they do not venture to explain the 'puzzling dip' around age 55 by any life-cycle factor (such as, for instance, gifts *inter vivos*) but invoke as 'one possible explanation' a vintage effect, namely a start of working life for these households during World War II.[1]

It thus seems as if there is no direct way to get rid of non-neutral time effects on age cross-sections. We are therefore forced to look for longitudinal wealth profiles: those represented on Fig. 1 do not show any double-humped pattern but (in nominal terms) a steady increase up to 70 years old.

II. A SIMULATION ACCOUNTING MODEL

There are no longitudinal wealth data in France, at least at a micro or group level,[2] but several cross-section data sets, for instance in 1949, 1967 and 1975, and a rather extended body of information for the post-war period concerning wealth-related variables: incomes, savings rates, capital-gains rates, etc.[3] In these circumstances we have decided to *reconstitute* wealth longitudinal profiles

[1] The 'puzzling dip' problem is taken here merely as a striking example of the caveats encountered by cross-section interpretations. A similar dip is found by Kurz (1981) in the U.S. data survey of the President's Commission on Pension Policy in 1979. Burbidge and Robb (1983) argue that the one observed around age 55 in King's and Dicks-Mireaux's study is due mainly to the elimination from the sample (for the sake of confidentiality) of wealthy households, a large group of which are clustered in this age-band.

[2] Longitudinal microdata for wealth seem to be available only in the United States. Using the Longitudinal Retirement History Survey, Bernheim (1984) has recently found rates of dissaving after retirement that are quite comparable to King's and Dicks-Mireaux's results, although more pronounced for single individuals than for couples. The main advantage of his methodology is that he is able to follow exactly the *same* group of households over time. Using the Parnes National Longitudinal Survey, Diamond and Hausman (1984) also find the presence of wealth decumulation after retirement of about 5% per year.

[3] The most numerous data obviously come from I.N.S.E.E. statistics, but some others, like the 1975 wealth distribution, are derived from sample savings conducted by the C.R.E.P. – Centre de Recherche Économique sur l'Épargne. Data from other sources were also used: for instance, the 1949 wealth distribution, derived mainly from estate data statistics. The definition of (material) wealth is quite comparable to that of King and Dicks-Mireaux for the market value of real estate (including farm and land) and financial assets. Omitted items include life insurance, livestock, gold, jewellery and works of art, foreign currencies, privately held company shares and durable goods.

coherent with cross-section data by a sequential computation of annual wealth variations using all available information.

For that purpose a dynamic simulation model of wealth accumulation, called 'EPHEBE', has been built in an accounting framework. This model appears to give reliable proxies for synthetic wealth cohort profiles for eight occupational groups[1] in France from 1949 to 1975.

We refer to households (the unit of account in most statistics). Moreover, we consider gross wealth rather than net wealth although the latter measure is the more usual one. Our choice, motivated both by conceptual and statistical problems,[2] has no important bearing for this study, which focuses on wealth-holding patterns during the late years of life when debts are almost nil.

Another characteristic of the model must be underlined. Annual wealth variations have been computed *backwards*, using the 1975 exogenous distribution as the starting point and the 1949 distribution as the final test of coherence for the model, since recent statistics are more accurate than those for remote years. To assess the reliability of the results, numerous tests of coherence with survey or macro data relative to wealth or other variables have been conducted, as well as tests of sensitivity performed by comparing simulations run with different values for the most shaky parameters. (For details, the reader is referred to Masson and Strauss-Kahn, 1978.)

Ideally all wealth-related factors should be included in an exhaustive account of annual variations in wealth. That means that we must at least consider together the three main factors: savings, capital gains, inheritance and gifts *inter vivos*.

We have to calculate the annual (average) wealth variations:

$$W(a+1, t+1, x) - W(a, t, x),$$

relative to the cohort $(x, t-a)$ of occupational group x and age a at time t. It is, however, convenient to begin by analysing the wealth variation of a single household. A household's variation of wealth is, in fact, the sum of two components.

The first is the result of the relationships between the household and the economic system (savings, capital gains, etc.) and depends mainly on the types of

[1] The four self-employed groups are: farmers, industrialists or commercial entrepreneurs, craftsmen and shopkeepers, and professionals. Wage-earners are divided into executives, middle management, white-collar and blue-collar workers. A dynamic group model also requires that the retired people should be reclassified in their category of origin: some French statistics (like the C.R.E.P. 1975 wealth survey) provide fortunately explicit information on their previous occupation.

[2] The usual measure of net wealth is current legal equity, which subtracts from gross wealth the amount of the debt in capital, say E. This measure is only justified in the rare cases where the loan is sold or interrupted by earlier full reimbursement. An 'L.C.H. adapted' definition of net wealth, which allows for the central equation (6) in this paper (see below) to hold, should rather deduce from gross wealth the value, denoted D, of the discounted sum of future total repayments (both in interest and capital) using, as rate of discounting r, the average total rate of return on wealth (including both income yields and capital gains but net of taxes and depreciation).

The value of debt D decreases much more rapidly than E according to the number of repayments already made. Moreover, low borrowing rates in France during the period considered (negative in real terms when the real value of r was 3% per year) imply that D will already be largely inferior to E at the beginning of the loan. It follows that the difference between gross and net wealth is much lower than usually expected. But the main difficulties for measuring net wealth are empirical. Reliable statistics for the amount of loan or total repayment do exist since at least 1955, but sample survey estimates of D or E are both scarce and shaky before 1967 and do not allow us to obtain reliable net wealth profiles before that date.

accumulation behaviour of the agent considered. This variation, linked to economic activity, is heavily dependent upon quantities observed or calculated *outside* the model.

The second takes into account the household's membership of a 'family dynasty': it is the dynastic variation which concerns circulation of wealth among households without relationship to other agents (at least, without relationships other than fiscal). For that reason, most of its elements are calculated *within* the model (we thus avoid relying directly on scarce and often unreliable statistics that are used instead in tests of coherence).

(*a*) *Variation linked to economic activity* (single household). The calculation of this variation supposes that one draws up the balance of the household's economic activity during the year. We make here a distinction between the 'realised variation', which assembles the elements of the balance that were the object of a transaction during the year, and the 'potential variation', composed of variation elements not usually marked by an exchange. The first includes savings and debts; the second, nominal capital gains and variations in volume of intangible elements of firms. This division underlies the random nature, closely linked to market fluctuations, of some wealth-variation elements.

Neglecting second-order terms, this first variation, ΔW_1, can be written (in a simplified form):

$$\Delta W_1 = \beta W + Y - C + \Delta L, \tag{1}$$

where β is the weighted average, depending upon wealth structure, of the discrete rates of potential variation of assets, Y is total disposable income, C is consumption and ΔL is the net variation of liabilities, i.e. the balance between loans (professional or real estate) incurred and repayments during the year.

(*b*) *Dynastic variation* (single household). The demographic analysis of the household is complex: its beginning often corresponds to the departure of children from their parents' home, but divorces are also accompanied by the creation of an additional household. A marriage can result in the creation of a household in the case where husband and wife were living with their parents, in a dissolution if both were already heads of household, in no effect in other cases. The household can survive the death of one of its members and even change age group if the head of the household dies, leaving his or her place to a younger or older spouse.[1]

These family movements are accompanied by wealth transfers (sharing of wealth in the case of a marriage, legacy to children, etc.): this results in *dynastic variation*; it must also include other private transfers between generations, such as financial assistance and gifts *inter vivos*.

Thus, provided that the household survives, its dynastic variation may be written:

$$\Delta W_2 = K + G_2 - G_1 - CD + MP, \tag{2}$$

[1] The age and occupation of the household are by hypothesis those of the head: the household income and wealth are the sums of those of its members. The fact that aged people disappear as independent households has been overlooked in the model. Franco Modigliani pointed to us that it creates a potential upward bias at the end of the wealth-age profiles, since those are likely to be the poorest.

where K is inheritance and G_2 gifts received from their parents and G_1 gifts bestowed to their children (reverse wealth transfers, from children to parents, have been overlooked as well as transfers between grandparents and children). CD is wealth taken by children leaving home to set up their own households. Finally MP is the resulting (positive or negative) effect of marriages, divorces and other changes in the mating pattern.

(*c*) *Variation of average wealth of a cohort.* At a cohort level (defined by group and generation), the wealth variation is the sum of three components: the variation linked to economic activity, the dynastic variation and an adjustment resulting from the mobility between groups, the main movement during the post-war period being the shift to wage-earning status (mostly blue-collar workers) of the small-scale self-employed (mostly farmers). The calculation of the first and third components presents us mainly with data problems, but dynastic variation computation needs a certain number of simplifying hypotheses, since the pattern of relationships between household and family appears to be relatively complex. In fact, we can use a rather simple demographic submodel as we are working at a group level with only an empirical objective.[1]

Let us emphasise only the two major hypotheses used for deriving dynastic variation. The first one concerns family structure by age: we assume that husband and wife are of the same age, as are their children; one can thus define the age difference between generations, called d. This hypothesis is fairly rough but acceptable at a group level and makes calculations far simpler.

The study of family wealth transfers assumes that wealth distribution among family members is known. The second hypothesis states that all *individuals* of the same age and the same group have the same amount at a given instant; notably a couple's wealth is equally shared between husband and wife (an assumption consistent with the existence of a strong social homogamy in France). This hypothesis is further extended to estate division patterns by assuming that the first parent to die will pass his own wealth to the children, the surviving parent keeping her own wealth.[2] Equal sharing between heirs is also assumed, as it is enforced by law in France.

The second hypothesis leads to a certain heterogeneity of household wealth within a cohort, and a simple relationship links average individual wealth w to average household wealth W. Let μ' denote the percentage of married individuals in the cohort and define the variable μ by the relationship: $\mu = 1 - \mu'/2$ we obtain then

$$w = \mu W. \tag{3}$$

This important relationship allows us to express very easily the effects on

[1] The demographic part of their microanalytic simulation model being on the contrary quite elaborate, Orcutt and Smith (1979) meet both theoretical and empirical difficulties in connecting it with their economic model. For a modelling of family structure and estate division practices closer to our approach, see Blinder (1976) or Davies (1982).

[2] That means that a couple's wealth is transmitted in two halves at each spouse's death, an assumption quite in concordance (at a group level) with French legal constraints (protecting children), marriage laws and bequest behaviour (see Fouquet and Méron, 1982). The Anglo-Saxon case appears quite different: in Davies' study for instance (pp. 485–6) only a quarter of the net bequest of the first parent is assumed to pass to the children.

average wealth per cohort of modifications in the mating pattern: deaths, divorces, marriages, etc., that is, to calculate the cohort-equivalent of the variable MP for a household (cf. relation (2)). These modifications make only the variable μ go from $\mu(a, x)$ to $\mu(a+1, x)$ for the cohort of age a and occupational group x (the time variable is omitted to simplify notations), since they do not affect the average wealth per individual. One must therefore introduce a term $MP(a, x)$ of the form $\delta(a, x)\ W(a, x)$, where $\delta(a, x)$ is worth

$$[\mu(a, x)/\mu(a+1, x)] - 1.$$

We can divide the rest of the dynastic wealth variation $\Delta W_2(a, x)$ into two components, as follows:

What is received, that is inheritance (K) and gifts (G_2) *inter vivos* from the parent generation. The calculation of inheritance, which is rather long, involves mortality rates, average number of children, tax rates, etc., but also assumes knowledge of the parents' membership group: whence the introduction of probabilities $\Pr(y|x)$ of having one's parents in group y when one belongs to group x. For gifts one must take into account the 'diffusion' factor – percentage of donors in a given year – and the 'amount' factor – share of wealth received as gifts.[1] On the whole, we are led to a term of the form:

$$\Sigma_y \Pr(y|x)\ W(a+d, x)\ k(a, y|x).$$

What is given; on the one hand, gifts (G_1) and, on the other, decreases in wealth due to the departure of children (CD), or a term of the form

$$\gamma(a, x)\ W(a, x).$$

Finally, by adding the dynastic variation and the one linked to economic activity and taking into account the adjustment for inter-group mobility, $AM(a, x)$, one arrives at:

$$\begin{aligned} W(a+1, x) = {} & W(a, x)\,[1 + \beta(a, x) + \gamma(a, x) + \delta(a, x)] \\ & + Y(a, x) - C(a, x) + \Delta L(a, x) \\ & + \Sigma_y \Pr(y|x)\ k(a, y|x)\ W(a+d, x) + AM(a, x). \end{aligned} \tag{4}$$

III. ESTIMATING WEALTH–AGE EFFECTS

In order to bring to light a stable, long-term age–wealth relationship for each occupational group two independent methods have been used. The first one applies a heuristic cohort analysis to the historical wealth profiles generated by the EPHEBE model. The second one makes the model converge to a steady-state cross-sectional distribution of wealth by age and occupational group.

The two methods are complementary: the first one is especially designed for estimating age-effects *stability* over time, the second is more appropriate to obtain precise *specifications* of these age effects.

[1] The two sources for gifts come from estate duty statistics and from a C.R.E.P. sample survey in 1975 collecting recall data on the dates and amounts of intergenerational transfers received or bestowed by French households (see Kessler, 1979 or Kessler and Masson, 1979). The *share* of the donor's wealth bestowed to children is found to increase with age but varies little with occupation and remains stable through time. However, there has been a regular increase of the annual *percentage* of donors, more likely to be in their fifties and professionals, farmers or executives. The donor's age has also decreased during the post-war period, so that parents' wealth transfers are now more evenly distributed over the life-cycle.

III.1. *Cohort Analysis*

To eliminate time effects we compare the longitudinal age–wealth profiles followed by different cohorts of a given group.

In other words, we implicitly adopt a crude specification of accumulation behaviour in the form of a function $F(a, t, l, x)$ depending upon age a, time t, generation l (date of birth) and occupational group x. It is well known that one cannot avoid a basic *identification* problem owing to the linear relation between vintage, calendar time and age ($a = t - l$), unless one is prepared to go further by attributing time effects to specific factors and/or by setting *a priori* constraints on age effects derived from some theoretical considerations (Weiss and Lillard, 1978; Jonsson and Klevmarken, 1978).

Our purpose is to avoid any *a priori* specification of the wealth–age relationship. But the historical reconstitution of accumulation profiles has allowed us to identify three major time effects during the post-war period.

The first and most important one is a real per capita growth of wealth at an average rate of 3 % over the period. Secondly, at least since 1955, there has been an important expansion in real estate purchases by households aged between 25 and 40, mainly through indebtedness eased by very low borrowing rates. This phenomenon thus concerned mainly cohorts born in the twenties who also benefited (especially between 1955 and 1962) from very high returns to real estate (both in income yields and capital gains).[1] Thirdly there has been a regular increase of gifts *inter vivos*, bestowed by parents mostly between ages 45 and 60.

With these facts in mind, the analysis focuses on the nominal rate of wealth accumulation by age in different cohorts:

$$\Theta_{l,x}(a) = \Theta(a, t = a + l, l, x),$$

with averages over all occupational groups, $\overline{\Theta}_l(a)$. The procedure is best described with the help of 'standard cohort tables' (see Glenn, 1977), represented approximately by Table 1 for $\overline{\Theta}_l(a)$: age brackets and time subperiods of the same length (here 7 years) are juxtaposed in columns and rows respectively, so that one can trace cohort profiles on diagonals. If time effects play a minor role, figures obtained for a given age should vary little from one column to another.

To take into account real per capita growth of wealth one can consider the ratio of growth rates at specific age, $\overline{\Theta}_l(a)$, to average growth rate (last row in Table 1). With this correction Table 1 still shows some discrepancies in the age profiles within each column, such as the higher wealth growth rates after 1955 for young households. But this gap is mostly accounted for by the rise in real estate purchase, as can be roughly checked by performing alternative simulations

[1] This relative increase in wealth, especially important among wage-earners, explains why the double-humped shape of their age–wealth cross-section in 1967 is more the result of a 'puzzling hump' around age 45, that is also apparent for net wealth (see Fig. 1 for net wealth as legally defined: the 1967 curve for an 'L.C.H. adapted' definition of net wealth – see footnote 2 on p. 177 – will be contained between the two 1967 curves plotted on Fig. 1). Note finally that the dip around age 55 has almost vanished on the 1975 curve.

of the model from 1949 onwards in which this change is arbitrarily cancelled (rates of growth are then much more similar from one column to another).

This procedure has been applied to the growth rates of each occupational group, $\Theta_{l,x}(a)$, and for a variety of standard cohort tables with various age brackets and time spans.

If the tables for one group show only limited differences between columns, which are largely explained by the time effects already mentioned, wealth–age effects are considered 'stable' for that group. If some important unexplained discrepancies remain, age effects are considered 'unstable'.

Table 1

Average Growth Rates of Wealth by Age and Cohort (%)

(Compound nominal rates per household for seven years)

Age	Period 1949–1955	1956–1962	1962–1968	1968–1974
23–29	3·6	6·9	4·7	5·1
30–36	3·0	3·9	3·3	3·5
37–43	1·9	2·2	1·7	1·8
44–50	1·1	1·5	1·1	1·2
51–57	1·3	1·8	1·3	1·5
58–64	0·94	1·2	0·92	1·0
65–71	0·36	0·45	0·33	0·39
Total	1·9	2·2	1·9	2·1

Furthermore, the method allows relative – if not very accurate – characterisations of stable age effects if one compares the age-growth rates for particular ages derived for a given group with those obtained for the overall population.

III.2. *Age Effects Derived from a Steady State*

The second method interprets directly asymptotic wealth cross-sectional distributions derived from a steady state in terms of age effects: indeed, the steady states corresponding to balanced growth, age cross-sections and cohort profiles of wealth in constant prices coincide except for a uniform real-growth effect.

The steady state is designed to capture the structural features of the post-war period (Masson and Strauss-Kahn, 1979). From average data representative of the last quarter century, on income, savings, capital gains, etc., kept constant in time, a convergence is attempted from the known wealth distribution of 1975 towards an invariant distribution representative of a steady state. The method is relevant whenever a steady state exists that is both unique and independent of the initial wealth distribution.

Practically, after having chosen a set of time-invariant values for the exogeneous parameters[1] appearing in relation (4), we use the wealth distribution of 1975 – denoted $W_0(a, x) = W(a, 0, x)$ – as a start to calculate that of the following year, denoted $W_1'(a, x)$. This distribution W_1' is then divided by $(1 + \omega_1)$, where

[1] The variable $AM(a, x)$, accounting for inter-group mobility is set equal to zero. The steady state is thus obtained while assuming notably that there is no more shift of farmers to wage-earning status.

ω_1 is the average growth rate in value for wealth over the year, so as to obtain W_1 with the same mean as W_0. One can then iterate this procedure, using the same invariant values, for the calculation of the cross-sectional distributions, $W_2, \ldots, W_n$.[1] When the sequence $W_0, W_1 \ldots W_n$ is convergent – as it can be[2] – the limit distribution of W is representative of a steady state which follows balanced growth at a constant nominal rate ω.[3]

IV. RESULTS

For all their shortcomings, the two methods lead to much more convincing conclusions concerning the wealth–age relationship when, age effects being stable, the broad characterisations of age effects derived from the cohort analysis appear in close agreement with the specifications obtained in the steady-state framework.

These conditions are fulfilled for 6 out of the 8 occupational groups. Fig. 2 *a–c*, representing the steady-state age–wealth *cross-sections*, clearly show that these groups can be put in three distinct categories according to their accumulation behaviour. *Wealthy self-employed*, including industrialists or commercial entrepreneurs and professionals, follow a regular hump-shaped pattern with maximum wealth at age 59, while age curves for wage-earners have a double peak (one peak may be reduced to a plateau), the first one around age 45, the second around 60. But maximum wealth is at age 45 for *modest wage-earners*, that is for white-collar and blue-collar workers, and at age 60 for *wealthier wage-earners*, including executives and middle management. Note that the wealth–age cross-section for the whole population (eight groups altogether) is more like those of wealthier wage-earners (see Fig. 2 *b*).

To obtain the *longitudinal* profiles (in constant prices) the steady-state cross-sections must be corrected for a constant rate of real growth of at least 3 % per year (the average rate for the 1949–75 period). On these profiles, which are more appropriate for studying the late years of life, the age of maximum wealth remains 59 for blue-collar workers and up to 65 for wealthy self-employed and executives.[4] But the most interesting concerns the average annual rate of decline after age 65 (until age 80 or 85): this rate is very low, around 0·7 % for wealthy self-employed, to be compared with rates for wage-earners between 3 % (modest

[1] Provided one knows for each year the wealth amount for young households who 'enter' the model: we have chosen to make those amounts equal to those for 1975.

[2] Using matrix manipulations and properties of norms in finite dimensional spaces, it can be shown that the convergence of the sequence (W_n) depends on certain inequalities verified by the coefficients of the linear system (4). In practice the iteration is stopped, as usual, when a measure of the difference between W_n and W_{n+1} becomes less than a given threshold.

[3] It is to be noted that the goal of this method is not to produce any accurate forecast but simply to reveal some underlying structural features of the wealth-accumulation process during the post-war period. But even with this limited ambition the method has obvious weaknesses (Masson, 1983). For instance, levels of incomes or loans, and rates of savings or capital gains are kept mechanically constant during a 'transitory' period of the order of two hundred years. Also the choice of these invariant values, 'representative' of the post-war period, is in part arbitrary, although alternative sets of plausible figures do not alter the basic conclusions.

[4] This difference is consistent with the fact that workers retire three to four years earlier, on the average, than executives.

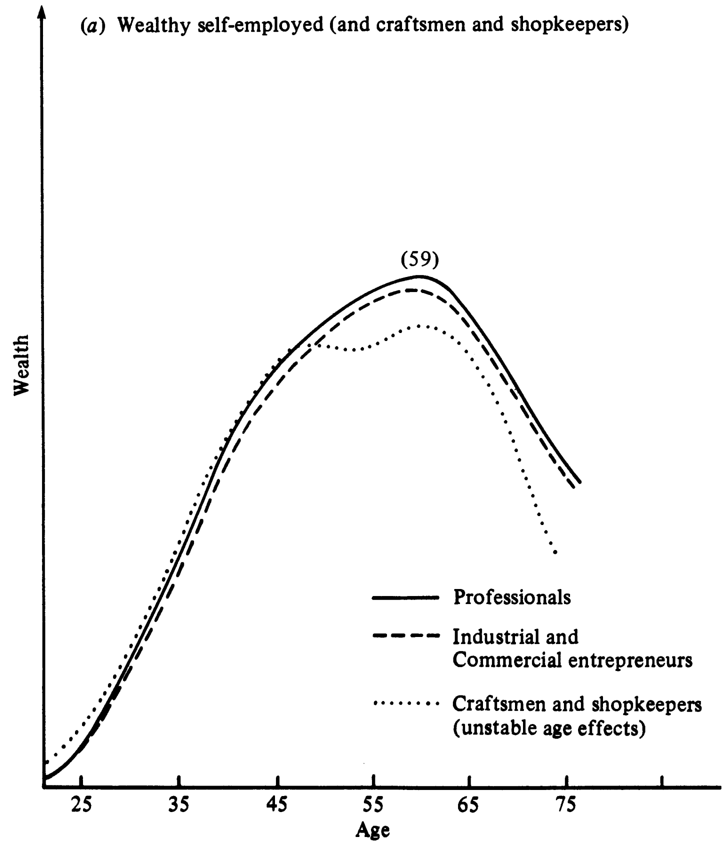

Fig. 2. Wealth–age cross-sections in a steady state (unscaled).

ones) and 4% (wealthy ones). In any case the average amount of wealth-holding is still substantial among the aged (say at age 80), a fact contradicting the elementary basic form of the L.C.H., which also predicts higher rates of decumulation after retirement.

The cohort analysis does not lead to stable age effects over the post-war period for the last two groups, that is for farmers and craftsmen or shopkeepers. If their rates of accumulation are not too far from those of the wealthy self-employed before 1962, both groups undergo a severe downgrading after that year, mainly before age 40.

Moreover, these results are not fully consistent with those derived from the steady-state method. Indeed, craftsmen and shopkeepers seem to adopt in the long run an accumulation behaviour which is intermediate between those of wealthy self-employed and wealthy wage-earners (see Fig. 2*a*), as if the down-grading after 1962 was only temporary. Conversely, farmers seem to adopt the accumulation behaviour of workers (see Fig. 2*c*) as if the decline after 1962 was a permanent one for them.

These last results should be cautiously interpreted. Age-effect instability, especially for farmers, is in part the outcome of the heterogeneous and changing (*b*) More wealthy wage-earners (and total population)

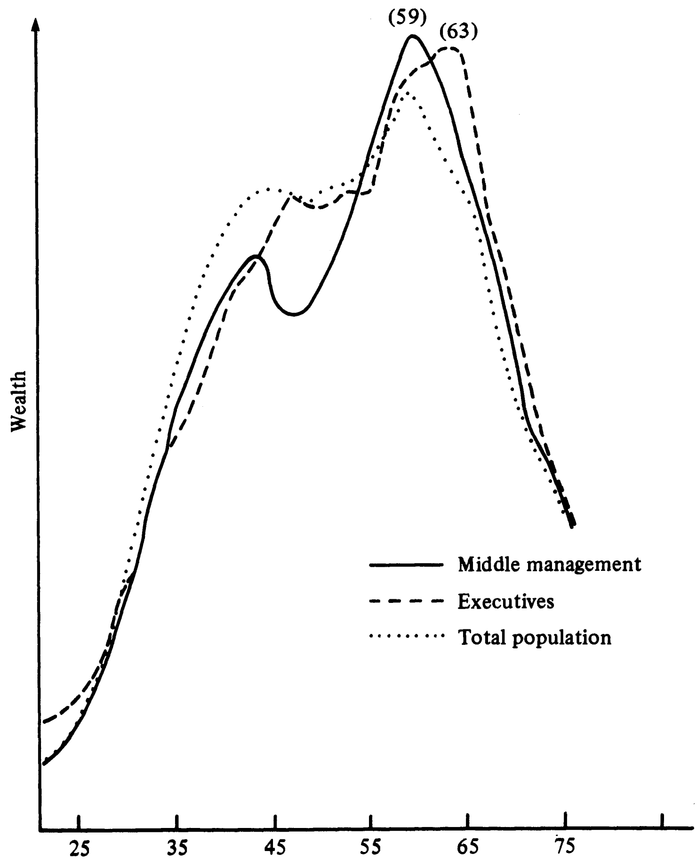

Fig. 2 (*b*)

composition of these groups.[1] It appears anyhow that the life-cycle framework is not fully adapted for those self-employed who tend to have a more traditional conception of wealth and family and to follow a 'backward-looking' behaviour.

V. UNCERTAIN LIFETIMES AND CONTINGENT BEQUEST

What is the capacity of life-cycle models to reproduce the long-term wealth–age pattern obtained for six occupational groups? We focus here on two points: the accumulation behaviour of the aged and the explanation of the differences observed between the three categories of households. It is clear that the 'test' is just of rough 'consistency' with the data and cannot claim to lend genuine 'support' to the L.C.H.

The elementary basic form of L.C.H. being rejected, we have to turn to more

[1] Averages for farmers are most representative of *small* farmers and conceal the existence of large agricultural estate owners. Moreover the shift of farmers towards blue-collar workers, at its peak during the sixties, concerns essentially the underprivileged ones (see Jegouzo and Brangeon, 1978).

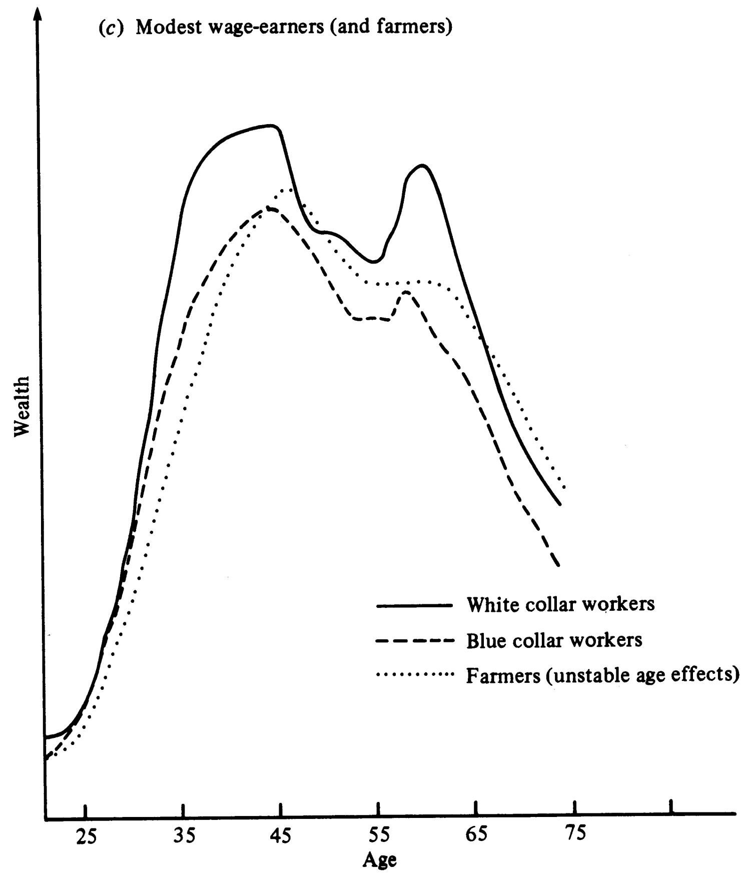

Fig. 2 (c)

elaborate versions of the model. Forms of the model including a bequest motive should be eliminated for this test since they are 'so inclusive... that no particular wealth–age relation would contradict the theory' (Mirer, 1979, p. 436). Dealing with long-term age effects at a group level we may also assume, in a steady-state context, that anticipations are fulfilled (or at least not revised). If the findings of substantial average amounts of wealth held at old age are to be interpreted as involuntary bequests owing to the uncertainty of survival, one has to require further that no life annuity of Yaari's type is available (Yaari, 1965; Barro and Friedman, 1977), an assumption which is apparently consistent with their empirically observed unimportance in household portfolios.

From the most recent life-cycle models with uncertain lifetime and imperfect annuity markets (see Davies, 1981; Kotlikoff and Spivak, 1981; Tomes, 1979 or Ulph and Hemming, 1980) we shall rely primarily on Davies' version, which is perhaps the simplest and most illustrative in our context.

This model assumes that the labour supply, retirement date and benefits are exogenous. The consumer is implicitly assumed to anticipate correctly actual survival probabilities. He faces borrowing constraints, since a negative wealth is not allowed. In most cases, this constraint will be binding at least at the beginning of the life-cycle, earnings being relatively low at the outset.[1] The existence of such 'blocked' intervals has the important consequence that the earnings–age pattern may now influence the consumption profile, which is not the case in a perfect capital market. Note finally that the stochastic open loop control used by Davies can be shown to be consistent.[2]

Let r be the real rate of interest, γ the relative risk aversion (assumed to be constant), and ρ the rate of time preference (under a certain lifetime). On 'free' intervals the logarithmic age-derivative of consumption at age a, $\hat{C}(a)$, is given by:

$$\hat{C}(a) = \frac{1}{\gamma}[r-\rho-q(a)] \tag{5}$$

where $q(a)$ is the instantaneous mortality quotient (equal to $-\hat{s}(a)$ if $\hat{s}(a)$ is the logarithmic age-derivative of the survival probability at age a): uncertainty changes only the rate of time preference by the additional term $q(a)$ depending on age. On blocked intervals, of course, $C(a)$ equals non-property income $YL(a)$. Now the variation of non-human wealth $W(a)$ is given in every case by the relation:

$$\hat{W}(a) = r+\frac{YL(a)-C(a)}{W(a)}. \tag{6}$$

With the most plausible values of the parameters – leading notably to a rather high relative risk aversion – the income effect or precautionary motive is found by Davies largely to dominate a limited substitution effect – the elasticity of intertemporal substitution in consumption, $1/\gamma$, being small. The introduction of uncertainty leads therefore to a considerable reduction in rates of wealth decumulation during retirement obtained under certainty. Using Canadian data (including 'non-investment income in retirement') Davies finds that 'the average rate of decumulation between ages 65 and 85 falls from 7·0 to 2·9 %'.

This last value of say 3 % is close enough to our corresponding empirical estimates for wage-earners, but remains markedly too high to account for the quasi-absence of wealth decumulation among wealthy self-employed. For this last category at least we should have to include other motives for holding wealth, for voluntary bequests but also for power, social status, etc.

Using Davies' model to account for differences in accumulation behaviour between the two categories of wage-earners, it is useful to write relation (6) in the form:

$$p(a) = \hat{W}(a)-\bar{r} = (r-\bar{r})+\frac{YL(a)-C(a)}{W(a)},$$

where $\bar{r}$ is the average rate of return on wealth. Since $\bar{r}$ is in the same order of

[1] Another blocked interval is bound to take place at the end of maximum lifetime, a fact apparently overlooked by Davies (see Ulph and Hemming, lemma 1).

[2] A more detailed analysis of Davies' model would also have to consider the following points. (1) Subjective forecasts of survival probabilities by households may differ from actuarial measures during a period of rising longevity; according to Hammermesh (1985) it will lower contingent bequests, since people fail to forecast reductions in mortality. (2) More realistic borrowing constraints on the aged would probably have to be stronger than merely net-wealth non-negativity: additional constraints will this time strengthen Davies' conclusions.

magnitude – about 3 % – as the rate of real (per capita) growth in wealth, the terms $p(a)$ can be roughly interpreted as the logarithmic derivatives of the steady-state age *cross-sections* in Figs. 2*b* and 2*c*.[1] The main difference to be explained concerns then the age of maximum wealth, around age 45 for modest wage-earners, but about age 60 for wealthier wage-earners. This maximum occurs before or after the age where consumption and income curves intersect according to the sign of the expression $(r-\bar{r})$. It may further be noted that this intersection takes place when consumption (following a hump pattern) is already declining as well as income and that the age of intersection depends primarily on the earlier age at which consumption is at its peak.[2] This peak occurs when r equals $\rho+q(a)$ (see relation (5)) that is, at a later date for a higher rate r.

With these observations in mind one can see that in the framework of Davies' model three factors may account for the later peak in the age–wealth cross-section of executives and middle management.

Their form of saving is different from that of white-collar and blue-collar workers so that they benefit on the average from higher rates of return to wealth ($r-\bar{r}$ is positive for executives, negative for workers).

They have generally longer life expectancies.

Their earnings–age distribution is more heavily concentrated in older ages (maximum earnings is attained later in life) and they retire later in life.

It is to be noted that these last differences could be deduced from the two first factors in a model of human capital investment.

VI. SUMMARY AND CONCLUSIONS

The possibility of a stable age–wealth relationship for eight occupational groups of French households during the post-war period has been analysed. For that purpose two complementary methods of cohort analysis have been applied to synthetic longitudinal wealth profiles generated by a simulation accounting model.

Cohort and period effects have considerably altered age–wealth cross-sections over the years, and prevent any direct life-cycle interpretations of these distributions.

The age–wealth relationship appears unstable for small-scale self-employed, notably farmers: that means that life-cycle factors do not play a clearly defined independent role in the accumulation process of this population.

Stable age effects were obtained for the other groups, with a hump-shaped pattern among wage-earners that vanishes as we reach higher income categories (wealthy self-employed). These results are, at least qualitatively, quite similar to those obtained in Britain (Shorrocks, 1975), in the United States (Wolff, 1980) and in Canada (King and Dick-Mireaux, 1982 and more specifically Burbidge and Robb, 1983 for age-effects variations among social groups).

[1] The fact that Figs. 2*b* and 2*c* relate to gross wealth while equation (6) refers to net wealth (properly defined) is not troublesome (see footnote 2 on p. 177): the qualitative differences in accumulation behaviour between the two categories of wage-earners that are emphasised in this study will appear with net wealth as well as with gross wealth.

[2] See Ulph and Hemming, lemma 2 and, for an illustration, Davies, fig. 1.

Life-cycle models without a bequest motive can 'explain' age–wealth profiles obtained for wage-earners if they allow for the uncertainty of survival in the absence of life annuities of Yaari's type. The question then is the explanation for the empirically observed unimportance of such annuities in (elderly) household portfolios.

This scarcity of annuities can be the consequence in France of historical factors, notably the lack of indexation against inflation. One can also note the criticisms that are traditionally made of existing market insurance: moral hazard, adverse selection, deception, and transaction costs (including time costs). But how can one explain the fact that old householders rarely sell their homes on an instalment payment to be provided with a life annuity that would avoid a great deal of the drawbacks mentioned above?

Of course wealth-holding motives ignored by the L.C.H. (social status, economic power, free disposal) and social–cultural constraints of not depriving one's children of expected inheritance can be invoked. Some authors (e.g. Kotlikoff and Spivak, 1981) have further claimed that the family plays the role of a proxy for an ideal annuity market. This explanation requires, however, a more careful study of the nature of social relations within the family, based as they are on principles which are often incompatible with those governing market activities.

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