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Gutta cavat lapidem. Survival as the ultimate driver of population age structures

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Abstract

Cross sectional life tables implicitly generate stationary populations, with their own age structure. In this paper, we show that these age structures act as a point of reference, or attraction, for current (real) age structures.

Reference age structures change over time, depending on how mortality evolves. While this complicates their connection with real age structures, which must then "aim at a moving target", it does not invalidate the basic principle: age structures change over time keeping close to their corresponding reference counterpart, even if their short-term variations tend to have limited relation with survival conditions. The share of individuals who can be properly classified by age based on the sole knowledge of recent mortality (i.e., having a life table at hand) is usually higher than 80%, and never below 64% in the very numerous cases examined here.

This finding has a series of implications, discussed in the conclusions of the paper: for instance, on the relative role of fertility and mortality in shaping age structures, on the theoretical meaning and practical use of cross-section life tables, and on the notion and measure of demographic dividend.

Keywords

Age structure; Ageing; Stationary population; Mortality; Fertility; Index of dissimilarity.

1. Introduction and Aim

This article is about population age structures: their shape, their evolution (with special reference to population ageing) and their determinants. Both the issue at stake and the how opinions about it changed over time are well summarized in the following excerpt:

> *Why are populations of rich countries so much older today than they were a century or two ago? ...Is the main driver falling mortality and lengthening life, or is it falling birth rates and slowing population growth? Common sense suggests that longer life is responsible for population ageing, but decades ago the work of demographers such as Coale (1956, 1957) and Keyfitz (1975) persuaded us that in fact fertility decline was more important. More recently, a new wave of demographic analysis suggests that mortality decline is the main demographic source of continuing population aging. Here we ... consider this possibility, but reject it.* (Lee and Zhou, 2017, p. 285-287).

Readers may note that migration, the third potential cause of change in population age structures, is left aside, which is correct when the focus is on the long period and, albeit implicitly, on large aggregates. This is also our choice.

To determine whether ageing depends more closely on low fertility or low mortality, two main lines of reasoning have been proposed: simulations/counterfactuals on the one hand, and empirical (decomposition) analysis on the other.

Simulations and counterfactuals were introduced in 1956 by Coale and later applied by several other scholars (e.g. Bengtsson and Scott, 2005, 2010). To these days, they are still considered a valid, possibly even the best, approach to the topic (Lee and Zhou, 2017). The typical steps of this kind of analysis are as follows:

- a population of the past is selected as a starting point (e.g. Sweden in 1860),
- one of its two demographic "behaviours" (e.g. fertility) is artificially kept constant, while the other (mortality) is (also artificially) forced to follow its observed historical path;
- after some time, selected age structures are compared: usually the original (real) one, the final (real) one and the hypothetical final one, obtained through simulation, and
- based on the distance between these age structures, conclusions are drawn on the relative structural impact of the two processes, fertility and mortality. The conclusion is, invariably, that "equivalent changes" in fertility and mortality (equivalent in terms of the growth rate, for instance) do not affect age structures in the same way: the former weighs considerably more than the latter.

While this line of reasoning is correct to answer questions of the type "if ... then ...", it does not necessarily lead to valid conclusions when it comes to interpreting reality, because it assumes that the conditions grouped in the premise (the "if"), may in fact materialize – and this is questionable. For instance, with declining mortality, can fertility remain at the high levels of a pre-transitional society? If the answer is no, as it seems reasonable, the model does not adequately represent reality. It should therefore be expanded, to include an explicit (causal) link between the two phenomena (fertility and mortality), which should itself be estimated. Imagine, for instance that mortality decline *causes* fertility to decline: in this case, the observed changes in the age structure are *all* attributable to declining mortality, both the direct (and small) ones, and the indirect (and large) ones, those that go through the induced change in fertility.[1] We are not claiming that this is actually the case: we are simply cautioning against hasty conclusions suggested by elegant, but possibly incomplete, simulation models.

The alternative to simulations is decomposition analysis, adopted for instance by Preston and Stokes (2012). It takes the following steps:

- select a synthetic indicator of the age structure (e.g. the average age A_t),
- observe its evolution over time together with that of fertility and mortality (proxied by birth and death rates, or similar variables), and
- evaluate which of the two "suspects" matters more (i.e., has a greater influence on the variation of A_t), possibly breaking results down by region or period.

[1] More on this in De Santis and Salinari (2022, 2023).

The typical conclusion of these studies is, once again, that declining fertility affects ageing more than declining mortality, but in this case with some qualifications. While in the past the influence of declining fertility was matchlessly stronger, in recent times the role of mortality has started to emerge, and has occasionally become prevalent, especially were survival is high.

We join this debate by showing that mortality "explains" a large part of a current population age structure – about 82% of it on average, and never less than 64%, in all the cases that we examined. To obtain this result we start from cross-sectional mortality, take the stationary population associated with the corresponding life table, consider its age structure as a standard of reference (or *RAS* – reference age structure), compare it with the observed (or current, or real) age structure and measure how close they are. We use different indicators (see below), but they all point in the same direction: most, and frequently a *very* large share, of the current age structure can be explained by this simple approach, based only on current mortality.
Of course, the stationary population is not a new concept in demographic literature: however, to the best of our knowledge, never before had it been used to assess the degree to which current mortality can explain a population age structure. Note, also, that "reverse causation" is excluded here: the age structure cannot possibly influence the age-specific death risks or rates on which a life table is built.
In the final section of the paper, we submit that our findings prove useful in several senses, and not only with reference to the debate on the causes of population ageing.

2. Data and Method

We take our data from two well-known sources: the Human Mortality Database, or HMD (https://www.mortality.org/) and the UN-DESA database on which the 2022 version of the World population prospects hinges (https://population.un.org/wpp/). Both are freely accessible, with a large set of well-controlled data, referring to different countries and epochs. To minimize data quality issues, we limited our samples:

- In the HMD case, to relatively recent (post 1860) data. This increases the number of countries that can be observed in the same period (up to 10 in our case: Belgium, Denmark, Finland, France, Italy, Norway, The Netherlands, Spain, Sweden, Switzerland) and improves the reliability of HMD data, which, although generally very high, is somewhat lower for very remote years;
- In the UN case, to relatively large countries (at least one million people in all years between 1951 and 2021), to reduce the influence of random variations. We also excluded two countries, Cambodia and North Korea (the Democratic Republic of Korea), because of their exceptionally high mortality during the war years (of 1976 and 1951, respectively). This leaves us with 131 countries (and, analysed separately, six regions: Africa, Asia[2], Europe,

[2] In this case, however, including Cambodia and North Korea.

Latin America and the Caribbean, Northern America, Oceania), each observed 15 times (from 1951 to 2021, every five years).

In both cases we use two series of data: $\mathbf{P}_t = P_{x,t}$ (population by age x, at time t - bold indicates a vector) and $\mathbf{L}_t = L_{x,t}$ (years of life lived at age x in the life table of period t). Age is always considered in five-year intervals: x=0–4; 5–9; ..., 95–99; 100+. Time t, instead, is considered in slightly differently ways in the two sources:

- with HMD data, both $\mathbf{P}_t$ and $\mathbf{L}_t$ are averages of the five-year interval considered: e.g. t=1860–64; 1865–69; ... This gives a total of 32 potential observations for each country, except that not all of them are present at all times;
- with UN data, instead, $\mathbf{P}_t$ and $\mathbf{L}_t$ refer to the population of specific years, spaced by five years. Here, we selected those ending in 1 and 6 (1951, 1956, ..., 2021), which makes 15 observations for each country or region.

We decided to work by five-year intervals also with UN data in part to preserve symmetry with age classes and with the HMD, and in part because the phenomena that we observe (changes in the age structures) are not sufficiently dynamic to justify an analysis by single calendar year.

The $\mathbf{L}_t = L_{x,t}$ (x=1, 2, ..., 21) series represents the age structure of the stationary population at time t: it summarizes the survival conditions of the period. In the rest of this paper, we refer to it as *RAS*, or reference age structure. Our purpose here is, first, to show how close *RAS*'s are to their corresponding current, or real, age structures, $\mathbf{P}_t = P_{x,t}$, and then to draw some inferences from this similarity.

To make the two series comparable, we transformed both of them into relative values $\mathbf{c}_t = c_{x,t}$ and $\mathbf{k}_t = k_{x,t}$, where

$$c_{x,t} = \frac{P_{x,t}}{\Sigma_x P_{x,t}} \quad \text{and} \quad k_{x,t} = \frac{L_{x,t}}{\Sigma_x L_{x,t}} \tag{1}$$

Of course, $\Sigma_x c_{x,t} = \Sigma_x k_{x,t} = 1$. Note that

$$\mathbf{c}_t = f(\mathbf{k}_t, \mathbf{F}_t, \mathbf{M}_t, \mathbf{k}_{t\text{-}1}, \mathbf{F}_{t\text{-}1}, \mathbf{M}_{t\text{-}1}, ...) \tag{2}$$

or, in other words, that the current age structure depends on the entire and very long history of survival ($\mathbf{k}_t$, $\mathbf{k}_{t\text{-}1}$, ...), fertility ($\mathbf{F}_t$, $\mathbf{F}_{t\text{-}1}$, ...) and migration ($\mathbf{M}_t$, $\mathbf{M}_{t\text{-}1}$, ...), with recent years weighing more than remote ones. In this article, we prove that by simplifying this relation to the extreme, and positing

$$\mathbf{c}_t \approx \mathbf{k}_t \tag{3}$$

a fairly good approximation of reality can be obtained. Of course, this approximation relies on the assumption that $\mathbf{k}_t$ does not differ too much from its predecessors ($\mathbf{k}_{t-1}$, $\mathbf{k}_{t-2}$, ...) or, in other words, that the current year is not "anomalous", e.g. because of a war or a major epidemic. Indeed, such cases should be excluded from the analysis[3] or their effects attenuated using a plurennial average.

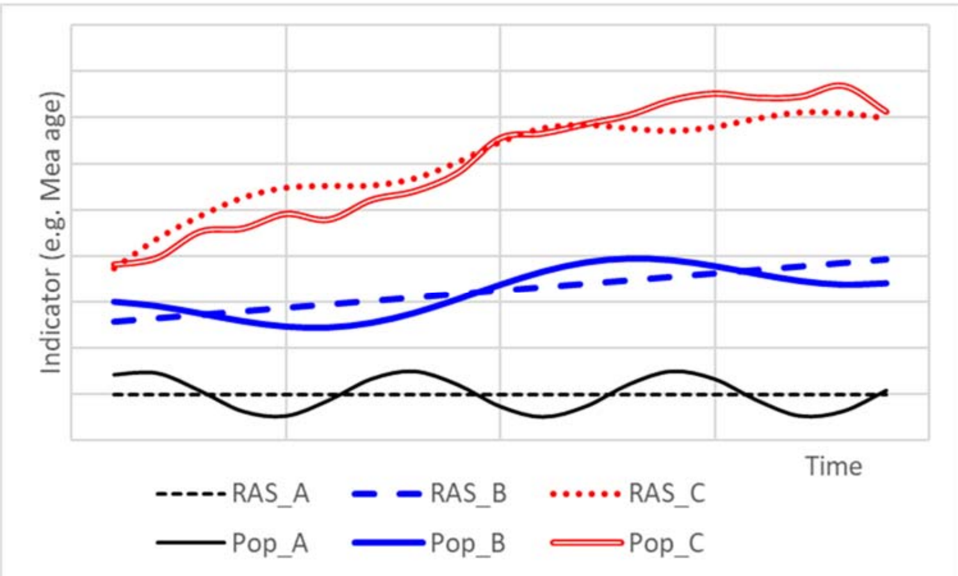
[3] As we did with Cambodia and North Korea (see earlier in the text).

As both $\mathbf{c}_t$ and $\mathbf{k}_t$ are multidimensional (for each year, 21 dimensions – as many as the five-year age classes that we use: 0–4; 5–9; ...; 100+), their comparison is not straightforward. To assess how close they are, we considered two blocks of synthetic indicators. First, we used the average age of the two populations A_t and S_t

$$A_t = \sum_{x=1}^{n} \dot{x}\, c_{x,t} \quad \text{and} \quad S_t = \sum_{x=1}^{n} \dot{x}\, k_{x,t} \tag{4}$$

where $\dot{x}$ is the central point of each of the n=21 five-year age classes ($\dot{x}$ = 102.5 for the final age class, 100 years and over). We show that A_t and S_t are close to each other and tend to evolve together. As the former (A_t) cannot possibly influence the latter (S_t), their proximity can depend either on a common cause (an unobserved third variable) or on the fact that S_t "drives" A_t. We submit that this is actually the case (S_t "attracts" A_t), although we do not prove it in this paper.
What we expect to find (with the average age of the population, the only index presented here, but in fact our conclusions hold for any other structural index, such as the median age, or the *OADI*)[4] is exemplified in Figure 1. Case A is the simplest, but also the least realistic: the reference value of the indicator (broken line) remains constant, while the corresponding empirical value (continuous line) oscillates around it, not necessarily as regularly as in the figure.
Case B is somewhat more realistic, in that the reference value evolves over time (increasing, in this example), which makes the corresponding empirical value oscillate around a "moving target". In case B, the wave period is longer than before, because we are now accounting for demographic inertia: structural elements modify only slowly. With a distance between vertical bars of some 50 to 60 years, for instance, a cycle may take more than a century to complete.

Figure 1. Selected examples of structural indicators evolving in line with their reference equivalent



Source: Authors' simulation.

[4] The old age dependency index (*OADI*) is the ratio between the old population (usually aged 65 years and over) and the adult population (usually aged 15–64 years). Anglo-Saxon scholars frequently use the inverse of this ratio, known as support ratio ($P_{15\text{-}64}/P_{65+}$).

Case C adds complexity, to better approximate reality: the reference indicator (dotted line) evolves irregularly and not necessarily monotonically; the corresponding empirical indicator moves around it, but more erratically than in the previous examples, under the influx of possible (indeed, frequent) ups and downs in births and migration flows.
What the three illustrative cases have in common is that the continuous line is a population statistics that is empirically observable, while its driving force, which acts as an attractor, is not – or, better, not directly. We submit that this "attractor" is the corresponding variable built on the reference age structure (the age structure of the "corresponding" stationary population, i.e. the stationary population of a recent period).

The average age is a very simple and intuitive indicator, which, on top of that, works very well in practice, as we will see shortly. In theory, however, because of its compensatory nature, it could hide some differences: in some peculiar cases, two populations with different age structures can end up by having the same, or almost the same, average age. To exclude this case, we computed also the non-compensatory index of dissimilarity *ID*.

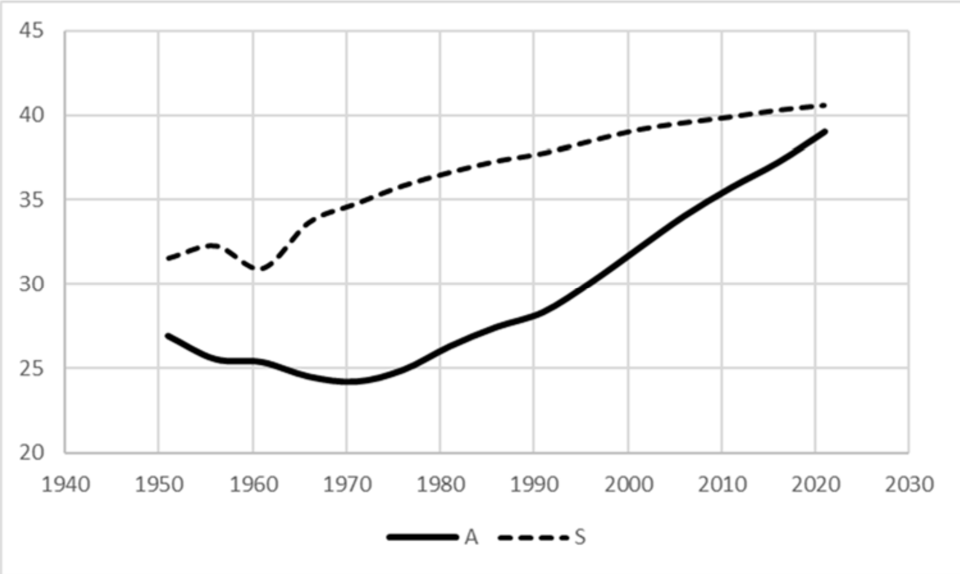
$$ID = \frac{1}{2}\sum_x |c_x - k_x| \qquad (5)$$

This (standard, but a bit neglected) statistical index gives the proportion of units of either distribution that should be "properly" moved to a different age class to make the two distributions identical. In our case, without loss of generality, we will assume that the $\mathbf{k}_t$ series, derived from the reference age structure, remains fixed, and only the units in $\mathbf{c}_t$ can and must be moved, so that, eventually, $\mathbf{c}_t = \mathbf{k}_t$.

3. The Example of China

To clarify the issue, our approach and our measures, let us consider the example of China between 1951 and 2021, with data taken from the UN database.
Figure 2 shows the evolution of the current (*A*) and standard (*S*) average age of the Chinese population: the similarity with the initial phases of our model (cases B and C in Figure 1) stands out – despite the mortality peak of 1961.

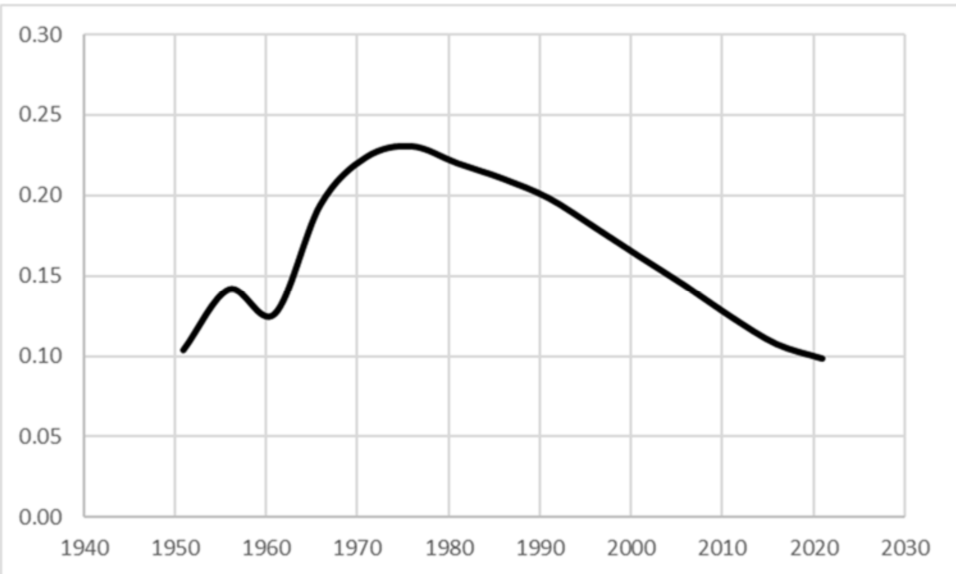
Figure 2. Current (A) and standard (S) average age of the Chinese population, 1951-2021



Source: UN (2022)

The index of dissimilarity *ID* is always low: 23% in the worst year (1976) and 16% on average over the past 70 years (1951-2021; Figure 3). This means that the share of Chinese who are correctly classified by age using *RAS* as a proxy for the current age structure is about 84% on average, and never below 77%, even in the worst year. This is a strong indication that the age pyramids that have formed in China since 1951 depend essentially (for about 84%) on mortality (more precisely, on *recent* mortality), and that all other factors (previous mortality, fertility and migration) compete to explain only the remaining part (the *ID* share, about 16% on average).

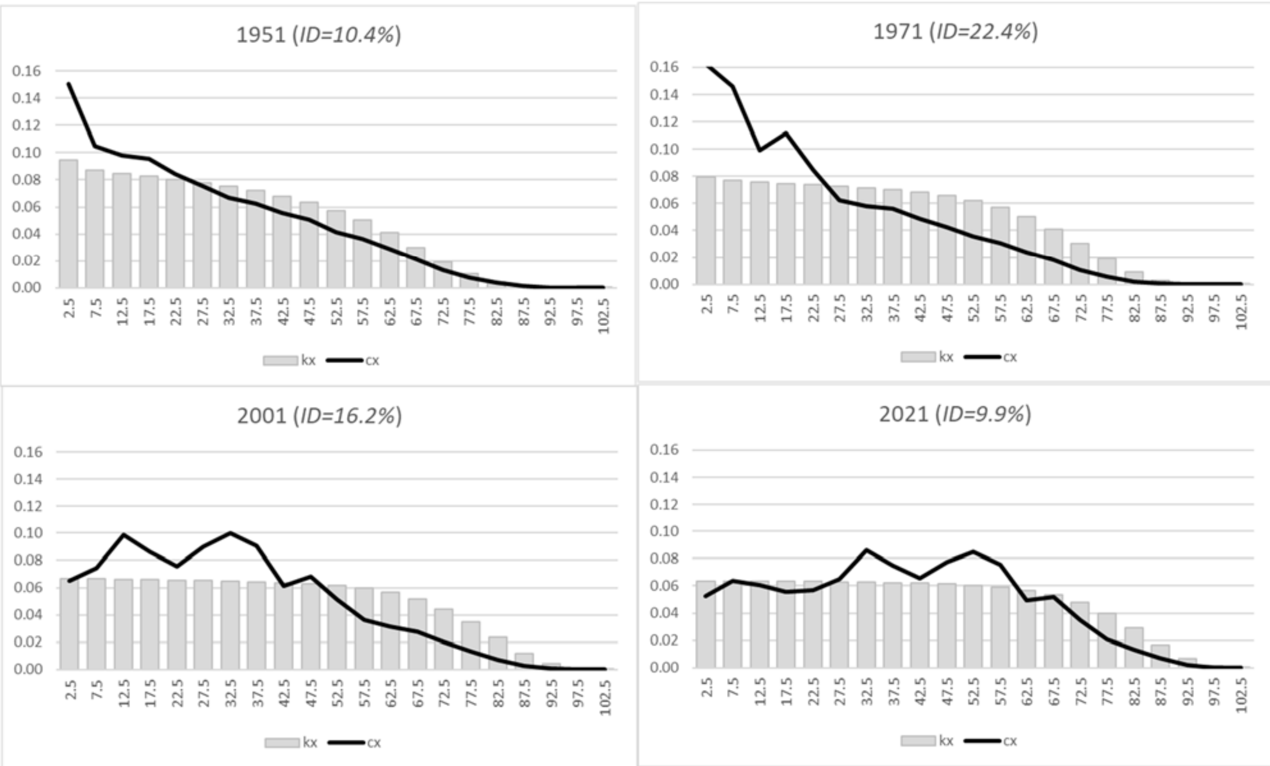
Figure 3. Dissimilarity index (ID) between the reference and the actual age structure (China, 1951-2021)



Source: UN (2022)

Figure 4 displays the current and the reference age structures in selected years. At all times, the age structure of China reflects very strongly its past waves of fertility, which was high until the 1960's (with rapidly increasing population), but has currently dropped to a mere 1.2 children per woman. This has strongly distorted the Chinese age structure in the observed years and will likely continue to do so in the future (not shown here). Yet, despite these rather extreme variations, the *ID* index tells us, by difference, that current mortality is always enough to "explain" a very large share of the age structure.

Figure 4. Current (k_x) and reference (c_x) age structures, China, selected years



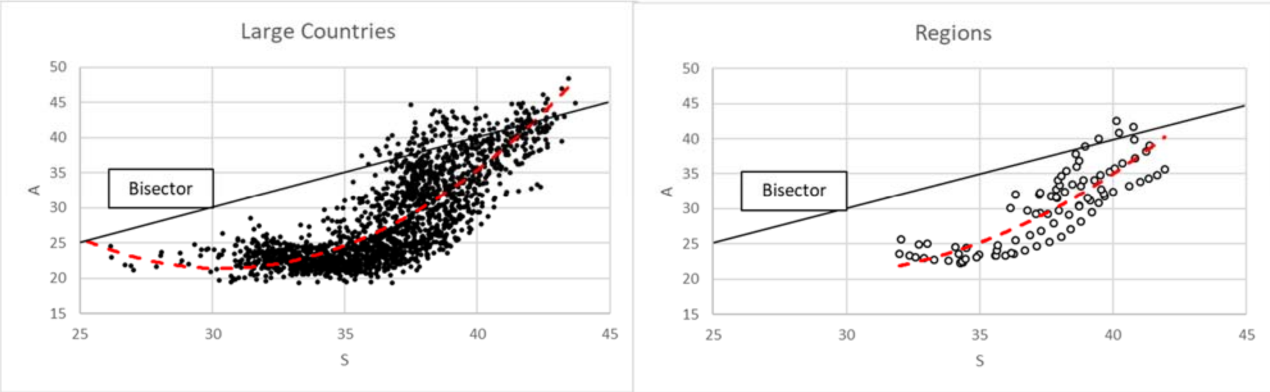
Source: UN (2022)

4. Results

Let us now consider not just China, but all world countries. Figure 5 (left panel) shows that there is a fairly good association, although not a linear one, between the reference average age *S* (that of the corresponding stationary population) and the observed average age *A*. Most countries went through their demographic transition in the period under observation (1951-2021), and this is why most of the observed points are under the bisector, which means that populations are younger than they "should" be, were mortality the only force at play. However, the figure also suggests that this "unbalanced" phase is temporary: the distance from the bisector increases at first (until *S* reaches about 36 years, corresponding to e_0≈60 years) but tends to decrease later on. The points can be imagined as "moving" rightwards (towards better survival conditions), forming a sort of wave that oscillates around the bisector, where *A*=*S*.

The same tendency, with less "noise", emerges in the right panel of Figure 5, displaying world regions. In both cases, the underlying pattern seems to be the same observed in China (Figure 2) and hypothesised in our model (Figure 1, cases B and C).

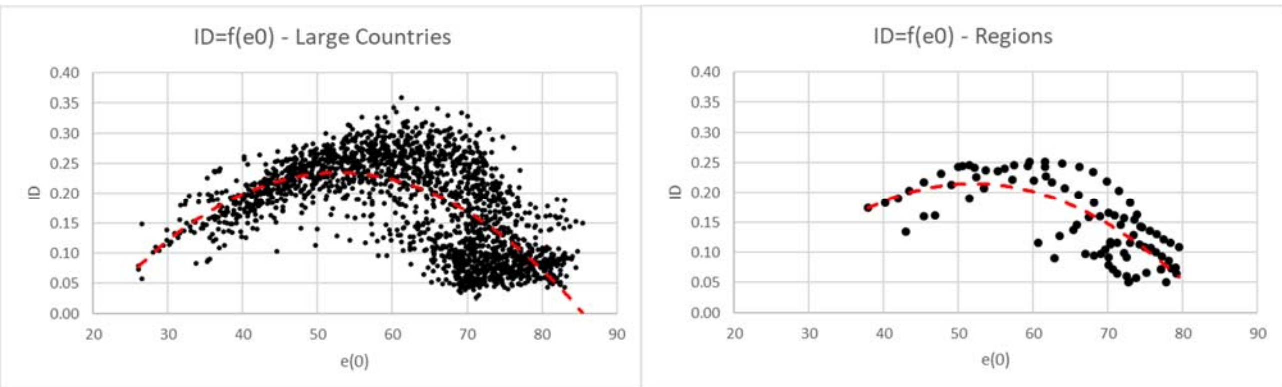
Figure 5. Observed (A) and reference (S) average age, by countries and regions, 1951 to 2021



Notes. Countries are 131: only those with at least 1m inhabitants, and excluding Cambodia and North Korea (the Democratic Republic of Korea), because of their high mortality during war years (1976 and 1951, respectively). *Regions* are six: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, Oceania. In both panels, each case is observed 15 times: 1951, 1956, ..., 2021.
Source: UN (2022)

The share of population who is misallocated (by age class) when our approach is used is shown in Figure 6: it is below 18%, on average, and never above 36%. This means that using only information on recent mortality, age structures can be described very accurately: they are 82% correct, on average, and at least 64% correct in the worst case. As before, using regions instead of countries reduces random variations and improves the precision of model estimates: *ID* declines to 15%, on average, with a peak of merely 25%. In both cases, a parabolic interpolation (a bit crude, admittedly, but perfectly acceptable as a first approximation), suggests that, after peaking for e_0 close to 55/60 years (i.e., in the midst of the demographic transition), *ID* tends to decline, and to get back to the extremely small values it had before the transition started. This reinforces our claim that current mortality, as measured by a recent life tables (the L_x series) explains practically all there is to explain in scarcely perturbed years, and remains the main driver of a population age structure even in periods of turbulent change.

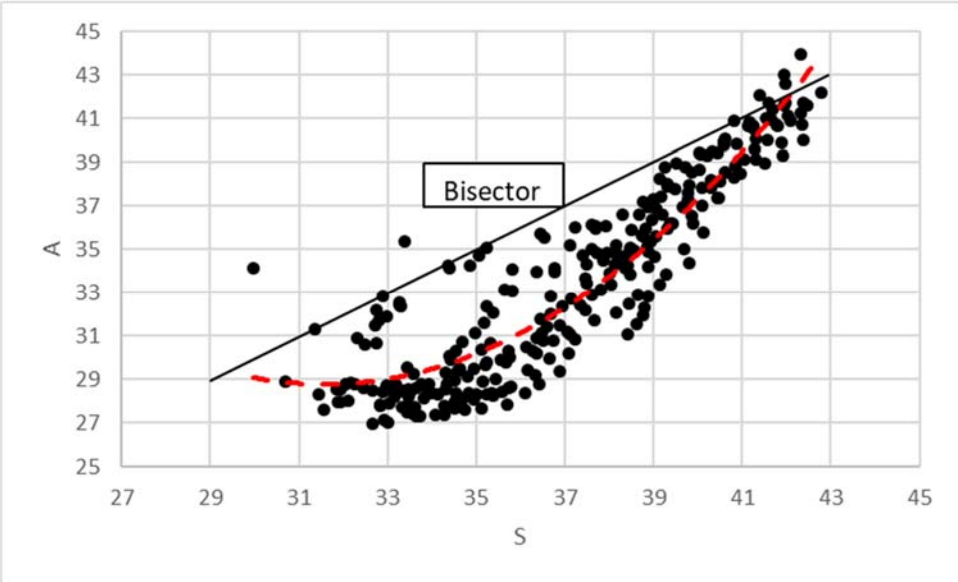
Figure 6. Dissimilarity index (ID) by level of survival, by countries and regions, 1951 to 2021



Notes. Countries are 131: only those with at least 1m inhabitants, and excluding Cambodia and North Korea (the Democratic Republic of Korea), because of their high mortality during the war years (1976 and 195, respectively). *Regions* are six: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, Oceania. In both panels, each case is observed 15 times: 1951, 1956, ..., 2021.
Source: UN (2022)

Essentially the same results, but with closer adherence to the predictions of our model, emerge with reference to a different period (starting in 1860) and a different set of countries: the developed ones included in the Human Mortality Database (Figure 7). As in the case of Figure 5, the initial phase of the demographic transition breaks the (presumed) original equilibrium, but once the process matures, the cloud of points tends to converge towards the bisector, where *A*=*S*, which constitutes, in our interpretation, the "attractor" of this dynamic system.

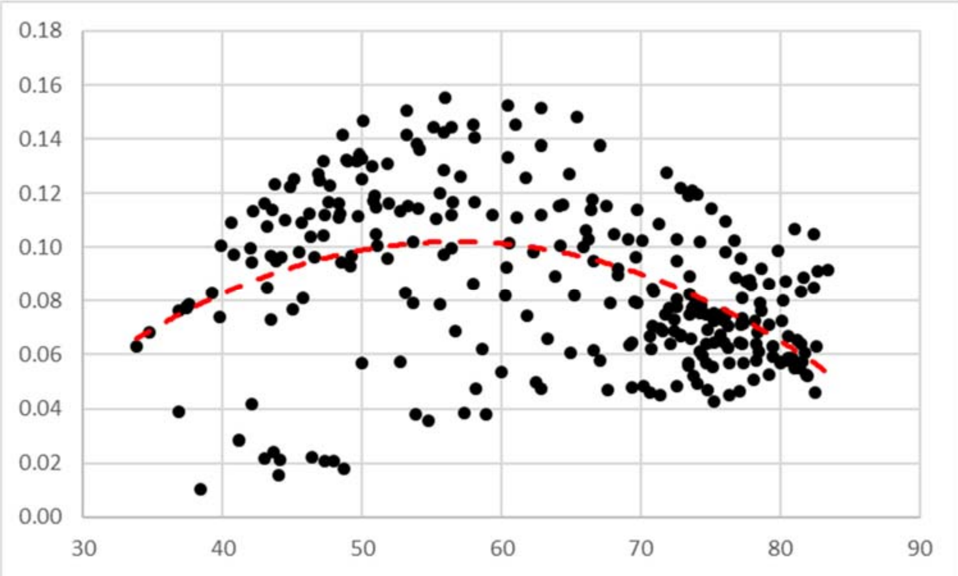
Figure 7. Observed (A) and reference (S) average age, in selected developed countries (circa 1860 to 2019)



Notes. Countries (with the chosen starting year) are: Belgium (1920), Denmark (1860), Finland (1880), France (1860), Italy (1875), the Netherlands (1860), Norway 1860), Spain (1910), Sweden (1860), and Switzerland (1880).
Source: HMD (courtesy of Samuele Gullotto, University of Florence, Italy)

The share of misclassified individuals is less than 9%, on average, and never above 16% (Figure 8). Once again, a curvilinear interpolation seems appropriate and suggests that the worst case for our model is when e_0 is close to 55/60 years, in the middle of the demographic transition. Even then, however, the explicatory power of recent mortality (i.e., its capability of predicting the shape of the age pyramid) is remarkably high, and only a small fraction of individuals is misallocated.

Figure 8. Dissimilarity index (ID) by level of survival in selected developed countries (circa 1860 to 2019)



Notes. Countries (with the starting year chosen for this analysis, or earliest available) are: Belgium (1920), Denmark (1860), Finland (1880), France (1860), Italy (1875), the Netherlands (1860), Norway 1860), Spain (1910), Sweden (1860), and Switzerland (1880).
Source: HMD (courtesy of Samuele Gullotto, University of Florence, Italy)

5. Discussion and conclusions

The most important result of this paper is that current mortality (measured with the "reference age structure", or *RAS*, the age structure of the stationary population derived from a recent cross sectional life table) approaches well, frequently very well, the current age structure. This result is robust and holds in all the cases that we could investigate with our data sets: the Human Mortality and the UN-DESA Database, both including several countries in different epochs and conditions. Besides, it is consistent with the dynamic analysis that we conducted elsewhere on the same topic, proving that the current age structure "moves" over time following the evolution of *RAS* (De Santis and Salinari, 2022, 2023).

In a way, this is obvious: the reason we observe individuals aged 40, for instance (which is not the case for mosquitos), but not aged 1000 (as it happens with sequoias) is that human mortality has certain characteristics, which translate into, and shape, the age structure of the population. These mortality characteristics do not remain constant over time, but their evolution is typically gradual and this is why even the use of just one piece of mortality information (a recent cross-sectional life table) is generally sufficient to provide a good, often a very good, approximation of reality.

Of course, there are periods or relatively rapid demographic change, the most important of which is the demographic transition, which started (slowly) in France and spread first to the rest of Europe, and then to the rest of the world. Decreasing mortality, not immediately followed by a parallel decrease in fertility, triggered a period of population growth. The most turbulent phases of the demographic transition are those where our predictions (mortality drives age structures, and recent mortality is enough to describe most of the phenomenon) are the least accurate. However, even in these extremely unfavourable cases (from the point of view of our model), at least two thirds of the age pyramid are correctly predicted by recent mortality. Similarly, the second demographic transition (or any other socio-economic transformation for that matter), may trigger new cycles, possibly of declining and even more rapidly ageing populations. Once again, these phases will cause waves in the age structures of the countries affected. Our prediction, supported by simulations and projections (not shown in this paper), is that the cycle will repeat itself: real and reference age structures will temporarily diverge, but the former will still be capable of "explaining" a large share of the latter.

The action of mortality is slow and steady, and this is how it eventually "wins the race" (in shaping the age structure): it erodes its base (a birth cohort) little by little, but consistently over several years, never stopping, and always in the same direction - like a water drop hollows a stone (*gutta cavat lapidem* – the Latin proverb of the title). Other forces, such as births and migration flows, are frequently stronger, more variable and more clearly visible in the short run, but they are less consistent, in strength and direction: their structural effects tend therefore to dilute over time.

Our findings have some relevance in several domains. The first, let us reiterate, is the debate on "what matters most" in shaping the age pyramid of a population, whether fertility or mortality. Demographers, following Coale (1956, 1957), tend to think that it is fertility (Keyfits, 1975; Bengtsson and Scott, 2005, 2010; Lee and Zhou, 2017), with a possible, partial exception in recent times, characterized by strong survival improvements in old age (Preston and Stokes, 2012; Murphy 2017). Our claim, instead, is that mortality is the main driver of the shape of age pyramids in the long period, although its action is slow and remains in the background, especially in times of rapid demographic change, such as the demographic transition.

Our findings may influence the debate on the pros and cons of cross sectional life tables. Some demographers (e.g. Borgan and Keilman, 2019; Keilman, 2019) have strong reservations about their theoretical and practical utility, and argue that they are likely to convey biased results in periods of mortality change (which means: almost always). Our study indicates instead that they are useful, both in theory and in practice, and that policy measures taken on the basis of cross-sectional mortality (such as adjustments of the retirement age, when life expectancy changes) are justified. More precisely: the basis for the decision is theoretically sound, while the decision itself may still be incorrect.

In the same spirit, our findings may lead to an alternative, possibly better definition of the "demographic bonus" or "dividend". Until now, to the best of our knowledge, the "window of opportunity", as it is also called, has been defined rather loosely, in terms of improvements over a recent past, or as periods when structural conditions that are better than a rather vague term of comparison. For instance Lee and Mason (2010, p. S159) call it a "phase of ... three to five decades ... [when] support ratios rise well above their pretransition levels", while Crombach and Smits (2022, p. 171) refer to it as "a period in which the working age population is large and the dependent population ... is small." Our proposition is that the comparison be made with the reference age structure: a demographic dividend (or the "first demographic dividend", in Lee and Mason's words) is present as long as the current age structure is "better" than that of the corresponding stationary population. Take Figure 4, for instance: 2021 is a year of demographic bonus for China, and a measure of the bonus can be obtained by comparing, for the selected indicator (e.g. the support ratio), the observed and the reference value. This, incidentally, implies that even a phase of decreasing support ratios may be a structurally favourable period, if it is better that its long term average, as proxied by *RAS*.

The question may be posed in more general terms: when looking at the age structure of a population, what do we expect to find and, against this implicit standard, how do we assess the current situation? Our answer is that (excluding exceptional cases, e.g. an ongoing war) the best possible expectation is based on the reference age structure, or *RAS*. All the relevant aspects of the real age structure (peaks and troughs, larger or smaller base, etc.) can be better appreciated if they are compared with this standard.

Our findings also help clarify the issues behind the frequently re-surfacing question: "Are immigrants substitutes for births?", launched by a famous United Nations (2000) publication. Those who reject this notion typically take some current structural index (e.g. the support ratio), and simulate how many immigrants would be needed to preserve that value forever — arriving, not surprisingly, at implausibly high values (e.g. Coleman, 2008). In the light of our study, the question appears to be wrongly posed. Only *RAS*-consistent long-term targets can be pursued, and, in this case, yes, simulations (not shown here) indicate that immigrants are quantitative substitutes for birth, within reasonable limits (meaning: unless fertility drops to very low levels).

Note, finally, that, because of mortality changes, all target values move over time, unless improvements in survival are neutralised by offsetting adjustments in the threshold ages. This, for instance, is the reason evoked to justify the increases in retirement ages that virtually all countries with extended social protection have been force to implement in the past few years. A deeper understanding of the attracting role of the reference age structure may help policy makers to enact such changes better (e.g., more timely and more extensively), and, by the way, it may also help citizens to accept these changes as necessary, if unpleasant, consequences of longer survival.

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Conflict of Interest

The authors have no conflicts of interest to declare.

Ethical Approval

This study did not involve research on human subjects.

Availability of Supporting Data

The data used in this study are publicly available.

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