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Wolfgang Lutz

This essay introduces a general theory of how societies change as a consequence of the changing composition of their members with respect to certain relevant and measurable characteristics. These characteristics can either change over the life course of individuals or from one generation to the next. While the former changes can be analytically identified and described by certain age- and duration-specific transition schedules, the latter changes resulting from cohort replacement can be modeled and projected using standard models of population dynamics.

Building on earlier qualitative work by Karl Mannheim and Norman Ryder, this new theory applies the quantitative tools of multi-dimensional mathematical demography to forecast the future composition of a population according to relevant characteristics. In the case of persistent characteristics (such as highest educational attainment) that typically do not change from young adulthood until the end of life, quantitative predictions about the distributions of such characteristics in the population can readily be made for several decades into the future. For other characteristics that tend to change over the life course (such as labor force participation), standard age/duration-specific patterns can be assumed. Hence, unlike other models that are called "theories" but cannot be used to make explicit quantitative statements about the future, this theory of socioeconomic change can make such statements in a way that can potentially be falsified. It can therefore be called a theory with predictive power according to Karl Popper's criteria (Popper 1959).[1]

This is a theory predicting aggregate-level change rather than individual behavior. It is a macro-level theory focusing on the changing composition of a population and hence has no micro-level analogue. It can be called a "demographic" theory of socioeconomic change, implying that its inspiration and approach are demographic though its purpose is not. It is not primarily intended to explain and forecast demographic variables (such as population size, birth and death rates, migration, and the like); rather the goal is to predict socioeconomic change in a broader sense (ranging from values and religions to skills and productivity of the labor force) using a demographic paradigm.

In this essay I first discuss the writings of Karl Mannheim and Norman Ryder, both of whom suggested that the process of social change can be analytically captured through the process of younger cohorts replacing older ones. This is followed by a presentation and discussion of the basic propositions of the theory and a description of the multi-dimensional demographic model of the changing composition of the population over time. Finally, the possible empirical applications of this theory are illustrated through two examples. The first reconstructs and projects the changing composition of the population by the highest level of educational attainment. This important individual characteristic can be unambiguously measured and is persistent over the life course after a certain age. The second example addresses a "soft" variable, namely the prevalence of European identity in addition to national identity. Forecasting the prevalence of European identity undoubtedly has great significance for the future of the European Union. I conclude with a brief discussion of further possible applications and key implications of this theory of socioeconomic change with predictive power.

Antecedents: Karl Mannheim and Norman Ryder

In its general form the idea that societies change as new generations take over is as old as human reflection, and one finds early writings on this topic by the pre-Socratic philosophers and in Confucian philosophy. It is such a plausible concept corresponding so well to everyday experiences of most families, institutions and companies across all cultures and times that it is indeed surprising how little systematic scientific effort has been made to formally describe this force for socioeconomic change. While this is true even for the systematic analysis of historical evolutions, it is even more the case when it comes to forecasting.

Over the past two centuries, the strain of writing that comes closest to the idea of projecting along cohort lines (the approach proposed here) is the literature on the succession of generations that was prominent in the late nineteenth and early twentieth centuries for explaining the sequence of historical epochs. In this view, the process was driven by the replacement of old generations by new ones with new views of the world, new priorities, and new styles. A comprehensive synthesis of this approach was offered by the sociologist Karl Mannheim in his 1928 essay "The problem of generations" (Mannheim 1952 [1928]). More than a generation later the demographer Norman Ryder published a seminal article titled "The cohort as a concept in the study of social change" (Ryder 1965). Ryder's article remains the key reference for anyone dealing with cohort analysis. Given Ryder's demographic background it is surprising that this article is entirely qualitative in nature, without a single table. And at no point in his article does Ryder refer to the great potential of this cohort approach not only for studying the past but also for forecasting future social change. Because these writings of Mannheim and Ryder are the most influential milestones in explaining social change through cohort replacement and hence form the historical basis on which this new theory will build intellectually, I discuss them in some detail.

Karl Mannheim (1893–1947) was Professor of Sociology in Frankfurt and later taught at London University. In "The problem of generations," Mannheim contrasts two opposite views on generations. One of these he calls "positivist," which is focused on measurement and the average periods of time required for the older generation to be superseded by the new in public life (1952, p. 278). He refers to this approach as having a biological perspective that we could accurately translate as meaning demographic. The opposite approach, which he calls "romantic-historical," is distinctly non-quantitative and associated with the writings of the German historian Dilthey. Here the central notion is "entelechy," one generation's expression of the "inner aim" or its "inborn way of experiencing life and the world." Mannheim seems clearly more amenable to the first view, but his focus was only on looking backward, trying to understand the forces driving history, rather than looking toward the future.

Mannheim defines a generation as being determined by its "social location" (*soziale Lagerung*), something shared by all members of a generation. He compares it to the way one is a member of a specific social class, viewed not cross-sectionally but over time: both generation and class "endow the individuals sharing in them with a common location in the social and historical process, and thereby limit them to a specific range of potential experience, predisposing them for a certain characteristic mode of thought and experience, and a characteristic type of historically relevant action" (p. 291). He discusses what produces generational units and under what conditions a new group of people growing up is sufficiently different from the previous one in order to be called a new generation. In this sense Mannheim's sociological approach, which to some extent seeks to identify the qualitative inner spirit of a generation, is quite different from the formal cohort approach proposed here, where inner values (entelechy) may be a consequence but not a defining criterion for membership in a generation.

One other decisive difference between my proposed approach and Mannheim's is that members of a generation (cohort in my case) are not all required to have the same social location, that is, to be similar in key aspects. Quite the opposite, I consider cohorts as being composed of groups of people with clearly distinguishable properties (which may define social locations) such as speaking different languages or having different levels of educational attainment or different national/European identities. Hence, the basic idea is not that generations are homogeneous but rather that they are heterogeneous in measurable ways, while their characteristics are persistent along cohort lines and the composition of the properties in the population changes as a consequence of the changing proportions of cohorts that possess the relevant characteristics.

More than a generation after Mannheim, Norman Ryder took up the topic from a demographic perspective. His seminal essay on the cohort and social change was published in 1965, but the paper originated in his 1951 doctoral dissertation at Princeton (eventually published as *The Cohort Approach* (Ryder 1980)). Ryder starts from the central but (then and now) rarely used notion of "demographic metabolism," which he defines as the "massive process of personnel replacement" driven by the births, lives, and deaths of individuals (1965, p. 843). While individuals die, societies become immortal if reproduction is sufficient to offset mortality. This view of society is combined with the notion that the appearance of new individuals provides an "opportunity for social change." While for individuals the flexibility to change over their lifetime tends to be limited, "the continual emergence of new participants in the social process and the continual withdrawal of their predecessors compensate the society for limited individual flexibility" (p. 844). Given the assumed inflexibility of individuals over their lifetimes, he arrives at the conclusion that "the society whose members were immortal would resemble a stagnant pond" (ibid.). An important additional thought is that "metabolism may make change likely, or at least possible, but it does not guarantee that the change will be beneficial" (ibid.).

Ryder's definition of a cohort has since become the standard in demography: "A cohort may be defined as the aggregate of individuals (within some population definition) who experienced the same event within the same interval" (p. 845). In most cases, birth is taken as the defining event, but this is only a special case of the more general approach. Cohorts differ from synthetic cross-sections (comparing people of different ages at the same point in time) because "time and age change *pari passu* for any cohort" (ibid.) Unlike Mannheim, Ryder allows for heterogeneity within generations/cohorts. This is also an important feature of the new theory introduced here, in which members of one birth cohort are subdivided into different categories such as groups with different educational attainment. Hence, under this definition a cohort is by its very nature an aggregate measure, that is, it refers to groups of people. In Ryder's words: "Thus a cohort experiences demographic transformation in ways that have no meaning at the individual level of analysis, because its composition is modified not only by status changes of the components, but also by selective changes of membership" (ibid.).

But in contrast to Ryder, the present theory does not necessarily depend on the assumption of complete cohort determinism. The tools of multi-dimensional population dynamics described below also allow for changes over the life course of cohorts that may be a function either of age or of external period changes (such as the introduction of new technologies that affect all cohorts) and interactions between the two. Hence, the possibility of lifelong learning and changing of cohorts can in itself provide an opportunity for socioeconomic change, and immortality would not necessarily result in Ryder's "stagnant pond." To what degree cohort effects dominate age and period effects might differ depending on the specific characteristic studied. In some cases (such as highest educational attainment after a certain age) it is persistent by definition; in other cases this is a matter of empirical analysis for the past and of corresponding assumptions for the future.

Inspired by Ryder, I have adopted the term "demographic metabolism" as the tentative name of this theory of socioeconomic change because it addresses the changing nature of a population through the replacement of individuals with certain characteristics by individuals with other characteristics. However, unlike in Ryder's usage, not only does metabolism affect the population in its entirety, but the notion is also generalized to refer to the changing composition of certain sub-categories such as the labor force or the young adult population. This generalization of Ryder's idea is discussed further in the concluding section.

A macro-level theory based on people as units

Before introducing the quantitative forecasting model and offering numerical illustrations of this theory, I specify and discuss some basic definitions and assumptions on which the approach rests. These foundations of the theory are presented in the form of four propositions.

Proposition 1*: People—individual humans—are the primary building blocks of every society and the primary agents in any economy. Hence, they form the basic elements of any theory of social and economic change.*

In the terminology of the pre-Socratic philosophers, people are the atoms of society. Theoretically, one could delve into sub-atomic structures: modern brain research shows that any decision at the individual level is the result of complex interactions among different parts of our brains. But for the present purpose, it is sufficient to assume that decisions happen at the level of individuals, who then interact with other individuals.

Proposition 2*: For any population, members can be sub-divided into disjoint groups (states) according to clearly specified and measurable individual characteristics (in addition to age and sex) for any given point in time.*

In principle, any sub-division of people that satisfies this criterion is legitimate and allows the application of the theory described below. Age is a special characteristic for forecasting because it automatically changes in tandem with chronological time. Hence, the applications and illustrations of the theory are designed to divide the entire population by the particular characteristics of interest and then further to sub-divide all people in this category by age and sex. Over time, people stay in their categories and simply become one year older every calendar year unless they die or move to another category.

Proposition 3: *At any point in time, members of a sub-population (state) defined by certain characteristics can move to another state (associated with different characteristics), and these individual transitions can be mathematically described by a set of age- and sex-specific transition rates.*

Transitions may occur not only to another state inside the system but also to an absorbing state (death) or to a state outside the system (out-migration). New individuals arriving (through birth or in-migration) will be instantly allocated to one state within the system. Not all transitions among a given set of states may be possible. Sometimes transitions are only possible in one direction, such as from lower to higher educational categories or from the single to the married state, from which people may move to the divorced or widowed state.

Proposition 4: *If any given population consists of sub-groups that are significantly different from each other with respect to relevant characteristics, then a change over time in the relative size of these sub-groups will result in a change in the overall distribution of these characteristics in the population and hence in socioeconomic change.*

The historical record offers many examples of significant changes of entire cultures, economies, and technologies as a consequence of the changing composition of populations. Most radical have been changes in the dominant characteristics among populations resulting from mass migrations combined with differential mortality. One may think of the end of the Roman Empire or the Spanish conquest of the Americas: new people brought with them their very different ways of thinking, acting, and using technologies (characteristics) and replaced the previously dominant characteristics, thus causing radical social change. In such major transitions, one may assume that most individuals did not actually change their characteristics over their life course. Rather the bearers of the old characteristics disappeared (through being killed, succumbing to new diseases, or out-migration) and were replaced by new arrivals and their offspring, a radical form of demographic metabolism. In some cases the surviving children of the bearers of the old characteristics were also socialized to display the new characteristics, thus creating a new and different society with the prevailing new characteristics through intergenerational change. Early efforts to assimilate aborigines in Australia were based on this strategy. On the other hand, existing characteristics can also be lost over generations without such major discontinuities. History is filled with examples of this sort that can also be viewed as a consequence of the changing characteristics of the populations, which also include the abilities to use certain technologies.

The choice of a characteristic that is worth studying with respect to its changing distribution in a society is necessarily context-specific. Hence, the definition of relevant sub-groups depends on the questions asked. In the second part of this essay I give several empirical examples of using this approach to address specific questions concerning future socioeconomic change. Before doing so, I briefly describe the methodological tool to make such forecasts.

The multi-dimensional cohort-component model

Most demographic methods deal with the transitions of people from one state to another over a certain time interval and are in one way or another based on the life table. In its most fundamental form the two states are being alive and being dead, and the life table was constructed on the basis of age-specific mortality rates to determine the probability of surviving to each age and the remaining years of life expectancy at any given age. These tables were originally calculated separately for men and women because observed age-specific mortality rates tended to differ substantially by sex. Aside from this differentiation by age and sex, conventional demography still considers populations to be largely homogeneous—for example, assuming that all men aged 50–54 are exposed to the same risk of death. In the multi-state case this restriction is relaxed and mortality rates can differ for sub-groups as defined by further characteristics.

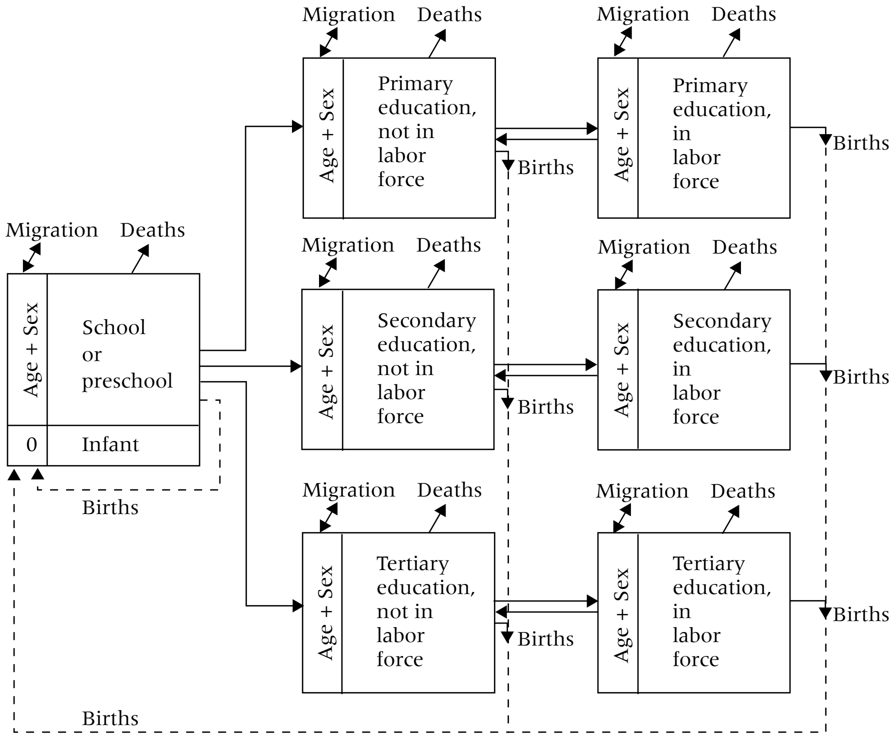
The cohort-component model has become the dominant method of projecting populations. While a simple exponential growth model considers changing population size solely as a function of the growth rate, the cohort-component model can deal with irregular age distributions and the differential impacts of fertility, mortality, and migration patterns on future age structures. The one-dimensional cohort-component model starts with a population stratified by age and sex and then projects cohorts by advancing their age t years over every time interval of t years while simultaneously exposing them to assumed age- and sex-specific schedules of mortality and migration and exposing the female cohorts to age-specific fertility rates. Because fertility, mortality, and migration are the three fundamental components of population change, this method of projecting along cohort lines is called the cohort-component model. In the multi-dimensional case the population is further sub-divided along additional characteristics. Since the origins of the multi-state model lie in regional population studies, these additional divisions were initially sub-regions, for example, provinces or states of one country. This explicitly heterogeneous population is then projected into the future by simultaneously considering different fertility, mortality, and migration schedules for the individual provinces as well as transitions (migrations) among the provinces. More generally, provinces can also be defined by other criteria such as marital status, labor force participation, and highest educational attainment.

The simple cohort-component model goes back to Cannan (1895). Later it was formalized and widely applied by Whelpton (1936) and Leslie (1945), after whom the Leslie Matrix is named. The detailed formal presentation of this model is given in any standard demography textbook (e.g., Preston, Heuveline, and Guillot 2001). The multi-state model is based on the generalization of the simple life table (single decrement table) to multiple-decrement and increment-decrement life tables (Rogers 1975; Schoen and Nelson 1974; Keyfitz 1985). Essentially such tables describe movements of people that can go back and forth between more than two states. These methodological advances, made in the 1970s largely by scholars affiliated with the International Institute for Applied Systems Analysis (IIASA), led naturally to the multi-state population projection model that can simultaneously project the populations of different categories (states, regions) with different fertility, mortality, and migration patterns as well as movements among the categories. Again, the methodology is extensively documented elsewhere (Rogers 1975; Keyfitz 1985; Keyfitz and Caswell 2005; Rogers and Willekens 1986). Here it suffices to say that the methodology is based on the Markovian assumption that the probability of transition to another state for a specific period of time is defined only by being present in the current state in addition to age and sex. In other words, all persons of the same age and sex in the same state have identical risks of dying or of moving to another state irrespective of their earlier transition histories.

After the initial focus on regionally defined states, applications were expanded to the analysis of marital status transitions (Schoen and Nelson 1974), the analysis of labor force participation and working life tables (Willekens 1978), the analysis of health and morbidity (Manton 1988), and family status cross-classifying marital status and number of children (Lutz 1989). The application of the multi-state projection model to education was to my knowledge used for the first time in a study of population–development–environment interactions on the island of Mauritius (Lutz 1994).

In the model developed for the study of Mauritius, the entire adult population is sub-divided into six states as defined by the cross-classification of three education categories (primary or less, secondary, and tertiary) and labor force participation (see Figure 1). The children and in-school population constitute a seventh state. The figure also depicts the essential transitions of the multi-state model: new births enter the category of child population, which advances one year in age every calendar year and is simultaneously exposed to assumed sets of mortality and migration rates. At a given age, then, all children become members of the adult population not (yet) in the labor force and according to their highest educational attainment. In adulthood, people can move back and forth between being out of the labor force and in the labor force, and they age one year every year within their respective categories, being always exposed to age-specific mortality and migration

FIGURE 1 A multi-dimensional projection model cross-classifying the population by age, sex, level of education, and labor force participation



SOURCE: Lutz 1994, p. 226

risks which are status-specific.[2] The female population of reproductive age is also exposed to assumed age-specific fertility rates—which differ by status—resulting in the births that then enter the model.

While Figure 1 gives the structure of one specific model, it also typifies the general design of a multi-dimensional demographic forecasting model. The two following illustrations of other applications differ from it only in their specific definitions of the state space and the possible transitions among states.

Modeling the dynamics of changing educational attainment distributions by age and sex

The multi-state model described above requires the fewest assumptions for studying characteristics that are persistent over the individual life cycle. One such characteristic, highest educational attainment, is typically attained at younger ages and then maintained throughout life. While this is almost entirely the case for primary and junior secondary education, the completion of tertiary education can also occur later in the life cycle. Because comparable data exist for many countries on the timing of transitions to higher levels of education, the age pattern of education transitions can be appropriately modeled and taken into account.

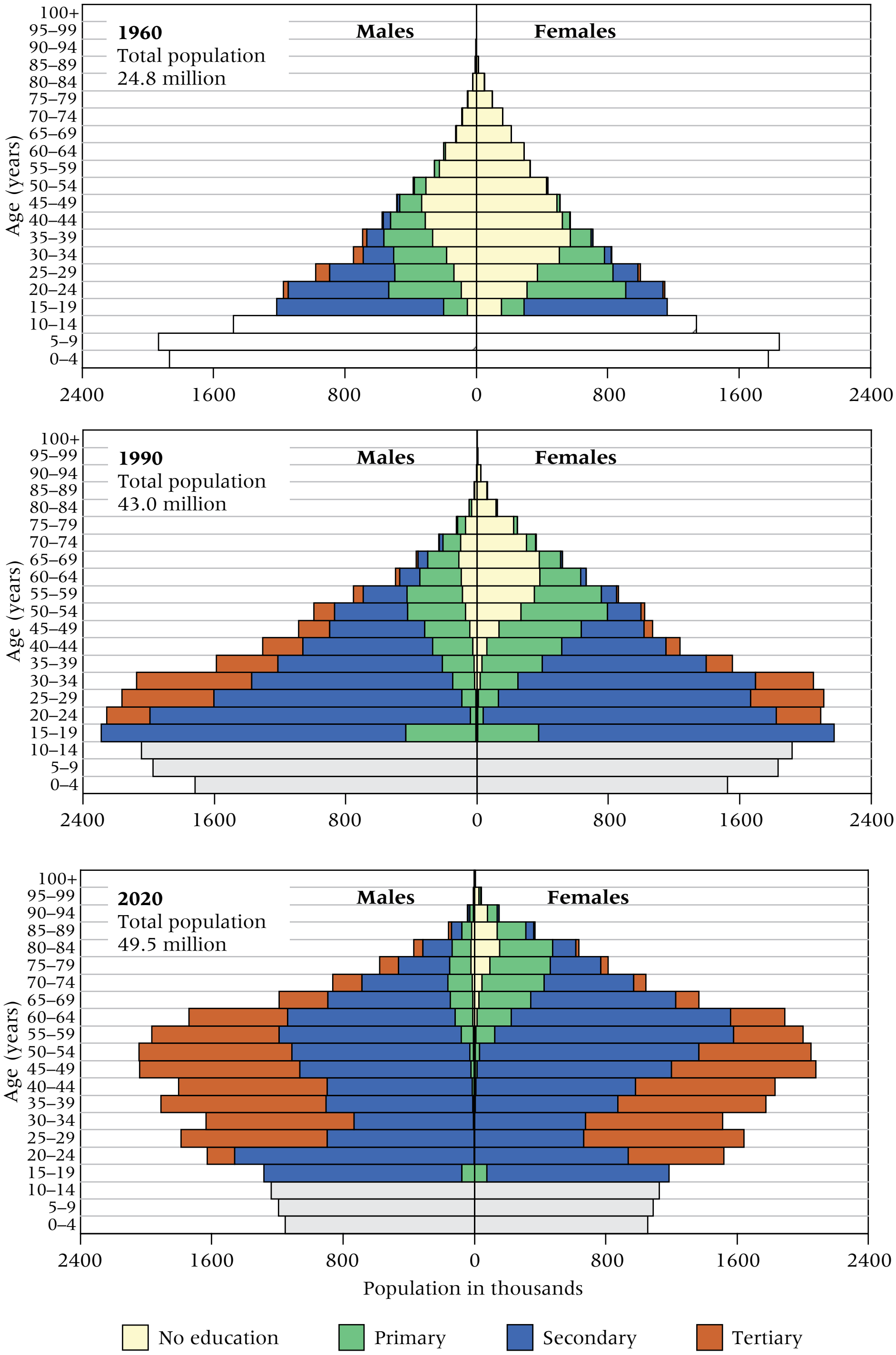
This persistence of educational attainment over time becomes particularly visible when looking at the distributions by age for countries that recently experienced significant increases in schooling. Figure 2 shows the education and age pyramids for South Korea as reconstructed and projected using the model of multi-dimensional population dynamics. Here, the education classification has been added to the conventional age pyramids through color (shading) with the following four educational categories: never been to school, some primary education, completed junior secondary education, and completed first-level tertiary. These 60 years of improvements in Korea's human capital reflect probably the most rapid expansion in education in history. While in 1960 the majority of the female population above age 20 had never been to school, 30 years later the population below age 50 already has nearly universal secondary education. By 2020 most of the uneducated older cohorts will have died, while young women in Korea will be among the world's most educated with more than half of them having completed college. By then, the demographic metabolism at the population level will have fully run its course and Korea will be a different society and economy than it was in 1960 in almost every imaginable dimension.

The data plotted in Figure 2 come from an ongoing project carried out by the Wittgenstein Centre for Demography and Global Human Capital (Vienna) to reconstruct and project educational attainment distributions by age and sex for more than 170 countries (Lutz et al. 2007; KC et al. 2010; Lutz and KC 2011). While the reconstruction uses the past age and sex distributions as given by the UN Population Division and therefore only needs to consider differential mortality (and where possible migration) by level of education, the projection also includes education-specific fertility rates.

This reconstruction of the educational attainment distributions by age and sex also produced a new data set that is superior to previous data sets (Barro and Lee 1996; Dela Fuente and Domenech 2006; Cohen and Soto 2007; Benhabib and Spiegel 1994) in at least four respects: (1) its detail (four educational categories for 5-year age groups of men and women) for most countries of the world; (2) the consideration of differential mortality by level of education; (3) the strict consistency of the definition of educational categories over time (a major problem in historical data sets, in which the underlying educational definitions often change); and (4) its natural extension to forecasting.

These new data have already formed the basis for a reassessment of the global empirical evidence on returns to education (Lutz and KC 2011). While there is little doubt that education has an important positive effect on

FIGURE 2 Age and education pyramid for South Korea 1960–2020 distinguished according to four educational attainment categories



NOTE: No educational classification given for population below age 15.

individual earnings, the evidence for its effect on aggregate-level economic growth has been more ambiguous (Becker 1993; Barro and Sala-i-Martin 2003; Benhabib and Spiegel 1994; Pritchett 2001). However, these earlier studies were based typically on the mean years of schooling of the entire adult population above age 25. As Figure 2 clearly illustrates for Korea, in 1990 this crude indicator averaged the human capital of the elderly uneducated cohorts with that of the highly educated young ones. As a result, the indicator has little statistical signal in its change over time and does not correlate strongly with the increase in economic growth, which in Korea accelerated when the better-educated cohorts entered the young adult ages. A recent study estimating economic growth regressions using the new age-specific human capital data found consistently positive and significant effects of educational attainment on economic growth (Lutz, Crespo Cuaresma, and Sanderson 2008). Because it also included the full educational attainment distributions (and not just mean years of schooling), the study also showed that for the poorest countries it is essential to complement primary education with broad-based secondary education in order to boost economic growth. This approach also has a stronger effect on poverty eradication than focusing on tertiary education in an otherwise largely uneducated population.

Beyond economic growth, these new data were also used to reassess the aggregate-level returns to education on a broad range of outcomes from population growth and health to quality of institutions. For instance, we have shown that the entry of large cohorts of better-educated men and women into the young adult ages appears to play a key role in the transitions of societies to modern democracies, as assessed through an analysis of global time series (Lutz, Crespo Cuaresma, and Abbasi-Shavazi 2010).

As shown in the case of South Korea, the multi-dimensional demographic approach with a focus on age, sex, and level of education can provide a portrait of key dimensions—if not the single most important dimension—of the rapid socioeconomic change that Korea has experienced over the past several decades. Starting in the 1940s and 1950s in a situation of widespread poverty—worse than many Eastern African countries at the time—and a setting in which more than 80 percent of the population received no schooling, a massive expansion of schooling at the primary and secondary level (complemented by an effective family planning program) resulted in a sharp fertility decline and was a necessary condition for the remarkable rates of economic growth that followed. While human capital alone may be not sufficient and effective governance and the right macro-economic strategies are also important, it is hard to see how Korea and the other Asian tigers could have had this economic success without the underlying changes in human capital. As Figure 2 illustrates, this change happened along cohort lines where demographic metabolism was the major engine of change in each relevant age group. Plausibly, with this cohort perspective, an informed observer of developments in Korea around 1970 could have predicted the subsequent course of socioeconomic development.

Moreover, the particularly rapid improvement in the education of younger women brought fundamental changes to Korean family structure and society in general. The total fertility rate declined from around 6.0 in the late 1950s to around 1.2 today. This change is also visible in the changing age structure as depicted in Figure 2. Korea is facing rapid population aging. It is not yet clear to what extent this will pose a problem in light of the fact that high levels of education among Korea's younger generations will not only yield higher productivity but will also likely result in much better health at older ages and a later age at retirement. While these specific economic consequences of aging cannot be readily forecast by this theory (partly because they have no precedent in human history), the fundamental underlying forces of aging and changing characteristics along cohort lines can be forecast with high certainty. These forecasts are likely to be more accurate and more relevant than those of most macro-economic models over a similar time horizon.

Predicting "soft" variables such as preferences and identities

My second example of the theory presented here comes from a field that is both highly contentious and highly political and is usually considered beyond the reach of quantitative modeling, not to mention forecasting: predicting the future evolution of European identity among EU citizens. The following description draws on the study by Lutz, Kritzinger, and Skirbekk (2006).

Many political observers of the current economic crisis and its effect on the Euro and the future of the European Union expect a revival of nationalism in many member countries and as a result a possible dissolution of the EU. It is often argued that existing economic interdependencies (particularly in the banking sector) are the main force that still holds the EU together. These observers overlook the changing opinions and identities of European citizens, the people who make up Europe.

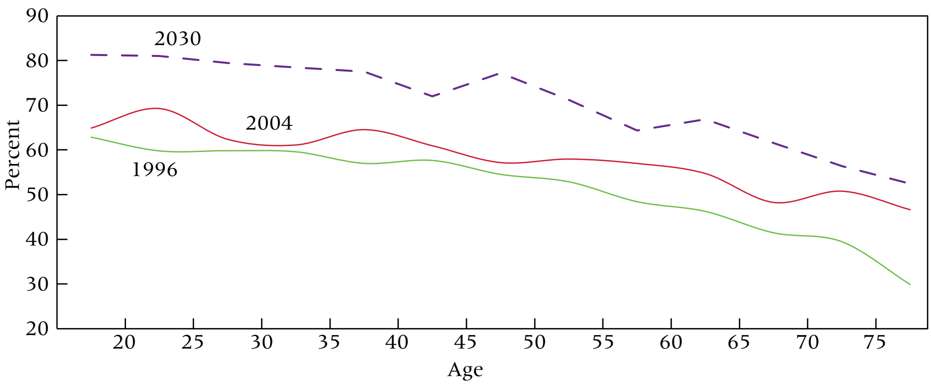
Political scientists tend to think that the question of identity is crucial for the legitimacy of any political system (Easton 1965). In this view the future of the European Union depends primarily on whether European citizens also maintain a European identity. Furthermore, recent work stresses that people usually have multiple identities that do not necessarily compete with each other. In this view European identity complements but does not displace national and regional identities (Risse 2000). The European Commission is concerned with this issue and collects information on it in the Eurobarometer surveys. The relevant question on European identity asks: "In the near future, do you see yourself as [Nationality] only, as [Nationality] and European, as European and [Nationality] or European only?" Since 1996 this question has been asked with identical wording more than a dozen times in the EU-15 (members of the EU as of 1995) with national samples of around 1,000 in each round.

In 2004, 42 percent of the adult population of the EU-15 above age 18 said that they felt themselves to be solely nationals of their own country, while 58 percent gave an answer that reflected multiple identities including a European identity. Figure 3 shows a clear decline in multiple identity with age. In other words, the older the respondent, the greater the chance that he or she will feel only a national identity. While for younger age groups those with only national identities are a minority, for the population above age 60 they constitute a majority.

Does this pronounced age pattern imply that as people get older they tend to assume a stronger national identity and abandon multiply identities they might have held earlier? In this case of a dominating age effect, the significant population aging that will occur over the coming decades would imply a decline in the proportion of citizens with multiple identities. Yet, the same pattern could also be explained in terms of a cohort effect: young cohorts are being socialized in a way that produces a higher prevalence of multiple identities than found among the previous cohorts which they then maintain throughout their lives. This effect would result in significant increases in future European identity through demographic metabolism, with the younger, more European-minded cohorts replacing the older ones. Both of these contrasting interpretations are possible, and based on one cross-sectional survey alone their validity cannot be assessed empirically. Only panel data, providing age profiles at different points in time, allow us to discriminate between age and cohort effects.

Lutz, Kritzinger, and Skirbekk (2006) conducted statistical analyses showing a highly significant positive cohort effect. The study found that for cohorts born one year later, the proportion with multiple identities is on average half a percentage point higher. This confirms the view that the

FIGURE 3 Proportion of the European population with multiple identities (including European identity) by age, 1996, 2004, and forecast for 2030



trend toward a greater prevalence of multiple identities in the European Union largely happens along cohort lines. In other words, cohorts born more recently are socialized in such a way that they adopt fewer solely national identities and more multiple identities. They then largely maintain these identities throughout their lives.

Because expressed national versus European identity can be viewed as a characteristic of individuals meeting the criteria set out above, its changing prevalence in the population can also be forecast using the new model. Doing so, Lutz, Kritzinger, and Skirbekk (2006) forecast future trends in the degree of multiple identities in Europe under the assumption that the estimated cohort effect remains relevant over time. In other words, we incorporate the assumption that in each subsequent cohort the proportion with multiple identities increases by 0.5 percentage points and remains stable along cohort lines. The top line in Figure 3 gives the predicted age-specific proportions with multiple identities in 2030 and shows a marked upward shift. In terms of absolute numbers the results predict that in 2030, only 104 million adult European Union citizens (EU-15) will have strictly national identities, while 226 million will have multiple identities. This study also suggests that the relentless forces of cohort replacement by which the older, more nationally oriented cohorts will die out and the younger, more European-minded cohorts will take their place are likely to produce significant changes in the pattern of European identity. These predicted cohort shifts are likely to have significant long-term implications for fundamental political and economic developments in Europe, even though short-term politics and market reactions are likely to remain volatile. With respect to the current political debate on the legitimacy of Europe-wide institutions, this study suggests that most commentators and analysts ignore one of the most important forces that can likely lead to greater European integration—namely, the demographic metabolism that will replace predominantly nationalistic cohorts with younger ones that predominantly identify with Europe.

If the theory of socioeconomic change introduced in this essay can produce quantitative forecasts for issues that are as soft and qualitative as the notion of national/European identity, it can also be applied to forecasting the future prevalence of a large array of personal views, opinions, preferences, and values. The preconditions for the applicability of this theory are the availability of data that allow a clear distinction between the different characteristics studied and the estimation of the existence and strength of cohort effects as well as age/duration-specific transition rates.

Discussion and outlook

Virtually all human populations can be subdivided into groups whose members differ from each other according to measurable characteristics that also influence their behavior. If membership in these groups is stable over the life course after a certain age (such as ethnicity, native language, highest educational attainment, or stable values and identities) or shows patterns of transition that can be modeled on the basis of plausible assumptions (such as marital status, labor force participation, income level, or health status), then the multi-dimensional demographic approach allows us to model how societies change over time according to the changing relative sizes of these sub-groups. Perhaps no other theory in the social sciences has potentially greater predictive power over decades into the future.

Many questions remain. Some of them I will mention in this concluding section, others will be elaborated in subsequent research. One question that requires significant further elaboration is how to deal with uncertainty in the context of prediction. Over the past two decades an extensive literature on probabilistic population projections has appeared (e.g., Lutz and Goldstein 2004; Lee 1998). These approaches, which replace point forecasts with ranges of explicitly stated uncertainty, can, in principle, also be applied to the kinds of multi-dimensional forecasts presented here. The main problem is that the uncertainty distributions need to be established for a much larger number of input parameters, and there often is scant empirical basis for grounding these assumptions. A more serious theoretical issue relates to the possibility of falsification of probabilistic statements. Under a probabilistic view, the probability of actually realizing a precise point forecast is practically zero: the real outcome almost certainly will be higher or lower. (This same problem arises with most predictive theories in the natural sciences: the question of falsification of probabilistic statements is one of the issues that are still largely unresolved in the theory of science (Pearl 2000).)

Space limitations have allowed only the description of two examples of predictions based on the theory of demographic metabolism. But these two have shown that this concept can be operationalized in a practical and meaningful way, resulting in new and relevant information about the future. The examples given also illustrate that the theory is applicable to almost any other meaningful and measurable sub-division of the population and even for cases in which the persistence along cohort lines is more questionable and becomes a matter of empirical assessment.

This demographic theory can possibly bring innovation not only to sociology but also to economics. Demographers tend to use many sociological and economic concepts in their work. Why should a genuinely demographic concept, applied far beyond the traditional realm of demography, not also advance thinking in those other disciplines? While for sociology and the study of social change the applicability of this theory is clear, there are many applications in economics as well. Wherever in economics the almost ubiquitous assumption of strictly homogeneous human agents is considered as too strong, this model offers a quantitative way of explicitly addressing heterogeneity. This can range from distinguishing between groups of people who have different sets of indifference curves underlying their choices to groups of people with different discount rates in their assessment of utilities or to people who have different degrees of rationality in their behaviors.

Finally, I should emphasize that the innovative aspect of this essay does not lie in the methodologies of multi-dimensional (multi-state) demography or in highlighting the importance of changes along cohort lines. Both have been well established in the literature for the past 40–50 years, although not given a high level of attention. The new feature of this essay is the combination of these elements in a way that forms a comprehensive theory of socioeconomic change with quantitative predictive power. If accepted and further corroborated, this theory could significantly alter the way socioeconomic change is viewed, analyzed, and forecast, with direct implications for policy decisions and choices at the level of individuals, organizations, and societies.

Notes

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1 To my knowledge, Karl Popper has never explicitly written about demographic theories, but thanks to his desire to eat his favorite dish (Wiener Erdäpfelgulasch, or Viennese potato goulash), I had the opportunity to have a lengthy discussion with him about this topic in 1984, when I stayed in London for an internship with the World Fertility Survey and Popper's private doctor in Vienna asked me to deliver a large number of packages with his favorite dish to him. In return for this service, he talked to me at his private residence, patiently answering the questions of a young demographer with an interest in philosophy of science. In essence, he told me that, with respect to the validity of theories, demography is not different from all the other sciences. But through its quantitative nature it should be actually easier than in many other social sciences to define hypotheses and theories that are specific enough so that they can be tested, i.e. potentially falsified. He also asked what would be the most important theories with predictive power in demography. After some hard thinking I could only come up with the theory of demographic transition, which predicts that all societies starting from pre-modern conditions will experience a fertility decline following the mortality decline. Despite its lack of precision about the time lags involved and the precise course of fertility decline, this theory has predictive power and as a consequence underlies all the population projections for developing countries where further fertility declines to at least replacement levels are assumed. After listening to my explanations with interest, he asked whether demographic models could be applied to forecast other social trends as well, in particular utilizing the great inertia of population changes over time. Since I had never thought about it in this way, he encouraged me to do so. And it took me over 25 years to finally take up the challenge.

I remember well his last words as we waited for a taxi outside his house: "As scientists we have to be like bats, sending out signals to an unknown world and based on the echoes we receive, build an image (theory) which is the basis for predictions where we can safely fly. And as we fly, we have to listen very carefully to be able to update our predictions."

2 If considered relevant, this model could easily be modified to also allow for adults to go back to school for continued education before reentering the labor market.

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