Lifetime Well-Being[1][2]

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> Life, the distinguishing feature of organisms, is best thought of as involving some kind of complex organization, giving an ability to use energy sources for self-maintenance and reproduction.
> Entry "Life" in *The Oxford Companion to Philosophy*

1. Introduction

Despite major advances in the last two centuries—life expectancy at birth grew, in Europe, from about 36 years in 1820 to more than 80 years today—human lives remain inherently fragile and uncertain. Individuals do not, in general, know *how long* they will live, or, to put it differently, most humans are ignorant of the age at which they will die. This uncertainty about the duration of life constitutes a major aspect of human lives. To illustrate this, figure 1 shows the probabilities of survival to different ages of life, for males and females in the United States (2010).[2]

Economists have, since the early stages of the discipline, paid particular attention to the material and social conditions making self-maintenance and reproduction—and thus life—possible for humans. In those early economic analyses of longevity, premature mortality was viewed as a mechanism adjusting the population size to the available resources.

Botero ([1588] 1985) regarded premature mortality (through conflicts, famines, or diseases) as a mechanism reducing the population size to a level compatible with the available means of subsistence. In a similar vein, Smith ([1776] 1922) argued that premature mortality adjusts the supply of men to the demand for men. Under excess labor, the market wage falls below its "natural" level—equal to the subsistence wage—leading to premature deaths within the population until the excess labor supply has disappeared. That adjustment is close to what Malthus ([1798] 1970) called the "positive population check." According to his Principle of Population, there exists an imbalance between the capacity of a society to produce men and its capacity to produce food, and premature mortality adjusts the population size to the available resources.[3]

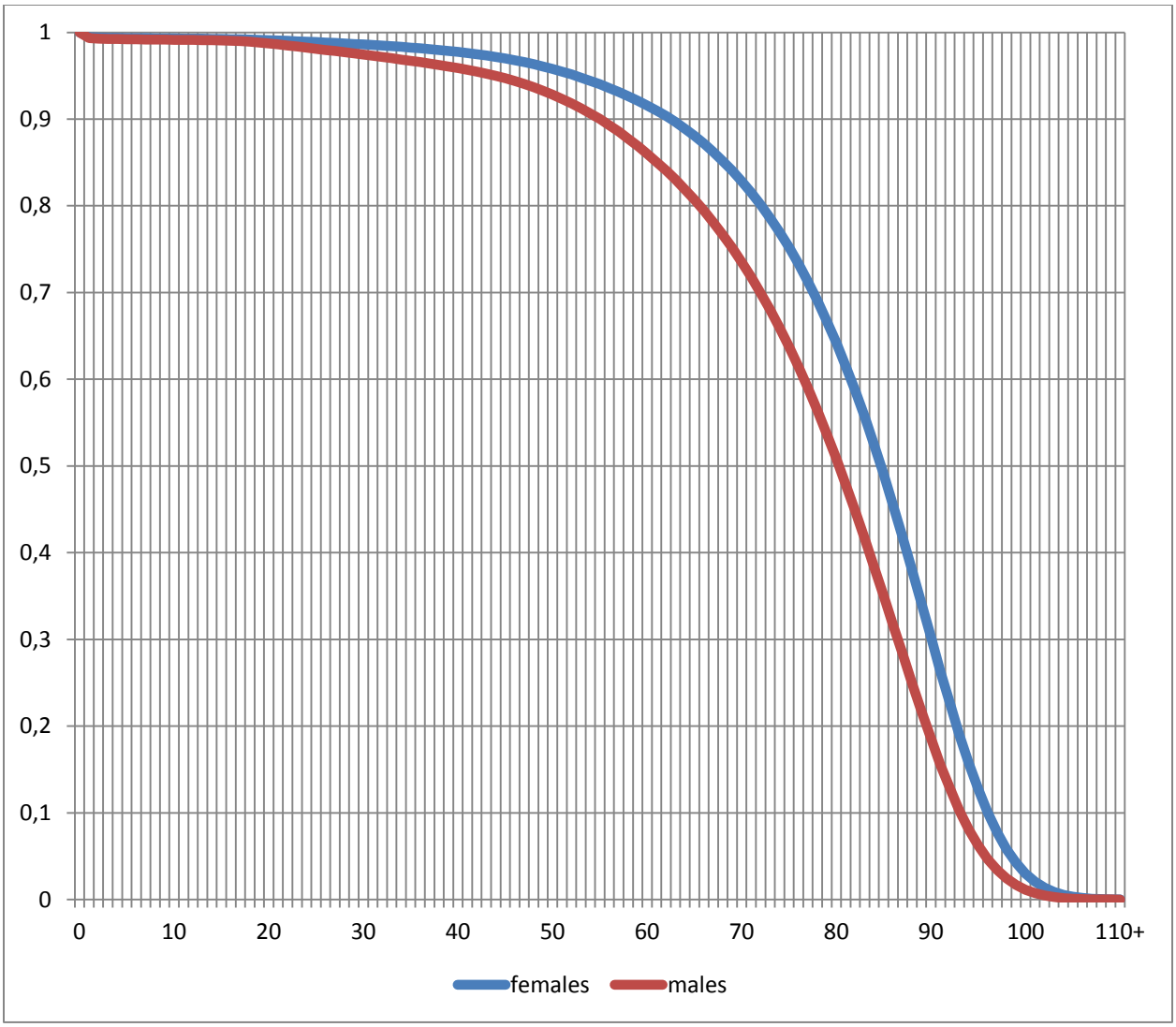

Figure 1. Period survival curves, United States, females and males, 2010. Source: The Human Fertility Data Base.

Premature mortality is also the starting point of the socialist criticism of market economies and of classical political economy. Marx (1844) criticized Smith's *Wealth of Nations* on the grounds that it promotes a market system where the production of men adjusts itself to the demand for labor, *as if* humans were a commodity like any other commodity. In later writings, Marx ([1867] 1970) argued that there exists no universal Principle of Population: premature deaths are due to large wealth inequalities under the capitalist regime of production.

As the father of modern "economics," Jevons (1871, 254) argued that the new economics should not be concerned with population (since "it forms no part of the direct problem of

economics"). The direct problem of economics should be, according to Jevons, the allocation of scarce resources (land, labor) among different uses for a *given* population.

Although Jevons's argument has not been decisive, it is nonetheless true that the new emphasis of economics on decisions regarding the allocation of resources has changed the way in which economists look at human lives. Instead of studying the material and social conditions affecting longevity, economists now examine how individuals tend, by their allocation decisions (in terms of resources and activities), to affect their life, in terms of quality and quantity. This economic analysis of human lives is known as *life-cycle theory*.

The goal of this chapter is twofold. First, I propose to review major economic theories of the life cycle, describing how individuals plan their lives in a context of risky lifetimes. Second, I study the optimal public intervention in that context, under different normative premises.

Given that life-cycle theory applies to all human decisions where the life horizon of decision-makers matters, I will have here to restrict my study to two particular aspects of life: on the one hand, consumption and savings decisions; on the other hand, prevention activities. One can regard those two aspects as reflecting, respectively, the "quality" and the "quantity" of life. Note that this exclusive emphasis on consumption and prevention is restrictive, since life-cycle analysis covers many topics (see Browning and Crossley 2011).

On the normative side, I will also have to restrict my focus. Since Parfit's (1984) canonical work on population ethics, comparisons between allocations are classified in three groups: (1) *same-number problems* (where the comparison concerns situations lived by the same population in terms of its size and the identity of the members); (2) *different-number problems* (where the comparison concerns situations lived by populations that differ in terms of size); (3) *different-identity problems* (where the comparison concerns situations lived by populations that differ in terms of the identity of their members). As it is well-known, problems of types (2) and (3) raise deep difficulties.[5] For the sake of presentation, I will restrict attention to the study of the social optimum in the context of longevity-affecting decisions under a fixed group of individuals (number and identity).

But even if one concentrates only on same-number problems, the normative treatment of varying lifetimes can rely on various ethical foundations. The normative analysis can, for instance, rely on a deontological approach, based on rights and duties, as does Kamm's (1993). Alternatively, one may adopt a teleological approach—that is, focusing on the good—as does

Broome (2004). It is not possible, because of space constraints, to present all these normative approaches to problems of life and death. On the contrary, I will focus here exclusively on a normative approach based on social welfare functions (SWFs). More precisely, I will compare optimal public policies obtained from two SWFs: on the one hand, the utilitarian SWF, based on welfarism, consequentialism, and sum ranking; on the other hand, the egalitarian SWF applied ex post, which consists of a maximin on realized lifetime well-being.

Anticipating the results, I show that the economics literature provides a large variety of explanations regarding how individuals allocate their resources along their uncertain lifetime, and regarding how they influence their survival chances. On the normative side, I argue that there exists a tension between, on the one hand, optimal policies derived from a utilitarian SWF, and, on the other hand, optimal policies derived from a nonutilitarian, inequality-sensitive SWF applied ex post. Actually, optimal policies under utilitarianism—encouraging savings, annuitization, and prevention—increase expected lifetime well-being, but at the cost of reducing the realized lifetime well-being of the unlucky short-lived.

This chapter is organized as follows. As a starting point, section 2 focuses on the definition and structure of lifetime well-being. Then section 3 studies an economy where individuals face risky lifetimes, and choose their lifetime consumption profile. I review different theories of behavior, and discuss the optimal policy under different normative foundations. Then section 4 considers a more complex economy where individuals, who still face a risky lifetime, can now affect their survival chances through their behavior, and studies preventive policies, whose goal is to improve survival conditions, by encouraging healthy behavior or discouraging unhealthy behaviors. Conclusions are left to section 5.

2. Lifetime Well-Being: Definition and Structure

2.1. Lifetime Well-Being: Definition

Before considering descriptive and normative challenges raised by risky lifetimes, it is worth paying attention to the definition and the formal structure of lifetime well-being. In a nutshell, lifetime well-being can be defined as the quantity of well-being associated with a life, as opposed

to temporal (or instantaneous) well-being, which is the quantity of well-being associated with a subperiod (or an instant) of life. In some sense—to be further described below—lifetime well-being constitutes some form of "lifetime aggregate" of well-being.

At this early stage of our explorations, it should be stressed that the mere concept of lifetime well-being presupposes some form of *continuity* of human identity over time, that is, that a human being remains, in general, one and the same person from birth until death. Without such a postulate, referring to someone's "lifetime" well-being—or to someone's "lifetime" income or "lifetime" consumption—would not make sense. Assuming that a human being remains one and the same person from birth until death is not, in general, a strong postulate. As emphasized by Adler (2012, 409), the vast literature in contemporary philosophy concerning personal identity and its evolution over the lifetime tends to support the general intuition that a human being remains one and the same person from birth to death (see McMahan 2003; Broome 2004).[6]

Regarding the definition of lifetime well-being, another important point to be stressed is that there exist not one, but several, concepts of lifetime well-being. A first reason for the multiplicity of lifetime well-being concepts lies in the mere fact that there exist different concepts of well-being, including, among others, hedonic well-being and preferences-based well-being. While *hedonic* well-being refers to how well individuals feel, in line with Bentham's (1789) concept of utility, preferences-based well-being is a mere numerical representation of individual's preferences, in line with Pareto (1909).[7] This second concept of well-being admits no trivial relationship with individuals' feelings and emotions.

These two concepts of "well-being"—hedonic and preferences-based—lead to distinct measures of well-being. At the individual level, these different measures of well-being are often correlated (see Clark, chapter 19, this Handbook). Spouses whose measured levels of hedonic well-being are low are more likely to divorce, so that measures of hedonic well-being and preferences-based well-being tend to be correlated in that context. Similarly, workers with low levels of measured hedonic well-being are more likely to leave their jobs, so that measures of hedonic well-being and preferences-based well-being are also correlated in that context. Note, however, that, even though different measures of well-being may be correlated at the individual level, these do not necessarily lead to the same results when comparing the well-being of different persons. As shown by Decancq and Neumann in chapter 19 of this Handbook, the

ranking of individuals in terms of their level of hedonic well-being does not coincide with the ranking of individuals in terms of their level of preferences-based well-being.

Lifetime well-being can be measured in different ways. First, one can measure lifetime well-being in a hedonic way, by summing up, over an individual's life, its temporary hedonic well-being levels. That approach was developed by Veenhoven (1996), under the name of "happy life expectancy." Happy life expectancy is the product of life expectancy at birth with average happiness scores (normalized on a 0-1 scale). Note, however, that the computation of happy life expectancy implicitly assumes constant happiness during the life, while Blanchflower and Oswald (2008) show that happiness exhibits a U-shape through life.

From a preferences-based perspective, lifetime well-being is a numerical representation of individual preferences on possible lives. Thus, the shift from temporary well-being to lifetime well-being is here a pure matter of extending the "baskets" of goods and services on which individual preferences are defined. Instead of being defined on the baskets of consumption goods and activities at a particular point in time, preferences are now defined on profiles of baskets of consumption goods and activities during the entire life. In this context, a higher level of lifetime well-being means that the life enjoyed by the individual better fits his preferences on possible lives. Preferences-based lifetime well-being can be measured by means of constant equivalent-income profiles.[8] This approach, first developed by Usher (1973), consists of computing the hypothetical constant income profile such that, if combined with nonmonetary life features of reference, this would make a representative agent indifferent between that hypothetical life and the actual life enjoyed (with current income profile and current nonmonetary life features).[9]

2.2. Lifetime Well-Being: Structure

Having discussed the distinction between hedonic and preferences-based lifetime well-being, we can now turn to the formal structure of lifetime well-being. When I defined lifetime well-being, I argued that this could be regarded as some kind of "aggregate" of well-being along a life. Studying the structure of lifetime well-being amounts to examining the form of this aggregate, that is, the formal relationship of lifetime well-being with temporal well-being.

In most economic studies concerned with lifetime well-being, it is assumed that lifetime well-being is a mere *sum* of discounted temporal well-being levels. The discount factor that is

used may either reflect pure time preferences (i.e., the degree of impatience), or may, in case of risky lifetimes, reflect the probabilities of surviving to different ages of life (i.e., biological discount factor under the expected utility hypothesis).

At this stage, it is important to stress that, even if we restrict ourselves to additive lifetime well-being, various representations exist in the literature. A first, major dimension on which additive formulae differ consists of the postulated time horizon: finite or infinite. Human beings have a finite life, but in case of pure altruism toward descendants, the lifetime well-being function becomes recursive (i.e., depending on the lifetime well-being of the next generation), and repeated substitutions yield a lifetime well-being function that is an infinite sum of weighted temporal well-being levels (see Barro and Becker 1989).

A second dimension concerns the form of discounting. The form of discounting depends on the particular type of lifetime well-being considered. If, for instance, lifetime well-being takes a hedonic form, the degree to which the level of temporal well-being associated with a given period of life is discounted may be related to the strengths or weakness of the mental links between that period and the present (see McMahan 2003). If, on the contrary, lifetime well-being is preferences based, the form of discounting aims at reflecting individual time preferences. Whereas most economic papers still rely on standard exponential discounting, recent studies rely on hyperbolic discounting, in such a way as to better fit the data showing the existence of time inconsistency (see Laibson 1997).. Finally, note that, in case of dynastic altruism (Barro and Becker 1989), the rate of time discounting consists of the altruistic weight assigned by parents to their descendants, to a power depending on the distance between parents and their descendants in the family tree.

Although widespread, the discounted time-additive lifetime well-being structure is not the unique possible way to aggregate temporal well-being levels. This formal structure exhibits a strong degree of *substitutability* between the temporal well-being levels prevailing at different periods of life. For instance, a bad period, characterized by an extremely low level of temporal well-being, can be compensated, from the perspective of time-additive lifetime well-being, by a much better period, characterized by a higher level of temporal well-being. Such a strong substitutability between each period's well-being is questionable.

Relaxing that substitutability assumption can modify the formal structure of lifetime well-being. One can, for instance, rewrite lifetime well-being as a *product* of temporal well-

being levels, as does Broome (2004, 227). Under such a product, the degree of substitutability between the temporal well-being levels associated with different periods is limited. If, for instance, one period of life is characterized by an extremely undesirable event, yielding a level of temporal well-being equal to 0 under the prevailing measurement scale, then the lifetime well-being is also equal to 0. Under a product of temporal well-being levels, the level of lifetime well-being is strongly sensitive to the occurrence of an extremely undesirable event, since substitutability is now limited.

When the degree of substitutability between the temporal well-being levels achieved in each life period is set to 0—that is, perfect *complementarity*—the level of lifetime well-being becomes equal to the minimum of all temporal well-being levels achieved during a life. Under this formula, a bad life period cannot be compensated by other, better life periods: there is no substitutability. On the contrary, one could assign a full weight to the highest level of temporal well-being achieved during the life. In that case, lifetime well-being would be defined as the maximum of all temporal well-being levels. Such an alternative concept of lifetime well-being regards life periods as perfectly *redundant*: a life is here reduced to its "best days," while the rest of life does not matter from the perspective of lifetime well-being. This approach can be called the "peak" approach (see Broome 2004, 228). Alternatively, one could adopt a hybrid form of lifetime well-being, which combines a concern for the best period of life with a concern for the last period of life. That approach, first studied in Kahneman, Wakker, and Sarin (1997, 381), is known as the "peak and end" approach, where lifetime well-being is defined as the sum of the maximum level of temporal well-being plus the temporal well-being associated with the last period of life (see Broome 2004, 228).

Obviously, perfect complementarity and redundancy of life periods are polar cases, which make lifetime well-being dependent only on what happens during some particular subperiods of life. The major problem with such functional forms is to make lifetime well-being insensitive to what happens during almost all periods of life. This limitation may explain why the economics literature has mainly focused on the time-additive lifetime well-being structure. However, several recent criticisms have been raised against the standard time-additive lifetime well-being structure.

A first theoretical criticism of time-additive lifetime well-being concerns the limited capacity of this formal structure to reflect the *value of longevity*. This point is discussed in detail

by Broome (2004, ch. 7). The question raised is the following: where does the value of longevity appear in the formal representation of lifetime well-being?

In order to answer this question, it is first necessary to define what is meant by the "value of longevity." Broome (2004, 108) defines it as follows. Suppose that some total amount of time is lived by people, at some level of temporal well-being. Longevity is valued if it is better for the time to be divided up among fewer lives rather than among more lives. Thus, longevity is valued if, for a given amount of temporal well-being per period and a given total time, it is better that time is concentrated on a smaller number of lives. When reformulated purely in terms of the structure of lifetime well-being, that condition states that, in the context of a unique life, longevity is valued if the increase in lifetime well-being from extending that life by a period is an *increasing* function of the duration of that life.

Under time-additive lifetime well-being, the addition of one life period is valued only through the level of temporal well-being associated with that additional life period. As a consequence (and abstracting from time discounting), the addition of one life period with a given level of temporal well-being has the same value, from the point of view of additive lifetime well-being, independently of the past duration of life. For instance, adding a life period with some level of temporal well-being has the same effect on the lifetime well-being of a person, whether this segment of life is added to a newborn person or to a 90-year-old person. This goes against valuing longevity in Broome's sense. Note, however, that under multiplicative lifetime well-being, the addition of a life period with some given level of temporal well-being would not have, in general, the same effects on individuals of different ages, suggesting that the criticism based on the value of longevity does not affect all forms of lifetime well-being representations.

Although the standard, time-additive, representation of lifetime well-being does not do justice to the value of longevity, it is nonetheless possible, thanks to some modifications, to make lifetime well-being inclusive of the value of longevity. For this purpose, a simple solution consists of making longevity part of temporal well-being at every time of life. This strategy, explored by Broome (2004, 110), consists of *dispersing the value of longevity*. The intuition behind such dispersion is that humans, throughout their lives, undertake projects, which take time to be completed. As a consequence, the contribution of a life project to lifetime well-being depends on the total time spent on it. The dispersion of the value of longevity does justice to that intuition. To achieve dispersion, one can add, to the level of temporal well-being associated with

each life period, some positive amount of well-being that is proportional to the total duration of life. Thanks to dispersion, longevity is valued, since the addition of a life period generates now a larger rise in lifetime well-being if the person benefiting from the extra period has a longer life. It follows from this that the first criticism—the incapacity of the time-additive form of lifetime well-being to reflect the value of longevity—can be overcome by dispersing the value of longevity across all periods lived. Note, however, that such dispersion requires going beyond the standard time-additive representation, and also faces the difficulties associated with the calibration of the extra amounts of well-being to be added at each period of life.

A second theoretical criticism against time-additive lifetime well-being, which relies on a preferences-based concept of well-being, supports the introduction of limited substitutability between the temporal well-being levels associated with different life periods. This criticism was formulated by Bommier in different pieces of work (see Bommier 2006, 2007, 2010). Bommier argued that if individual preferences on lotteries of life satisfy the expected utility hypothesis (i.e., can be represented by a weighted sum of the well-being of each scenario of the lottery, weighted by its probability of occurrence), if lifetime well-being is time-additive (with zero discounting), and if consumption per period of life is constant along the life cycle, then individuals must be indifferent between lotteries of life characterized by the same life expectancy and the same constant consumption profiles, even though these lotteries differ on the variance of longevity. That phenomenon is known as the net *risk neutrality* with respect to the duration of life.

Net risk neutrality with respect to the duration of life implies, for instance, that a person is indifferent between, on the one hand, a life with a sure duration of 80 years and, on the other hand, a lottery with a probability ½ of dying at the age of 60 years, and a probability ½ of dying at the age of 100 years (consumption profiles being assumed to be flat in all cases). This result is quite counterintuitive, since one expects that individuals are likely to prefer the certainty of living 80 years over the lottery involving a probability ½ of dying at age 60. To put it differently, it is likely that individuals exhibit some form of risk aversion with respect to the duration of life, instead of risk neutrality. If this is true, the time-additive measure of lifetime well-being is questionable.

As a consequence, Bommier proposed a new formal structure for lifetime well-being, allowing for risk aversion with respect to the duration of life: a concave transform of the sum of

temporal well-being levels. The standard time-additive case coincides with the case of a linear transform, which is responsible for the implausible property of risk neutrality with respect to the duration of life. Once that linear transform is replaced by a concave transform, risk neutrality does no longer occur, and agents opt for the lottery with the lower variance for lifetime.

Although Bommier's solution is attractive and has given rise to many applications (see Bommier, Leroux, and Lozachmeur 2011a, 2011b), it is important to stress that it does not constitute the unique way to escape from risk neutrality with respect to the duration of life. One can, for instance, obtain risk aversion with respect to the duration of life by merely replacing the expected-utility hypothesis by a non-expected-utility framework, while keeping a standard time-additive lifetime well-being.[10] Hence, although Bommier's criticism points to a fundamental limitation of the standard representation of individual preferences on lotteries of life, it is not obvious that it definitely leads to the rejection of the time-additive lifetime well-being formula. One may reconcile Bommier's criticism with the additive model, while changing other assumptions.

Summarizing, the standard time-additive model suffers from some limitations: a high degree of substitutability between temporal well-being levels, a limited capacity to reflect the value of longevity, and a tendency to lead to (implausible) risk neutrality with respect to the duration of life. However, despite such criticisms, the time-additive model remains the most widespread framework in economics, probably because of its simplicity. This is the reason why the rest of this survey relies on it, except in a few cases. It should be stressed, nevertheless, that deviations from the standard time-additive model may significantly affect descriptive and normative conclusions. These deviations remain largely—except for a few exceptions—on the research agenda of life-cycle economists.

3. Consumption, Savings. and Risky Lifetimes

3.1. Consumption Profiles: Behavior

Having examined the definition and structure of lifetime well-being, let us now concentrate on a major pillar of life-cycle theory: the study of the relation between lifetime well-being and

consumption profiles. Various empirical studies examined the shape of individuals' consumption profile over their life cycle (see Poterba 1994; Lee and Tuljapurkar 1997; Börsch-Suspan 2003; Gourinchas and Parker 2002; Jappelli and Modigliani 2005). All these studies found—approximately—the same result: the lifetime consumption profile exhibits an inverted-U shape, with a maximum around 45–50 years.

How can economic theory explain those profiles? To answer this question, it may be worth describing what life-cycle theory says about consumption along life. Life-cycle theory first appeared in the economics literature under the form of the *life-cycle hypothesis* (Modigliani and Ando 1963) and of the *permanent income hypothesis* (Friedman 1957).[11] According to this theory, individuals allocate their resources along their life so as to maximize their lifetime well-being, subject to their lifetime budget constraint. The shape of the lifetime consumption profile then depends on three factors: (1) the consumers' preferences (in particular their *time preferences*, that is, how they weight future well-being in comparison to current well-being); (2) the interest rate; (3) the duration of life.

Under the life-cycle hypothesis, the precise way in which individuals use their resources over time depends on the postulated functional form for lifetime well-being. Given that lifetime well-being takes, most often, the form of a discounted sum of temporal well-being levels, which are themselves increasing and concave in temporal consumption, it follows from this that the optimal consumption profile generally involves no large fluctuations over the life cycle. The intuition behind the consumption smoothing phenomenon lies in the fact that large fluctuations in consumption over time would, under the concavity of temporal well-being in consumption, lead to a smaller lifetime well-being level in comparison with what would prevail under a smoother consumption profile. As a consequence, life-cycle theory predicts that individual consumption must, along the life cycle, exhibit a lower volatility than individual income. Actually, lifetime well-being maximization implies that individuals tend to save when they are working (i.e., their income being larger than their consumption), while they stop saving once retired (i.e., their income being then smaller than their consumption).

While early life-cycle theory presupposed a fixed lifetime known by individuals, Yaari (1965) extended the study of consumption profiles to the more realistic context of uncertain lifetimes, and studied how individuals choose to consume their wealth during their unknown lifetime. Yaari assumed that individual preferences on lotteries of life satisfy the expected utility

hypothesis, and considered two institutional environments: one where there exists no market for annuities and one where such a market exists. By definition, annuities give a right to an income flow conditionally on survival, and, accordingly, can constitute a good insurance against a long life (i.e., the risk of becoming poor in case of survival to the old age).

Considering first the economy without annuities, Yaari shows that the introduction of risky lifetimes tends, in comparison to the benchmark model without risk, to increase the rate of time preferences for the present for most people, except for those who have loved descendants. Indeed, the perspective of possible death tomorrow is likely to make individuals consume more now (and thus to make them more impatient), because individuals are likely to want to avoid savings losses due to premature death.[12] In other words, the risk of dying early acts here as a "biological" discount factor, which reinforces human impatience.

Then, turning to the economy with an annuities market (which is supposed to be actuarially fair), Yaari shows that, provided individuals have no will to leave bequests, it is optimal for them to convert their entire savings into annuities.[13] The existence of an annuity market thus involves a well-being gain for agents. As a consequence of full annuitization, the lifetime income profile of individuals reveals a lower degree of impatience than the profile without annuities (but keeps the same monotonicity, i.e., either increasing or decreasing).

Real-world consumption profiles do not look like the consumption profiles prevailing under Yaari's model. Annuity markets are underdeveloped in most countries of the world. Johnson, Burman, and Kobes (2004) report that only 5% of people older than 65 buy annuities in the United States, which is far below the predictions of Yaari's model.[14] The strong contrast between the predictions of Yaari's model and the real world is known as the *annuity puzzle*.

Various explanations are given for that puzzle (see Davidoff, Brown, and Diamond 2005; Benartzi, Previtero, and Thaler 2011). Some explanations lie on the supply side of the annuity market: Poterba (2001) showed that the price of annuities is higher than the actuarially fair price (> 10%–15%), unlike in Yaari's world. Another possible explanation lies on the demand side: the role of the family as an insurance. Indeed, as shown by Kotlikoff and Spivak (1981), the family acts as an informal insurance company offering implicit contracts, thus insuring individuals against risk about date of death. The advantage of such implicit contracts is that there is, in the family, a higher degree of information and trust, which reduces the standard problems faced in insurance markets (moral hazard and adverse selection).[15] Another explanation, still on

the family side, would be individuals' will to leave bequests. This hypothesis is confirmed by Brown (2001), who shows that individuals who consider that leaving a bequest is important have a lower probability of buying annuities.[16] However, this result is in contradiction with a previous study by Hurd (1989), who showed that most bequests are involuntary, since the marginal utility of the money that is given to descendants seems to be very low. Besides the family, another possible explanation for the annuity puzzle may be the role of the state as a Good Samaritan. According to this explanation, the low degree of annuitization would result from the fact that individuals rely on the state to help them in case of old-age poverty.

While these explanations presuppose rational agents with standard preferences, there also exist behavioral explanations of the annuity puzzle. Holmer (2003) analyzed the demand for annuities in a framework where individuals are not expected utility maximizers (unlike in Yaari 1965), but behave as in prospect theory (Kahneman and Tversky 1979).[17] Holmer concludes that, under prospect theory, annuities seem less attractive (because of an overestimate of the probability of death before retirement). Another possible explanation is flow aversion. Fetherstonhaugh and Ross (1999) asked respondents to choose between, on the one hand, an annuity plan, and, on the other hand, a mix made of a smaller annuity and of a given (immediate) amount of cash. Although the two options had been computed to yield the same expected total wealth, 75% of individuals preferred the second option.

There is a simpler explanation to the annuity puzzle: individuals tend, for various reasons, to save too little for their old days, making annuities useless. Insufficient savings may come from the environment in which individuals live (imperfect markets), which would prevent them from achieving consumption smoothing. A first possible explanation lies in the existence of liquidity constraints (Deaton 1991): under liquidity constraints, consumption at the young age is lower than at higher ages, because of lower wages early in the career.

Alternatively, recent studies provided several behavioral explanations for individuals' tendency to save too little for their old days. A first explanation consists of myopia—that is, the incapacity to take the future into account (see Feldstein 1985; Feldstein and Liebman 2002; Cremer et al. 2008). A second explanation for undersaving consists of time inconsistency due to hyperbolic discounting—that is, agents valuing the future, but being unable to commit themselves to any savings (Thaler 1981; Laibson 1998; Angeletos et al. 2001; Diamond and Koszegi 2003).[18] Under time inconsistency, there is a conflict between current and future selves.

Current selves cannot commit themselves to save for the sake of achieving a distant goal in the future: avoiding old-age poverty. Another explanation for insufficient saving may be a human tendency toward prodigality (see Homburg 2000; Pestieau and Possen 2008). In all those cases, undersaving is regarded as the outcome of some kind of behavioral imperfection, which prevents individuals from acting in a way maximizing their lifetime well-being.

In sum, life-cycle theory, which generally assumes that lifetime well-being takes the form of a sum of discounted temporal well-being levels, supports annuitization and (relatively) smoothed consumption profiles. These predictions do not fit the data. However, it is possible to reconcile the theory with facts by assuming various deviations from the standard representation of human behavior (e.g., myopia, time inconsistency, etc.).

3.2. Consumption Profiles: Policy

Should governments intervene regarding individual lifetime consumption profiles? The answer depends on whether individual lifetime consumption profiles under laissez-faire coincide or not with the profiles at the social optimum. In order to derive optimal policies, it is first necessary to define a social objective. It can, under some conditions, be formalized by a social welfare function (SWF), which can take various forms, depending on the ethical postulates or axioms from which the SWF is derived (see Weymark, chapter 5, this Handbook). For the sake of presentation, I will, in this section, contrast the optimal policies obtained under two distinct kinds of SWF: first, the standard utilitarian SWF (based on Bentham 1789); second, nonutilitarian, inequality-sensitive SWFs of the maximin type (based on Rawls 1971).

Let us first consider the utilitarian SWF. A key feature of the utilitarian SWF is that it satisfies the ex ante Pareto principle, according to which, if an allocation yields a larger level of expected lifetime well-being for some individual than another allocation, while it leaves other individuals with the same expected lifetime well-being level than in another allocation, then that allocation must be socially preferred to the other allocation.

An important corollary of the ex ante Pareto principle in the present context concerns the treatment of behavioral mistakes in the context of savings decisions. When individuals make such mistakes—either because of myopia, time inconsistency, or prodigality—they do not behave in a way that maximizes their expected lifetime well-being. As a consequence of those

suboptimal behaviors, there exists a gap between laissez-faire and the social optimum. That gap requires some public intervention, as argued in the recent "behavioral" public economics (Camerer et al. 2003; O'Donoghe and Rabbin 2003; Thaler and Sunstein 2003).

When individuals tend to save less than what would have maximized their lifetime well-being, this individual tendency toward undersaving can be corrected by means of some commitment device forcing agents to save more than what they would have saved without state intervention. Such a commitment device can take the form of a social security system that forces young individuals to save by taxing their incomes, and then uses such fiscal revenues to fund the pensions of the old. This system is regarded as an institutional remedy against individual behavioral imperfections (either myopia, or time inconsistency, or prodigality). Alternatively, the government can encourage savings by appropriate savings subsidies, inducing individuals to save more in comparison with laissez-faire.

The underlying justification for government intervention is that, in the absence of intervention, individuals would save too little and then be poor in old age. In other words, individuals would, in the absence of policy, fail to maximize their expected lifetime well-being. Once old and poor, individuals would then realize their mistakes and would regret their past behaviors. Public policy would thus prevent the emergence of regrets, by encouraging individuals to save more when they are young, through a mandatory pensions system or a subsidy on savings. Note that the pension system associated with the forced savings system solves the other problem identified above: it is formally similar to an annuity system, since it provides constant resources conditionally on survival. Hence one can regard (compulsory) pensions systems as forcing individuals both to save more and to annuitize their savings, unlike what prevails under laissez-faire. Social security is, in this context, a remedy for some form of human myopia (Feldstein 1985; Feldstein and Liebman 2002).

Hence, from the perspective of the ex ante Pareto principle—and, thus, of the utilitarian SWF—behavioral mistakes should be corrected, and saving and annuitization should be promoted by public policies. Note, however, that such policies do not generally suffice to decentralize the utilitarian social optimum. Utilitarianism also requires some transfers across individuals, aimed at equalizing the marginal expected lifetime well-being across individuals, in order to maximize the utilitarian social objective.

Bommier, Leroux, and Lozachmeur (2011a, 2011b) considered the utilitarian social planning problem in an economy à la Yaari (1965) where rational (i.e., nonmyopic) individuals face risk about the duration of their life and choose how to allocate a given endowment of resources over their life cycle. At the utilitarian optimum (and assuming away pure discounting), consumptions are, under time-additive lifetime well-being, equalized across all life periods, so that individuals who enjoy a longer life also benefit from more resources than those who have a shorter life. Hence, starting from an initial situation where resources are distributed equally, the equalization of consumption per period per person consists of transferring resources from the young age to the old age of life. However, given that some individuals die before reaching the old age, such a transfer is equivalent to transferring resources from short-lived agents toward long-lived agents.

It should be stressed here that this direction of transfers is attenuated when lifetime well-being takes a nonadditive form, in such a way as to account for net risk aversion with respect to the length of life (see *supra*). Hence, the form of the utilitarian social optimum is affected by the postulated structure of lifetime well-being. Note, however, that utilitarianism still tends, to some extent, to redistribute from short-lived toward long-lived agents, even when lifetime well-being is defined as a concave transform of the sum of temporal well-being levels (see Leroux and Ponthiere 2013).

Such transfers from short-lived toward long-lived agents are quite counterintuitive: they induce a kind of double penalty for the short-lived. Short-lived persons are penalized first by nature (their shorter life reduces the maximum achievable lifetime well-being for a given amount of resources) and additionally by Bentham (since utilitarianism requires them to transfer resources toward the longer-lived).

Many find that utilitarianism leads to counterintuitive outcomes in situations where individuals are heterogeneous. As Mirrlees (1982) underlined, utilitarianism can, at most, be taken as an ethical benchmark when the population under study is fully homogeneous. However, once agents differ on fundamental characteristics, utilitarianism can lead to quite counterintuitive consequences. This is true for handicapped persons, whose lower marginal utilities make them penalized under utilitarianism (see Arrow 1971 and Sen 1973). But this is also true for short-lived agents, whose shorter lifetime reduces their capacity to transform resources in terms of well-being (except under linear temporal well-being functions).

Let us now consider the optimal resource allocation under risky lifetimes, but under an egalitarian SWF. At this stage, it is worth underlining that there exist, in the literature, various ways to be egalitarian from a life-cycle perspective. The most widespread approach consists of trying to minimize inequalities in well-being from the perspective of lives taken as a whole. This "complete view" is the approach adopted in the rest of this section. Note, however, that one may rather argue that equality should not only concern lives taken as a whole, but, also, all sublives, that is, all segments of the lives under comparison. That alternative egalitarian approach, developed by McKerlie (1989), is more demanding than the approach adopted in this chapter, which allows for inequalities in well-being in different sublives, as long as these tend to counteract each other, leading to perfect equality at the level of the whole life.[20]

In the rest of this section, the social objective consists of a nonutilitarian, inequality-sensitive SWF defined in terms of individual well-being over the entire life. Such a SWF may or may not satisfy the ex ante Pareto principle. If, for instance, the SWF to be maximized is the minimum expected lifetime well-being within the population, then the ex ante Pareto principle is satisfied. If, on the contrary, we take as a SWF the minimum realized lifetime well-being within the population, then the ex ante Pareto principle does not hold any more.

To illustrate this, let us now consider the social planning problem studied in Fleurbaey, Leroux, and Ponthiere (2014). They consider the optimal allocation of resources in an economy with risky lifetimes, while adopting an ex post egalitarian social objective (specifically, one of the maximin form). They identify the conditions under which short-lived persons can be compensated so that the realized lifetime well-being levels of short-lived and long-lived persons may be equal.

At first glance, the compensation of short-lived persons seems impossible. Ex ante (i.e., before the duration of life of each person is known), short-lived persons can hardly be identified. Ex ante information consists of life tables, which give us information at the group level. However, since compensation requires information on realized longevity at the individual level, life tables are not suitable for the compensation of individuals for shorter realized lifetime. Note also that, ex post, the compensation of short-lived persons cannot be carried out. Hence compensating the short-lived seems to be impossible.

Nonetheless, Fleurbaey, Leroux, and Ponthiere (2014) show that such a compensation for premature death can be carried out, by promoting the consumption of resources early in the life

cycle. The ex post egalitarian optimum equalizes realized lifetime well-being across all individuals, short-lived and long-lived, by setting old-age consumption to a level that makes individuals indifferent between, on the one hand, further life with that consumption, and, on the other hand, death. Such a "neutral" consumption level is the one that makes temporal well-being equal to the neutral well-being level for continuing life (see Broome 2004). Given that the "neutral" consumption is quite low (see Becker, Philipson, and Soares 2005), this social optimum involves, in general, *decreasing* consumption profiles along the life cycle.

At the policy level, adopting an ex post egalitarian SWF has strong consequences: instead of redistributing resources from short-lived toward long-lived agents as under utilitarianism, the policy consists here of taxing savings so as to transfer resources from the old to the young, that is, from the lucky long-lived to the (potentially) unlucky short-lived.

Note, however, that the equalization of realized lifetime well-being across short-lived and long-lived agents has a cost: the violation of the ex ante Pareto principle. To see this, it suffices to note that ex ante individually optimal insurance decisions—such as the purchase of actuarially fair annuities—may not be optimal under an ex post egalitarian social objective. Although buying annuities may increase expected lifetime well-being ex ante, redistributing the savings of the prematurely dead to the surviving old through annuities tends to increase inequalities in realized lifetime well-being between the short-lived and the long-lived, and, accordingly, cannot be optimal from an ex post egalitarian perspective.

Another aspect by which ex post equality may conflict with ex ante Pareto efficiency concerns the treatment of myopic behavior. From an ex ante perspective, it is worth correcting behavioral mistakes, in such a way as to increase expected lifetime well-being prospects. However, correcting for myopia can increase inequalities in realized lifetime well-being. To see this, take the case of a myopic person who turns out to be short-lived. Since he dies prematurely, encouraging him to save would be a pure waste of resources from an ex post perspective.

Hence, if one adopts an ex post egalitarian view, myopia, time inconsistency, and prodigality are no longer necessarily problematic. On the contrary, from the perspective of ex post egalitarians, those "behavioral mistakes" may have positive effects, since these allow unlucky short-lived persons to minimize losses in realized lifetime well-being caused by premature mortality. This is the reason why ex post egalitarians may, quite paradoxically, welcome those behavioral mistakes.

The incompatibility between ex ante Pareto efficiency and ex post equality is not specific to the optimal allocation of resources under risky lifetimes. As discussed in detail by Mongin and Pivato (chapter 24, this Handbook), this incompatibility between ex ante Pareto efficiency and ex post egalitarianism constitutes a general result in the literature on social choice under risk. Allowing for all ex ante Pareto improvements—including, in our context, the supply of insurance contracts and annuitization, as well as the correction of behavioral mistakes—can go against the equalization of realized lifetime well-being across all individuals.

Note, however, that the extent to which the utilitarian and the ex post egalitarian social optima—and the associated policies—differ depends on the postulated form of lifetime well-being. The standard, time-additive form of lifetime well-being tends to exacerbate the differences between the two optima, in comparison to a decision framework with positive risk aversion with respect to the duration of life.

4. Prevention and Risky Lifetimes

4.1. Prevention Profiles: Behaviors

Longevity inequalities are partly determined by exogenous factors, over which individuals have no control. For instance, according to Christensen, Johnson, and Vaupel (2006), genetic background contributes to about 25% to 30% of longevity inequalities within cohorts. However, recent studies also highlight that individuals can, by their behavior, affect their survival chances. For instance, Balia and Jones (2008) show, on the basis of a longitudinal study of premature death in Great Britain, that individual lifestyles predict about 25% of overall inequality in mortality, with strong contributions of smoking and sleeping patterns.[21]

This production of health and longevity has given rise to much theoretical work. The canonical model in this literature is the life-cycle model of health production by Grossman (1972). Grossman's model presents the health of individuals as a "health capital" stock, which depreciates as the individual becomes older. In that model, individuals choose their health investment in such a way as to maximize their lifetime well-being, subject to the constraint describing the dynamics of the health capital stock across the life cycle. Individuals' investments

in their health capital are costly (since they reduce temporal consumption), but they reduce also the depreciation of the health capital, and, hence, allow individuals to postpone their death (death occurring when the health capital stock falls below the minimal subsistence level).[22] The Grossman model can also be modified to take into account the effect of lifestyles on health and longevity: the health capital depreciation may be reduced by preventive investment but increased by unhealthy activities, such as the consumption of "sin goods," defined as goods whose consumption brings immediate satisfaction, but which have bad effects on health and survival chances, such as cigarettes, alcohol, and fatty food (see Case and Deaton 2005). There exist also extensions of the Grossman model with risky longevity, such as by Picone, Uribe, and Wilson (1998) and Asano and Shibata (2011).

Those models of health production have largely relied on the rationality axiom, according to which individuals choose actions that are the best for them, while fully taking into account the consequences of their actions. Such a rationality axiom seems to be a weak postulate when considering simple choices, but this becomes a much stronger hypothesis when considering more complex choices. This can be illustrated by considering the decision to consume some goods, such as cigarettes and alcohol, which not only have the property of harming health, but also have another feature: these are *addictive* goods, that is, goods whose consumption now increases the marginal utility from future consumption of those goods. The reinforcement property of addictive goods may be either ignored by consumers—in which case there is a myopic addiction—or taken into account by consumers in their decisions—that is, the case of a rational addiction (Becker and Murphy 1988).

To what extent do those models explain actual risk-taking behaviors? Empirical evidence surveyed in Cawley and Ruhm (2012) shows that risky health behaviors, such as smoking, drinking, drug use, and poor diet remain nowadays major sources of premature death. For instance, about 467,000 deaths were related to tobacco smoking in the United States in 2005. That figure seems surprising, since public health studies showing the negative impact of cigarettes on health, which date back to work by Doll and Hill (1950), have become increasingly disseminated among the population. The same observation could be made regarding other—largely documented—risky behaviors.[23] The large prevalence of risky behaviors is quite hard to reconcile with the standards models of rational decision-making presented above.

One possibility to reconcile the observed prevalence of risky unhealthy behaviors with the theory consists of assuming that individuals' preferences are such that little weight is assigned to the future. Indeed, as underlined by Fuchs (1982), the bad effect of risky unhealthy behaviors will take place at higher ages of life, whereas the good effect takes place now. Hence one way to rationalize the observed behavior is to assume that individuals have strong impatience. Note, however, that one could provide the inverse explanation, in line with Becker and Mulligan (1997). Bad health is not only the consequence of strong impatience; it is also its cause: bad health in the future, by reducing the incentives to invest in patience, leads to higher impatience, which in turn leads to less investment in health.

The large prevalence of unhealthy risky behaviors can also be explained by the presence of time inconsistency, that is, the difficulty of committing oneself to achieving a goal in the future. That explanation differs from the previous one, on the grounds that, under time inconsistency, individuals assign a low weight to future well-being, but regret it later on. Gruber and Koszegi (2000, 2001) applied the concept of time inconsistency to the consumption of addictive goods. The explanation based on time inconsistency is particularly relevant for unhealthy behavior. Cigarettes and alcohol are not only addictive goods; these are also "sin goods," that is, goods that bring immediate satisfaction, but at the cost of a future worsening of health. In comparison to standard goods, the large amount of immediate satisfaction derived from the consumption of sin goods encourages individuals to consume those goods in larger quantities, which yields larger health damages later on in their life. As it was stressed by O'Donoghe and Rabbin (2003, 2006), time inconsistency is likely to be even more severe in the context of sin goods, because of the large immediate satisfaction given by their consumption. This explanation is quite plausible, since there exists a large prevalence of regrets among consumers of sin goods. For instance, phone surveys by Slovic (2001) reveal that, in the United States, about 85% of adult smokers state that they would not start smoking if they had to do it over again.[24]

Models of multiple selves can also be used to understand unhealthy risky behavior. In those models, such as Thaler and Shefrin's (1981), individual consumption choices reveal an internal conflict between a myopic self wanting immediate satisfaction, and a planner self, who has a longer time horizon. In the context of health-related actions, the myopic self would definitely opt for the consumption of sin goods, since these bring immediate satisfaction, while

the planner self would recommend less sin good consumption and more prevention. Another model of multiple selves is the one by Bernheim and Rangel (2004), where the human mind can belong to two distinct states: the "hot" state or the "cold" state. When in a cold state, individuals are rational planners making detailed cost-benefit analysis. By contrast, individuals in the hot state do not make any calculus, and follow their instantaneous desires. Here again, the model can fit the observed prevalence of risky behaviors. Individuals in a hot state do not care at all about their future health and longevity, and consume sin goods. Inversely, individuals in the cold state do care about their remaining lifetime, and act accordingly.

Unhealthy risky behaviors can also be explained by individual myopia. Individuals may underestimate the danger associated with some unhealthy lifestyle, such as smoking or drinking, and this may explain the large prevalence of unhealthy lifestyles, in line with the psychological literature showing that individuals tend to believe what they like, and thus to underestimate the likelihood of bad events (like death).[25]

Whereas the above behavioral explanations share the postulate of a self-oriented agent, one can also explain the observed prevalence of unhealthy risky behaviors by the existence of peer effects. The underlying idea behind peer-effects models is that individuals choose their actions in order to conform to the social norm (see Manski 2000; Alesina, Glaeser, and Sacerdote 2005). Hence, if those in one's social neighborhood smoke, the individual will choose to smoke, and this has nothing to do with a taste for smoking per se: individuals act in such a way as to reproduce or mimic the behavior of others in the network. Such an attitude is known as the bandwagon effect, following Simon's early work on voting behavior in response to electoral polls (Simon 1954). Models with peer effects can be applied to decisions affecting health and longevity.[26]

Alternatively, unhealthy risky behavior can also be explained by imperfect or bounded rationality, in line with other pioneer works by Simon (1955, 1984). According to those behavioral models of choice, individuals want to maximize some objective, but gathering the relevant information is costly, so that individuals will opt for a satisfying action, but not for the one that would ideally have maximized their well-being. Within Simon's model, a central role is played by individuals' cognitive capacities, since these determine the cost of gathering the relevant information. In the context of health-related choices, an obvious corollary of models of

bounded rationality is that individuals with low education will face larger costs of gathering information about healthy lifestyles, and are thus more likely to adopt unhealthy behaviors.

4.2. Prevention Profiles: Policies

Let us now consider what the government should do when facing unhealthy risky behaviors. For the sake of presentation, I will, as in section 3.2, contrast the optimal policies obtained under two distinct kinds of SWF: first, the standard utilitarian SWF; second, the egalitarian SWF applied ex post.

Given that the utilitarian SWF satisfies the ex ante Pareto principle, this social objective pays particular attention to the correction of behavioral mistakes that prevent individuals from maximizing their expected lifetime well-being. When individual risk-taking (or lack of prevention) is not the outcome of agents' fully rational optimization program, but is rather the outcome of imperfect decision-making as described above, the ex ante Pareto principle legitimates the correction of behavioral imperfections, which will lead individuals to regret their past choices (Besley 1989). This behavioral motive for public intervention has been much studied in the recent years (Camerer et al. 2003; O'Donoghe and Rabbin 2003; Thaler and Sunstein 2003). The intuition behind such policies goes as follows. If, for instance, individuals suffer from time inconsistency, myopia, or bounded rationality, they will, once old, be grateful to the government for having, through public policies, prevented them from making mistakes that they would have otherwise regretted. Hence governments intervene, in order to avoid the occurrence of frustrations, regrets, or inconsistencies.

Public intervention can take various forms. A standard policy instrument consists of taxes and subsidies, whose goal is to distort the prices of goods, in such a way as to make individuals choose what will turn out to be the best for them. Gruber and Koszegi (2000, 2001) study the optimal tax of addictive sin goods (in particular cigarettes) in the presence of time-inconsistent agents. The authors argue that taxing sin goods can serve as a self-control device for time-inconsistent individuals and recommend, on behavioral grounds, a one-dollar rise of the tax on cigarettes. Optimal taxes on sin goods are also studied by O'Donoghe and Rabbin (2003, 2006), who consider an economy where agents differ in the taste for sin goods and in the degree of time inconsistency.[27]

The effect of sin taxes on behavior is debated in the empirical literature. As stressed by Cawley and Ruhm (2012), sin taxes are often regressive: sin goods are in greater proportion consumed by individuals with lower education and lower incomes. Moreover, those taxes can have other perverse effects. For instance, taxing cigarettes may push teenagers toward other, less taxed, sin goods, such as illicit drugs. Furthermore, the effect of taxes may be relatively small. For instance, Carpenter et al. (2007) showed that a 1% rise in the tax on beers contributes to reducing the consumption of teenagers by only 1%.

Whether a given policy instrument is successful or not depends on the particular behavioral imperfection that is at the origin of the excessive risk taking. If, for instance, individual behavior is driven by peer effects, then small taxes on sin goods may be sufficient to have a large effect on the overall prevalence of some unhealthy behavior. If, on the contrary, excessive risk-taking is due to a strong time inconsistency, small taxes may not suffice to decentralize the social optimum. The mixed effect of fiscal instruments has led economists to consider other possible interventions: partial prohibitions, limitations of advertising for sin goods (Saffer and Chaloupka 2000), and instantaneous rewards for buying healthy goods (Cawley and Price 2011). Yet another road for public intervention consists of nudging (Thaler and Sunstein 2008). Nudging means, for instance, reshaping the architecture of choices faced by individuals, in such a way as to include, as default option, the option that maximizes their expected lifetime well-being. Such a reshaping of the menu could favor the adoption of healthier lifestyles.

Hence, from the perspective of the ex ante Pareto principle—and, hence, of the utilitarian SWF—excessive risk-taking should be corrected by preventive public policies. However, as was noted above in the context of savings policy, such interventions do not, in general, suffice to decentralize the utilitarian social optimum. Clearly, utilitarianism also requires some transfers across individuals, aimed at equalizing the marginal expected lifetime well-being across individuals.

Leroux, Pestieau, and Ponthiere (2011) study the optimal tax/transfer policy under a utilitarian SWF in an economy where individuals can, through preventive health investment, affect their chances to reach the old age. In that economy, population members differ on three dimensions that, directly or indirectly, affect their life expectancy: genetic background, market productivity, and degree of myopia. At the laissez-faire equilibrium, individuals invest various amounts in prevention against premature death, depending on their labor income, on the shape of

the survival process they face, and on their degree of myopia. Comparing this equilibrium with the social optimum under a utilitarian SWF reveals various differences. Individuals tend, because of myopia, to underinvest in prevention. Moreover, the utilitarian optimum also differs from the laissez-faire on the grounds that it equalizes consumptions across periods and individuals. As a consequence, the decentralization of the utilitarian social optimum requires not only a subsidy on savings and on prevention (in order to correct for myopia), but also lump sum transfers from high-productivity agents to low-productivity agents, and from agents with bad genetic background to individuals with good genetic background—the latter transfers contradicting, here again, any intuition for compensation. Note, however, that the postulated form of lifetime well-being, here again, affects the form of the social optimum. If time-additive lifetime well-being were replaced by a concave transform of the sum of temporal well-being levels, the treatment of the short-lived would be significantly improved.

Let us now consider the optimal resource allocation under a nonutilitarian, inequality-sensitive SWF. Fleurbaey and Ponthiere (2013) study the implications of a maximin SWF defined on indices of realized lifetime well-being in an economy where individuals, who differ in their tastes, can affect their survival chances through preventive activities (e.g., jogging). As under exogenous survival conditions, the optimal consumption profiles are, from an ex post egalitarian perspective, decreasing with the age. Regarding the optimal prevention levels, Fleurbaey and Ponthiere show that the maximin SWF defined on indices of realized lifetime well-being leads to a strong differentiation of prevention levels across individuals, depending on their attitude toward prevention. Under the ex post egalitarian optimum, only individuals who like prevention—independently of its impact on future survival chances—should carry out a positive level of prevention, whereas individuals who dislike prevention—except insofar as this improves future survival prospects—should not invest in prevention.

To understand the intuition behind that result, suppose that prevention increases the proportion of survivors, but without full success. From an ex post egalitarian perspective, what matters is to increase the realized well-being of the worst off, who are, in general, the short-lived, for whom prevention did not succeed. Among those unlucky short-lived persons, some dislike prevention, and, for these, investing in prevention has been a pure waste of resources. Hence, adopting an ex post point of view, unlucky short-lived persons who dislike prevention would have been better off provided that prevention—which turned out to be useless—had not been

carried out. Given that the social planner, who cares about the unlucky short-lived, cannot identify, ex ante, with which person prevention will be successful or not, the optimal prevention level must be zero for those who dislike prevention.

That corollary of the maximin SWF applied ex post is counterintuitive. When considering prevention issues, it is reasonable to promote large-scale prevention against early death, in such a way as to save as many lives as possible. Obviously, the maximin SWF applied ex post leads to low prevention levels for those who dislike prevention and, accordingly, does not allow us to save as many lives as possible. The maximin SWF applied on realized levels of lifetime well-being lays strong emphasis on the well-being of the unlucky short-lived, for whom prevention has been a waste of resources, without considering the impact of prevention on the total number of survivors. The exclusive emphasis on the realized well-being of the unlucky short-lived leads to ignoring the impact of prevention on the proportion of survivors.

Fleurbaey and Ponthiere (2013) study the tension between two goals: (1) promoting large-scale prevention, to reduce the extent of premature death; (2) minimizing inequalities in realized lifetime well-being due to unequal lifetimes (that is, compensating the prematurely dead). They show that there exists no SWF pursuing the two goals satisfactorily. Thus, concerns for prevention and for compensation ex post are logically incompatible: if it is socially desirable to raise prevention levels so as to increase the proportion of long-lived agents in the population, it must also be socially desirable to harm the living conditions of the unlucky short-lived who dislike prevention. Hence governments face a dilemma between postponing death and compensating the unlucky short-lived. Given that public preventive policies can be regarded as allowing for ex ante Pareto improvement, but may go against ex post equality, we find here another occurrence of the incompatibility between the ex ante Pareto principle and ex post equality, as studied in general terms by Mongin and Pivato (chapter 24, this Handbook).

In sum, there exist, in the context of economies where individuals affect their survival chances, important tensions between public policies derived from the utilitarian SWF and from inequality-sensitive SWF applied ex post. This fact highlights the importance of studying the normative foundations of public health policies. Moreover, given that the optimal preventive policy is not independent of the overall shape of the life-cycle consumption profile, it remains true, as in section 3, that the differences regarding the treatment of the unlucky short-lived vary also depending on the postulated form for lifetime well-being (additive or not). This latter point

reemphasizes the need for further scrutiny of the robustness of optimal public policies to the representation of lifetime well-being.

5. Concluding Remarks

What do people do with their lives? What should government encourage them to do or not to do with their lives? These questions, which were at the very center of Foucault's (2004) study of *biopolitics*—the art of governing and shaping human bodies—are quite complex, and deserve a more exhaustive treatment. The present chapter has focused on recent studies on the relationship between the quantity of life, lifetime well-being, and public policy.

There exist various models aimed at explaining how individuals allocate their resources over their uncertain lifetime, and how they influence, through their behavior, their survival chances. Some models presuppose rational choices—that is, individuals choose what maximizes their expected lifetime well-being—whereas other models regard actual behaviors as resulting from behavioral mistakes, such as myopia, time inconsistency, or prodigality.

On the policy side, the optimal public intervention depends on the particular social objective that is pursued. Clearly, the utilitarian SWF, by satisfying the ex ante Pareto principle, justifies public policies aimed at encouraging savings, annuitization, and preventive efforts, in such a way as to make the economy closer to the utilitarian social optimum. However, such policies may contradict what would be recommended by a nonutilitarian distribution-sensitive SWF applied on an ex post basis. Although increasing savings would benefit the lucky long-lived, this would harm, from an ex post perspective, the unlucky short-lived, and would thus increase inequalities in realized lifetime well-being. The same observation can be made regarding the encouragement of annuitization and costly prevention, which are valuable only to the lucky long-lived, not to the unlucky short-lived.

In this light, the general conflict between the ex ante Pareto principle and ex post equality raises lots of difficulties for the design of optimal public policies in the context of risky lifetimes. At the end of the day, the precise way in which governments should shape individual lives in terms of consumption and prevention remains a matter of social choice.

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[2] Sources: The Human Mortality Database, University of California, Berkeley, and Max Planck Institute for Demographic Research, Germany.

[3] Note that there exists, in Malthus’s *Essay*, another adjustment mechanism, which reduces the population size through a smaller number of births: preventive population checks.

[5] On the difficulties raised by variable population size for normative analysis, see Parfit 1984; Broome 1992; Blackorby, Bossert, and Donaldson 2005; and Arrhenius, forthcoming. See also Broome, chapter 30, this Handbook.

[6] Note, however, that this assumption is no longer weak once one starts considering *nonnormal lives*, i.e., lives involving brain transplants, psychological diseases, or strong discontinuities in mental life. This important qualification was made by Parfit (1984). If one considers nonnormal lives, the lack of psychological continuity between different temporal selves questions the fact that a human being remains one and the same person from birth until death. I assume, in the rest of this chapter, that lives are normal lives.

[7] On hedonic well-being, see Haybron, chapter 12, this Handbook. The preferences-based view of well-being is examined by Bykvist, chapter 11, this Handbook.

[8] For a general examination of the equivalent income approach to well-being measurement, see Fleurbaey, chapter 16, this Handbook. Note that the equivalent income approach is not the only possible approach to preferences-based well-being measurement. Adler, in chapter 17 of this Handbook, explores an alternative road: the extended-preferences approach.

[9] See also Becker, Philipson, and Soares 2005; Hall and Jones 2007; and Fleurbaey and Gaulier 2009.

[10] On this, see the study by Leroux and Ponthiere (2009), who obtain, under time-additive lifetime well-being, risk aversion with respect to the duration of life by assuming a mean and variance utility framework, in line with regret theory.

[11] On the life-cycle hypothesis and its implications, see Modigliani 1986 and Deaton 1992.

[12] That rationale does not hold if individuals prefer their descendants to consume their own resources rather than consuming these by themselves.

[13] “Actuarially fair” means that buying annuities for an amount x brings, under a survival rate p, a total return equal to $x(1 + r) / p$, where r is the market interest rate.

[14] James and Song (2001) find similar results for other countries.

[15] The family insurance function is also studied by Brown and Poterba (2001).

[16] On this, see also Bommier and Legrand 2013.

[17] Prospect theory has two important features: (1) utility is no longer associated with consumed quantities, but with gains or losses in consumed quantities with respect to a status quo; (2) individual choices are not governed by the right probabilities of different states of natures, but by transformed probabilities (unlikely events being assigned larger subjective probabilities, while the opposite holds for very likely events).

[18] On preference inconsistencies, see Shafir, chapter 28, this Handbook.

[20] On the choice between lifetime and sublifetime approaches to an egalitarian SWF, see Adler 2012, ch. 6.

[21] Other empirical studies include Mullahy and Portney 1990; Mullahy and Sindelar 1996; Bender et al. 1998; and Contoyannis and Jones 2004.

[22] On the Grossman model, see also Ehrlich and Chuma 1990 and Grossman 2000.

[23] On the impact of excess alcohol, see Poikolainen 1982; on excessive or inadequate eating, see Stamler 1973 and Bender et al. 1998.

[24] Similar proportions are found in the United Kingdom by Jarvis, McIntyre, and Bats (2002) and by Fong et al. (2004) for Canada, the United States, the United Kingdom, and Australia.

[25] On optimism and subjective probabilities in general, see Kahneman and Tversky 1979 and Yaari 1987. For recent advances, see the survey by Starmer (2000).

[26] On Alesina, Glaeser, and Sacerdote's (2005) model for the choice of physical activity, see Goulao and Thibault 2013.

[27] Other studies on optimal sin taxes include Cremer et al. 2012 and Pestieau and Ponthiere 2012.