On the Economics of Wellness-linked Life Insurance Products

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(based on joint work with An Chen)

Table of Contents

Motivation - Chronic Diseases

- Approximately 60% of global fatalities result from four chronic diseases (WHO, 2023):
  - cancer, diabetes, cardiovascular diseases and respiratory diseases
  - in Germany cardiovascular diseases alone count for 36% of all deaths
- Similar proportions when we look at the Years of Life Lost (YLL) (Wengler et al., 2021).

Motivation - Prevention as a Global Goal

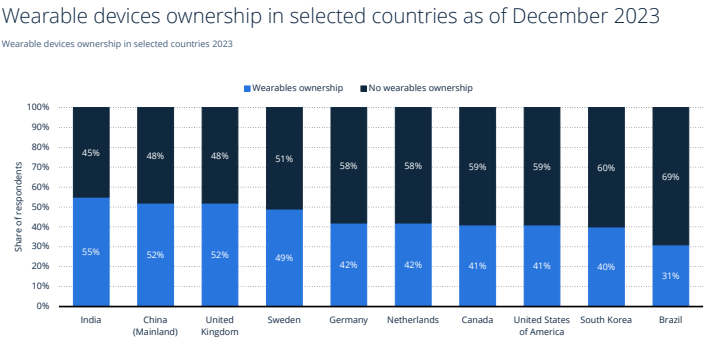
- Chronic diseases are heavily driven by behavioral/lifestyle risk factors like
  - physical inactivity, unhealthy diet, smoking and excessive alcohol consumption as well as metabolic risk factors like raised blood pressure. (WHO, 2023)
- Indicates large potential of wellness measures / prevention to reduce biometric risks.
- **WHO Roadmap 2023-2030** for the Global Action Plan for prevention and control as part of the United Nations Sustainable Development Goals.
  - i.a. heads of state and government committed to develop ambitious national responses, by 2030, to reduce by one third premature mortality from chronic diseases through prevention and treatment.
    - includes tabacco advertising ban, salt policies, fat policies, physical activity mass media, etc.
- **Improving prevention is a global societal goal** $\rightarrow$ Comprehensive concepts are required to achieve a sustainable and lasting effect.
  - This also includes rethinking entire ecosystems the role of individual parts of the economy.

Motivation - Digitalization

- Digitalization and new technologies, like wearables, boost the possibilities for individuals and other relevant parties to gain personalized health insights.

Motivation - Digitalization

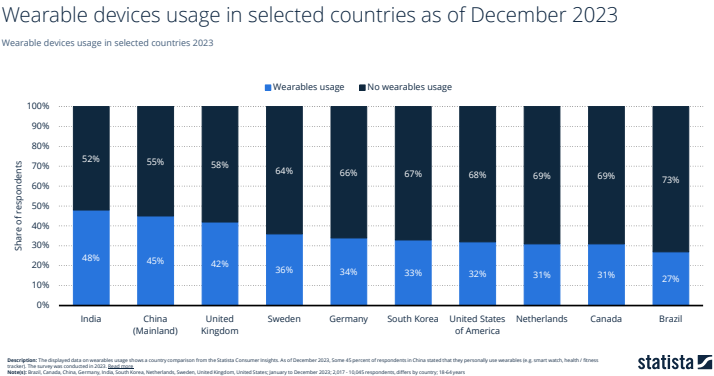
- Wearable Ownership 2023:



Source: Statista (2024) `https://www.statista.com/forecasts/1101101/wearable-devices-ownership-in-selected-countries`.

Motivation - Digitalization

- Wearable Usage 2023:



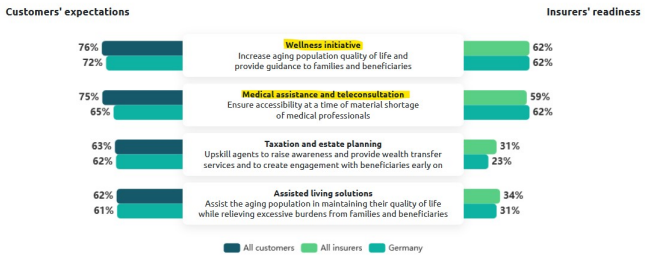
Source: Statista (2024) `https://www.statista.com/forecasts/1101110/wearables-devices-usage-in-selected-countries`.

Motivation - Digitalization

- Various studies show that wearable devices and co. can increase the short-term prevention effort (especially physical activity). (Brickwood et al., 2019)
- However, in particular, initially healthy users often fail to sustain the use.
- One main reason is that the short-term impacts they perceive are lower than expected.
- How to obtain **sustainable and lasting prevention effort**?
  - gamification, interactivity, group dynamics, etc.
  - Studies show that short-term benefits (even small ones) can have a big impact. (Hajat et al., 2019)

What is the role of life insurers?

- Changing role of life insurers (Eling & Lehmann, 2018):
  - Traditional: protecting against financial losses from biometric risks like mortality
  - Future: increasingly important to offer more comprehensive risk management services
    - proactive engagement and predictive risk management (predict and prevent)
    - using digital ecosystem approaches
- Capgemini World Life Insurance Report (2023):

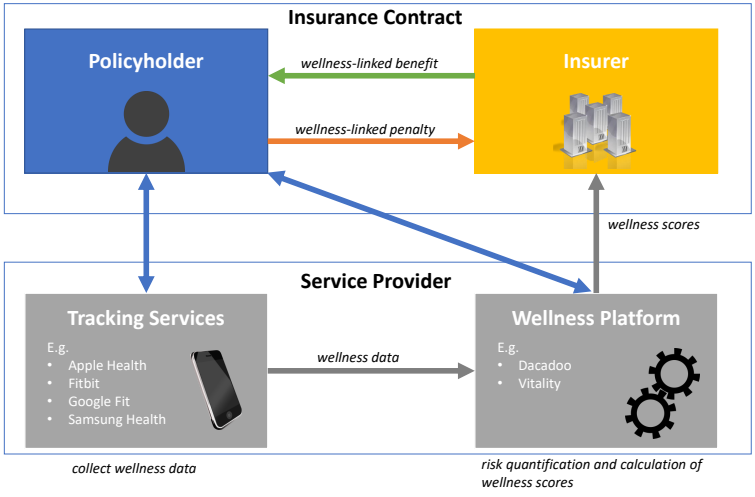


Source: Capgemini Research Institute for Financial Services Analysis, 2023; Capgemini Voice of the Customer Survey, 2023 (N=6775); World Life Insurance Report 2023 Executive Interviews, 2023 (N=200) https://www.capgemini.com/insights/research-library/world-life-insurance-report/

What is the role of life insurers?

- One trend in this direction are so-called **Wellness-linked life insurances**.
- By this we mean products that fulfill at least one of the following two aspects:
  1. policyholders receive ongoing non-financial motivational support to improve their health,
  2. products include wellness-related goals that trigger financial rewards (or penalties).
- Wellness-related goals can include aspects known from conventional bonus programs:
  - vaccinations, preventive medical check-ups, etc.
- Product which in addition make use of tracking technologies are often referred to as **Pay-As-You-Life (PAYL)** (or Usage-Based Life Insurance (UBI)).
- For PAYL products wellness-related goals can also include aspects like
  - number of steps per day, heart rate, caloric consumption, blood pressure, cholesterol levels, blood sugar, hours of sleep, etc.

Stylized Implementation



Brief Summary

- It is to be expected that due to
  - increasing digitalization and the resulting new possibilities of tracking and measuring health and
  - the changing consumer demand and behavior in digital ecosystems,

  PAYL wellness-linked insurance and similar product features will play a more important role
  - and could aid progress towards WHO prevention targets.

- **Main goal of the paper**: Investigate, from a theoretical perspective within a classical model framework, the conditions under which wellness-linked life insurance can increase prevention efforts. society).

Table of Contents

Prevention and Insurance

- Eeven in simple model settings, it is hard for economic theory to guide prevention. (Bleichrodt, 2022) *"Prevention Puzzle"*
- Ehrlich & Becker (1972) already show that insurance and prevention can be compliments depending of the probability,
  - i.e. insurance can increase prevention compared to a situation where no insurance is available.
  - More precisely, insurance can have two opposite effects on prevention:
    - negative effect as it reduces the marginal gain of prevention $\rightarrow$ moral hazard
    - positive effect possible if insurance premium is reduced sufficiently
      (for risk averse individual likely the case if loss probability is not very small)

- **Our paper** contributes to this literature by investigating in a classical and simple setting, the conditions under which wellness-linked life insurance can incentivize prevention efforts and the specification of the optimal insurance.

Model Framework

- one-period setting, i.e., $t \in \{0, 1\}$
- individual derives utility solely from the wealth at the end of the period $W_1 \geq 0$
  - individual endowed with an initial wealth $\omega_0 > 0$
  - income $I > 0$ at $t = 1$ if alive at $t = 1$
- The objective of the individual is to maximize subjective expected utility:

$$V(W_1) = E\big(u(W_1)\big) \tag{1}$$

  - $u(x) : [0, \infty] \to \mathbb{R}$
  - $u'(\cdot) > 0,\ u'(0) = +\infty$ and $u''(\cdot) \leq 0$

Model Framework

- $e \geq 0$ denotes the level of effort
  - $e \leq \bar{e}$ maximal affordable effort
- initial status quo death probability $q_0 \in (0, 1)$
- improved death probability $q(\cdot)$ is a function of the level of effort:
  - $q(0) = q_0$
  - $q'(e) \leq 0$
  - and $q''(e) \geq 0$ for all e
- cost of effort $c(e)$ with $c'(e) > 0$

Model Framework

Wellness-linked term life insurance:

- total death benefit $S_W(e) = S_W \cdot (1 + g(e)) > 0$ at time $t = 1$
  - effort-independent base death benefit $S_W > 0$
  - additional effort-dependent benefit $S_W \cdot g(e)$
  - $g(e)$ a non-decreasing function in e and $g(0) = 0$
- upfront premium: $P_W = \alpha_W \cdot q_W \cdot S_W$
  - $\alpha_W \geq 1$ loading rate
  - q_W is the death probability employed by the insurer for pricing
    - independent of the individual's actual effort (which is not observable for the insurer at outset)

Table of Contents

Selected results

Creating additional awareness:

- In situations dealing with traditional term life insurance, the insurance does not create additional awareness for the impact of prevention efforts.
  $\rightarrow$ the individual uses q_0 as the basis for calculating their expected utility.
- In contrast, when considering a wellness-linked life insurance product, the possible improvements in the death probabilities $q(e)$ are taken into account. Hence,

$$V(W_1) = q(e) \cdot u\Big(\omega_0 - P_W - c(e) + S_W(e)\Big) + (1 - q(e)) \cdot u\Big(\omega_0 - P_W - c(e) + I\Big).$$

Result 1

In case of

- an increasing effort-dependent benefit represented as $S_W(e)$ with $g'(e) > 0$ or
- a constant benefit denoted as $S_W(e) \equiv S_W < I$,

a positive effort level, denoted as $e^* > 0$, is possible.

Selected results

In the previous result

- the optimal insurance coverage can be $S_W^* = 0$,
- the optimal coverage depends also on the loading α_W.

What is the optimal wellness-linked insurance products, where the focus is on

- achieving optimal wellness-linked insurance demand for the individual and
- maximal profit for the insurer.

We consider two cases:

- **Case 1**: effort is exogenously given
- **Case 2:** effort is endogenously generated

We use a Stackelberg equilibrium framework for the optimization.

Selected results

Case 1: effort is exogenously given

In this case the Stackelberg game proceeds as follows:

1. The insurer (leader) sets the premium with choice variable α_W.
2. Based on the given α_W, the individual (follower) chooses the optimal coverage $S_W^{*(\alpha_W)}$ and hence $S_W^{*(\alpha_W)}(e) = S_W^{*(\alpha_W)} \cdot (1 + g(e))$.

The insurer knows *ex ante* that the individual would act optimally based on the announced risk premium. Hence, the optimization problem for the insurer can be stated as

$$\begin{aligned} &\max_{\alpha_W \geq 1} \quad \alpha_W \cdot q_W \cdot S_W^{*(\alpha_W)} - q(e) \cdot S_W^{*(\alpha_W)}(e) \\ &\text{subject to } S_W^{*(\alpha_W)} = \underset{S_W}{\operatorname{argmax}} \quad V(W_1) \end{aligned} \tag{2}$$

Selected results

Case 1: effort is exogenously given

Result 2 - Individual's optimization problem

An interior solution for $S_W^{*(\alpha_W)}(e)$ is possible when α_W falls within the range

$$\left(\frac{q(e)(1+g(e))}{q_W}, \frac{1+g(e)}{q_W} \right)$$

- $\alpha_W \geq \frac{1+g(e)}{q_W} \Rightarrow S_W^{*(\alpha_W)} = 0$
- $\alpha_W = \frac{q(e)(1+g(e))}{q_W} \Rightarrow S_W^{*(\alpha_W)} = \frac{I}{1+g(e)}$ and hence $S_W^{*(\alpha_W)}(e) = I$
- $\alpha_W < \frac{q(e)(1+g(e))}{q_W} \Rightarrow S_W^{*(\alpha_W)}(e) > I$

Selected results $u(x) = log(x)$

Result 2 - Individual's optimization problem for $u(x) = log(x)$

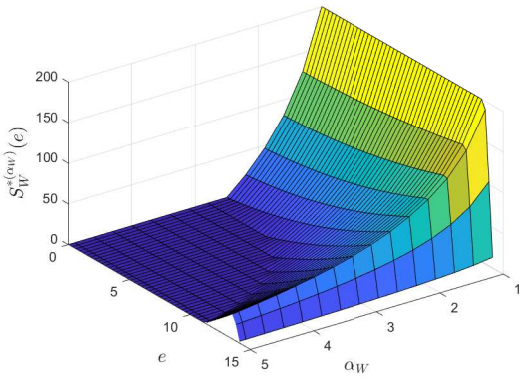
An interior solution for $S_W^{*(\alpha_W)}(e)$ is exists if and only if α_W falls within the interval

$$\left(\frac{q(e) \cdot (1 + g(e))}{q_W}, \frac{1 + g(e)}{q_W} \cdot \underbrace{\frac{q(e)(w_0 - c(e) + l)}{w_0 - c(e) + q(e) \cdot l}}_{\leq 1} \right)$$

- if additional $q_W = q_0$ and $g(e) = \frac{q_0 - q(e)}{q(e)}$, i.e., $S_W(e) = \frac{q_0}{q(e)} \cdot S_W$

$$\left(1, \frac{w_0 - c(e) + l}{w_0 - c(e) + q(e) \cdot l}\right)$$

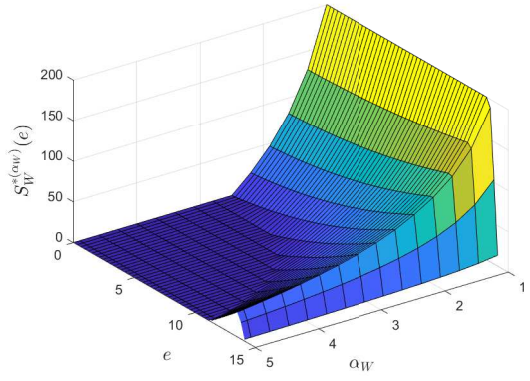
Selected results $u(x) = log(x)$

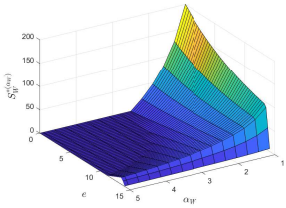


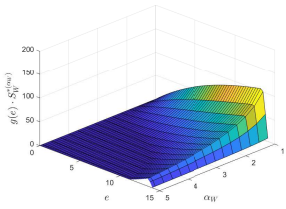
- optimal total benefit $S_W^{*\alpha_W}(e)$
  - $= I$ for $\alpha_W = 1$
  - often increasing in e

$c(e) = \frac{e^2}{2}$, $w_0 = 100$, $I = 200$, $q_0 = 0.1$, $q(e) = q_0 \cdot (1 - m_q(1 - \epsilon^e))$, max relative reduction rate $m_q = 0.7$, $\epsilon = 0.9$.

Selected results $u(x) = log(x)$







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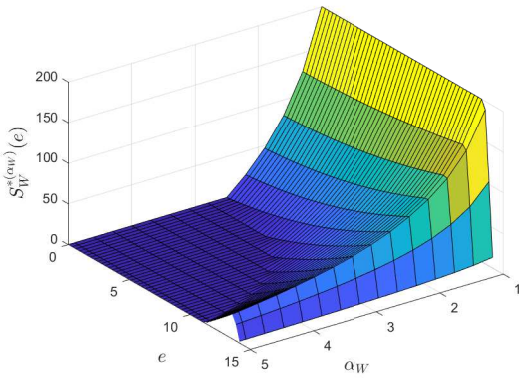

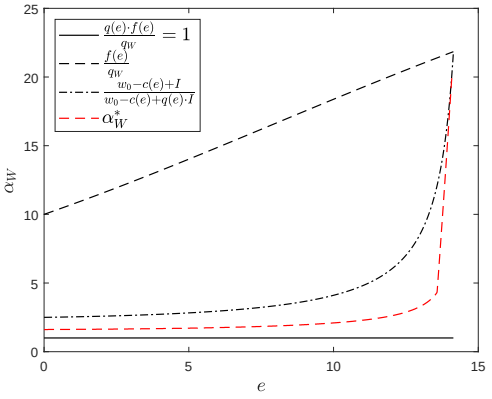

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Selected results

Case 2: effort is endogenously generated

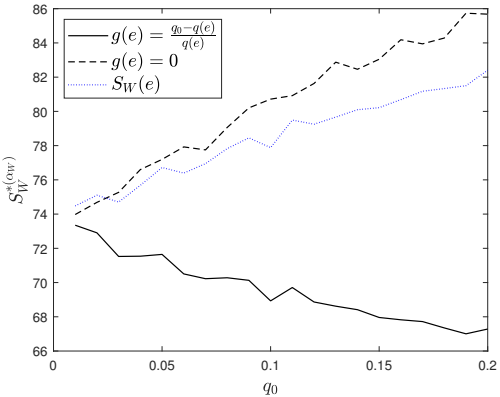
In this case the Stackelberg game proceeds as follows.

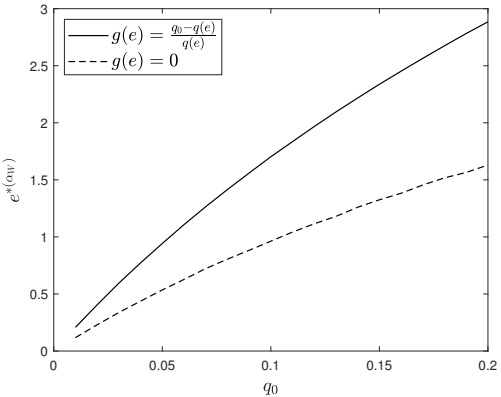
1. The insurer (leader) sets the premium with choice variable α_W.
2. Based on the given α_W, the individual (follower) chooses the optimal coverage $S_W^{*(\alpha_W)}$ and effort $e^{*(\alpha_W)}$.

Hence, the optimization problem for the insurer can be stated as

$$\max_{\alpha_W \geq 1} \quad \alpha_W \cdot q_W \cdot S_W^{*(\alpha_W)} - q(e^{*(\alpha_W)}) \cdot S_W^{*(\alpha_W)}(e^{*(\alpha_W)})$$
$$\text{subject to } \left(S_W^{*(\alpha_W)}, e^{*(\alpha_W)}\right) = \underset{S_W, e \leq \bar{e}}{\operatorname{argmax}} \quad V(W_1). \tag{3}$$

Selected results $u(x) = log(x)$





$g(e) = \dfrac{q_0 - q(e)}{q(e)}$ (solid line) as well as with $g(e) = 0$ (dashed line), $c(e) = \dfrac{e^2}{2}$, $w_0 = 100$, $I = 200$,
$q(e) = q_0 \cdot (1 - m_q(1 - \epsilon^e))$ with maximal relative reduction rate $m_q = 0.7$, $\epsilon = 0.9$, $q_0 \in (0, 0.2)$.

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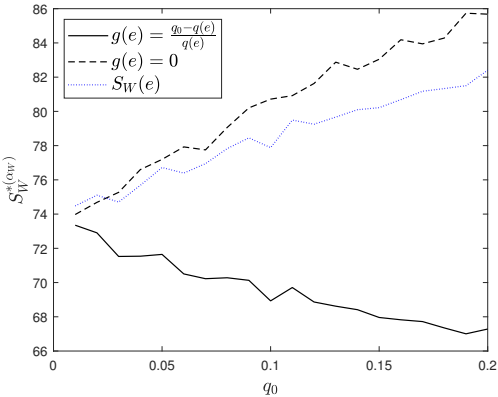

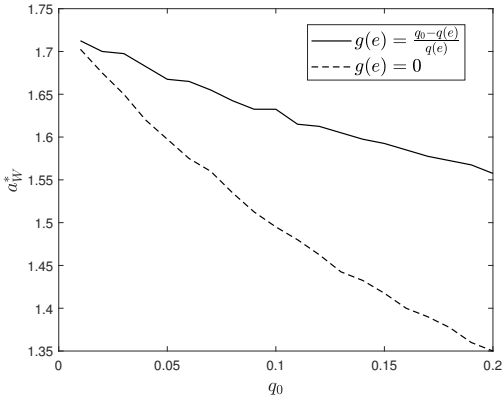

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$q(e) = q_0 \cdot (1 - m_q(1 - \epsilon^e))$ with maximal relative reduction rate $m_q = 0.7$, $\epsilon = 0.9$, $q_0 \in (0, 0.2)$.

Summary

We find that

- wellness-linked life insurance products can increase the prevention effort due to creating additional awareness,
- there are various situations in which the optimal total benefit (i.e. insurance coverage) is increasing in the effort (complements),
- wellness-linked benefits can increase the optimal effort as well as the optimal loading rate (compared to products without wellness-linked benefits),
- wellness-linked life insurances with wellness-linked benefits can be optimal for policyholders (compared to products without wellness-linked benefits). - *not presented*

Thank you for your attention!

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