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# Testing for fragility: a valuable public policy and an opportunity for postal operators*

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**Abstract**

Because of population aging, dependency represents a major societal challenge. While some of the issues including insurance design and the provision of Long-Term-Care have recently been studied and debated, the potential role of prevention has been mostly neglected. To fill this gap the World Health Organization advocates deploying throughout the territories a systematic approach to the prevention of loss of autonomy called ICOPE (Integrated Care for Older People). It involves several stages, starting with testing and screening individuals for their risk. These screening tests use simple tools and can be performed by persons who are not health professionals. But the deployment, management, evaluation of testing requires a large human infrastructure throughout the whole territory. The national postal operators through their ability to reach each citizen at home, thanks to their large human network and the bonds of trust forged over decades between the population and mail carriers, may provide a significant contribution to the screening stage.

To study the economic foundations of this approach, we present a simple model, assuming that a certain proportion of the relevant age group is screened at some cost for their dependency risk. The individual risk is measured by an exogenous parameter, which along with the individual specific expenditures on prevention, determines their probability of dependence. Screening makes it possible to target prevention according to the individual risk. Prevention reduces the probability of dependence and its cost by reducing its severity or delaying its onset. The cost of dependence includes that of formal and informal care.

We determine the optimal levels of expenditures on screening and prevention to maximize welfare subject to a budget constraint. The budget constraint requires that total (expected) expenditures on screening, prevention and on the care of dependent persons equal a given budget. Determining the optimal policy involves a tradeoff between screening and prevention on the one hand and caring for dependent individuals on the other hand. Our analysis provides a precise description of costs and benefits of testing and of providing preventive care. We present and discuss the conditions under which a universal testing program is desirable.

**Keywords:** Long-term care, health expenditures, screening....
**JEL Codes:** I13, I18, H51

# 1 Introduction

According to DRESS (Direction de la recherche, des études, de l'évaluation et des statistiques), the number of elderly people in loss of autonomy in France would increase from 1,265,000 persons in 2015 to 1,582,000 in 2030 and 2,235,000 in 2050. The increase would be around 20,000 people per year until 2030, but would sharply accelerate to nearly 40,000 people per year between 2030 and 2040, due to the arrival at an advanced age of the first generations of the baby boom.

Public spending on long-term care, which mostly consists of expenditures relating to the loss of autonomy of the elderly, is 2.01% of French GDP in 2020, a level close to the EU average of 1.81%. However, these expenses are significantly lower than in the Netherlands (3.23%) or Sweden (2.98%), countries often cited as examples for their management of loss of autonomy. While in France expected life expectancy at 65 years is the highest in Europe (respectively 23.1 for women and 19 years for men), the healthy life expectancy as a proportion of life expectancy is lower than the EU average (76.5% for women and 80.6% for men in France versus 77.5% for women and 81.2% for men in Europe). As an extreme example, the healthy-life expectancy represents 90.3% of life expectancy for women and 86.34% for men in Sweden.[1]

To sum up, a better designed dependency policy appears to be required to prevent a grim future for the upcoming "Pappy-Boomer" generation. In particular it seems necessary to develop preventive care. For instance, Libault (2019) and many authors in the medical literature exploring recent medical evidence (e.g., De Souto et al., 2018 and Ngandu *et al.*, 2016) argue that there is a need to improve the prevention of conditions that would otherwise decrease the individuals' autonomy. Currently, the little prevention there is, is administered by many actors a uncoordinated way, without precise knowledge of the real needs of the population, the relevance and the quality of the preventive actions implemented.

In terms of prevention of loss of autonomy, it is proposed in particular to rely on the standards recognized by the World Health Organization (WHO) to deploy throughout the territory a renewed and systematic approach to the prevention of loss of autonomy called ICOPE (Integrated Care for Older People). This is a public health program of integrated care for the elderly (from 60 years) launched in 2019. A detailed description of the ICOPE program is provided in the next section. To explain our theoretical model it is sufficient at this point to mention that it involves a number of stages. The first stage consists in testing and screening individuals for their risk. These screening tests use simple tools and can be performed by persons who are not health professionals such as for instance specially trained postal employees. They come in the form of questions and tests to assess and track areas of intrinsic ability. But the testing requires an infrastructure for ensuring its deployment, management and evaluation. The national postal operators through their ability to reach each citizen at home, thanks to their large human network and the bonds of trust forged over decades between the population and mail carriers, can provide a significant contribution to the screening stage.

We present a simple model, assuming that a certain proportion of the relevant age group is screened for their dependency risk. Screening involves some cost. The individual risk is measured by an exogenous parameter, which along with the individual specific expenditures on prevention determines the probability to be dependent. This screening makes it possible to target prevention according to the individual risk. Prevention reduces the probability of dependence and the cost of dependence by reducing its severity or delaying its onset. The cost of dependence includes that of formal and informal care. Formal care consists of health care

[1] Source: Eurostat: https://ec.europa.eu/Eurostat (Health and long term care).

and formal long-term care (provided at home or in an institution). In addition dependent individuals receive informal care provided by members of their family. Currently, informal care provided by family members represents a significant part of long-term care services; see Bonsang and Schoenmaeckers (2015) for an overview of the relevant empirical studies. Recent and precise estimates of the contribution of informal care to total care hours across countries are provided by Barczyk and Kredler (2019). They show that informal care is indeed very important in most countries; in Europe informal care ranges from 22% in the Northern countries (Belgium, Denmark, the Netherlands and Sweden) to 81% in Southern countries (Italy and Spain), with approximately 43% the in Middle countries (Austria, France and Germany). In the US, it is estimated at 54%. Informal care is provided for a variety of reasons. For long, we have adopted the fairy tale view of children or spouses helping their dependent parents with joy and dedication, what we call pure altruism. We now increasingly realize that family solidarity is often based on forced altruism (social norm) or on strategic considerations (reciprocal altruism); see Cremer *et al.* (2021). Either way, informal care is costly for the caregivers. It often implies a reduction in labor supply, and even more significantly it may involve substantial emotional and psychological costs; see Barigozzi *et al.* (2020) for further discussion and references.

We determine the optimal levels of expenditures on screening and prevention to maximize welfare subject to a budget constraint. The budget constraint requires that total (expected) expenditures on screening, prevention and on the care of dependent persons equal a given budget. Determining the optimal policy involves a tradeoff between screening and prevention on the one hand and caring for dependent individuals on the other hand. Our analysis provides a precise description of costs and benefits of testing and of providing preventive care. We present and discuss the conditions under which a universal testing program is desirable.

There exist some papers that deal with prevention; see for instance Ellis and Manning (2007) or, for an overview, Zweifel *et al.* (2009, p. 226–233). However, this literature studies the issue from a different perspective. It concentrates on the design of health insurance and specifically the reimbursement rates for preventive and curative care. This problem involves an issue between *ex ante* and *ex post* moral hazard. Subsidizing preventive care mitigates *ex ante* moral hazard in that it reduces the probability of becoming ill and needing curative care. Subsidizing curative care on the other hand fosters *ex post* moral hazard in that it may result in an overconsumption of medical services and products.

We remain agnostic about insurance design and assume that all medical expenses are fully covered by the public health insurance. Instead, we concentrate on the determination of the optimal level of prevention and screening which permits a better targeting of prevention.

# 2 The ICOPE program

ICOPE is a public health program of integrated care for the elderly (from 60 years) launched at the end of 2019 by the World Health Organization (WHO) aimed at reducing the prevalence of dependency and at maintaining seniors at an optimal level of intrinsic capacity.

The intrinsic capacity of an individual is represented by the six key areas for healthy aging: cognition, nutrition, mobility, psychology, vision and hearing. This implies developing targeted prevention actions between ages 60 and 75 to maintain essential capacities needed for autonomy as long as possible. Beyond the age of 75 these functions would be monitored to trigger an alert in the event of a risk of functional loss.

This approach assumes the implementation of awareness-raising actions, prevention meetings and the deployment of training actions for all health professionals dealing with seniors (e.g. general practitioners, nurses, geriatricians...). Prevention actions begin after a step 1 screening test assessing whether the individual is at risk or not. These preventive actions are then implemented for individuals at risk and are declined in 4 steps (from step 2 to step 5) by health care professionals. The ICOPE step 1 screening tool proposed by the WHO is a simple tool that can be used by actors who are not necessarily health professionals. It comes in the form of questions and tests to assess and track areas of intrinsic ability of which we now provide a brief overview.

**Cognitive decline**
This part consists in the learning of 3 words with immediate then delayed recall and the evaluation of temporal and spatial orientation.

**Mobility**
The subjects are asked to get up from a chair 5 times in with their arms crossed on their chest in less than 14 seconds.

**Undernutrition**
There are two questions: Have you lost at least 3 kg in the last 3 months? Have you lost your appetite recently?

**Visual deficit**
There are several simple questions: Do you have difficulty seeing from afar or reading? Do you have a known ocular pathology? Are you currently undergoing treatment for diabetes or high blood pressure?

**Hearing loss**
The tester uses the whisper test which consists of standing behind the subjects at an armslength distance or about 60 centimeters so that they cannot read lips. The subjects are asked to place a finger on the tragus of the left ear to obscure the sound. The tester whispers a word with 2 distinct syllables into the subject's right ear and asks the subject: " Can you repeat the whispered word?". The test is performed a second time for the left ear by asking the subject to place a finger on the tragus of the right ear.

**Depressive symptoms**
There are two questions: during the past two weeks: Have you felt depressed or hopeless? Did you find little interest or pleasure in doing things?

# 3 The model

We consider a subgroup of total population which is identified by a costlessly observable exogenous variable like age. In this group, there is a mass 1 of individuals. A proportion $n_i$ $(i=1,2)$ is of type $\theta_i$, where $\theta$ measures the health status, which determines the probability that the individual will become dependent. Note that $n_1+n_2=1$. Without loss of generality we also normalize the total number of individuals to 1.
We suppose that $\theta_1>\theta_2$, so that type $\theta_1$ has a better health status, which translates into a smaller probability of becoming dependent. Formally, the probability that a type $\theta_i$ individual becomes dependent is denoted $\pi(p,\theta_i)$, where $p$ measures expenditures on prevention and since type 1 has a lower risk we have $\pi(p,\theta_1)<\pi(p,\theta_2)$. We further assume that

$\partial\pi(p,\theta_i)/\partial p = \pi_p(p,\theta_i) < 0$ so that the probability to become dependent decreases with the level of prevention. We finally assume that $\partial^2\pi(p,\theta_i)/\partial p^2 > 0$ and

$$\partial\pi(p,\theta_2)/\partial p < \partial\pi(p,\theta_1)/\partial p \qquad (1)$$

The last assumption says that for a given increase in prevention, the decrease in the probability of becoming dependent is larger for type $2$ individuals. In other words, prevention is more effective for high-risk individuals. Our assumptions are illustrated on Figure 1.

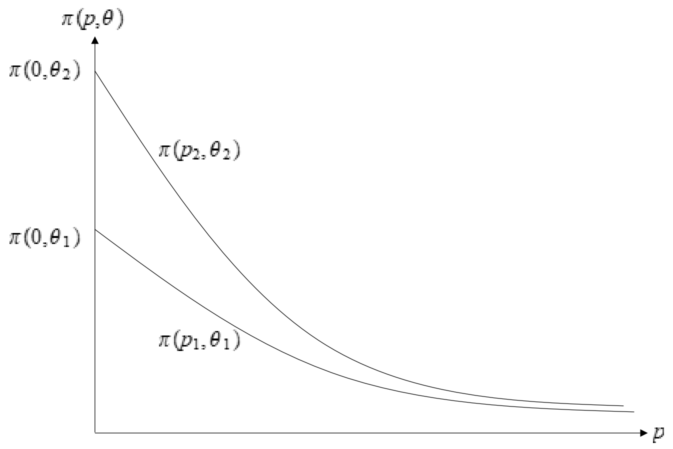


Figure 1: The probability of becoming dependent for the two types as a function of expenditures on prevention.

When dependent, an individual causes health expenditures of $S(p)$ for any $p$ while health expenditures when not dependent are normalized to zero. We assume that $S'(p) < 0$, $S''(p) > 0$ and denote $S(0) = \overline{S}$. These assumptions are illustrated in the Figure 2.

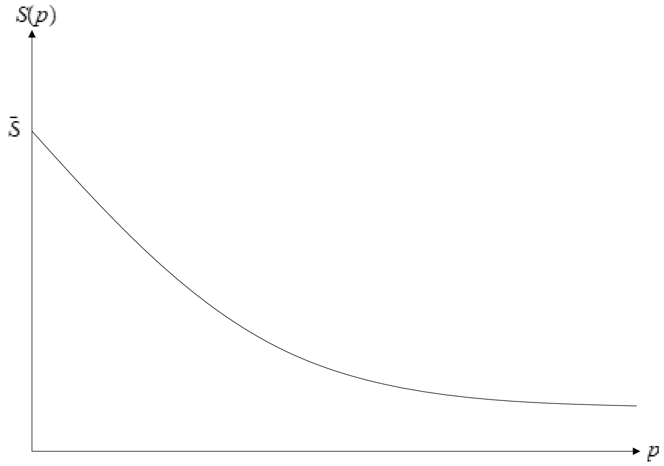


Figure 2: Health expenditures caused by dependency as a function of $p$.

In addition to formal care, dependent individuals also receive informal care, provided by family members $\alpha(p)$ with $\alpha^{'}(p) < 0$ and $\alpha(0) = \overline{\alpha}$, which involves a utility cost of $V(\alpha)$ for the caregivers. For healthy individuals we have $\alpha = 0$ and we assume that $V(0) = 0$.
A proportion $a$ of the population belonging to the relevant subgroup (*e.g.*, above a certain age) is tested. A test perfectly reveals an individual's type, but testing involves a cost of $c(a)$, which is an increasing and convex function of the tested proportion, with $c(0) = 0$, $c^{'}(0) = 0$.

When tested, $n_2 a$ individuals of type $2$ receive a prevention level of $p_2$, so that their probability of becoming dependent is $\pi(p_2, \theta_2) < \pi(0, \theta_2)$. Similarly,when $n_1 a$ receive a prevention level $p_1$ their probability to become dependent is $\pi(p_1, \theta_1) < \pi(0, \theta_1)$. When not tested, individuals receive an amount of prevention $p_n$ which is normalized to zero.

Let $u_j$, $j = H, D$, denote the Bernoulli utility of the individual when in state $j$, where $H$ and $D$ respectively denotes the states " healthy" and " dependent" with $u_H > u_D$. These utilities do not account for formal health care expenditures which we assume to be covered by public health insurance. The loss in utility due to dependency thus reflects for the decrease in the quality of life and possible expenditures on formal long-term care which are not covered by social insurance.

When tested, the expected utility of type $1$ individuals is:

$$EU(p_1, \theta_1) = \pi(p_1, \theta_1) u_D + (1 - \pi(p_1, \theta_1)) u_H,$$

and

$$EU(0, \theta_1) = \pi(0, \theta_1) u_D + (1 - \pi(0, \theta_1)) u_H$$

otherwise. Similarly, the expected utility for type $2$ individual is

$$EU\left(p_2,\theta_2\right)=\pi\left(p_2,\theta_2\right)u_D+\left(1-\pi\left(p_2,\theta_2\right)\right)u_H,$$

when tested and

$$EU\left(0,\theta_2\right)=\pi\left(0,\theta_2\right)u_D+\left(1-\pi\left(0,\theta_2\right)\right)u_H,$$

otherwise.

# 4 Policy design

In this section we determine the optimal testing and prevention policy that is the policy which maximizes individuals' expected utility subject to a resource constraint. Social welfare includes both the utility of the elderly and that of the informal caregivers.

## 4.1 Problem

The social welfare function is:

$$\begin{aligned} SWF = & a\left[n_1(EU\left(p_1,\theta_1\right)-\pi\left(p_1,\theta_1\right)V(\alpha(p_1))+n_2(EU\left(p_2,\theta_2\right)-\pi\left(p_2,\theta_2\right)V(\alpha(p_2)\right] \\ & +\left(1-a\right)\left[n_1(EU\left(0,\theta_1\right)-\pi\left(0,\theta_1\right)V(\overline{\alpha})+n_2(EU\left(0,\theta_2\right)-\pi\left(0,\theta_2\right)V(\overline{\alpha}))\right]. \end{aligned} \tag{2}$$

The resource constraint of the economy is

$$\begin{aligned} & B-an_1p_1-an_2p_2-c\left(a\right)-a\left[n_1\pi\left(p_1,\theta_1\right)S\left(p_1\right)+n_2\pi\left(p_2,\theta_2\right)S\left(p_2\right)\right] \\ & -\left(1-a\right)\left[n_1\pi\left(0,\theta_1\right)\overline{S}+n_2\pi\left(0,\theta_2\right)\overline{S}\right]\geq 0 \end{aligned} \tag{3}$$

The problem is to maximize social welfare defined by (2) with respect to $a$ (the proportion of the population to be tested), $p_1$ and $p_2$ that is the type specific prevention expenditures on the tested individuals.

## 4.2 First-order conditions

Denoting by $\mu$ the Lagrange multiplier associated to the resource constraint, the FOCs w.r.t $a$ and $p$ are respectively:

$$\begin{aligned} \frac{\partial SWF}{\partial a} = & n_1\left[EU\left(p_1,\theta_1\right)-EU\left(0,\theta_1\right)\right]+n_1[\pi\left(0,\theta_1\right)V(\overline{\alpha})-\pi\left(p_1,\theta_1\right)V(\alpha(p_1)] \\ & +n_2\left[EU\left(p_2,\theta_2\right)-EU\left(0,\theta_2\right)\right]+n_2[\pi\left(0,\theta_2\right)V(\overline{\alpha})-\pi\left(p_2,\theta_2\right)V(\alpha(p_2)] \\ & +\mu n_1\left(\pi\left(0,\theta_1\right)\overline{S}-\pi\left(p_1,\theta_1\right)S\left(p_1\right)\right)+n_2\left(\pi\left(0,\theta_2\right)\overline{S}-\pi\left(p_2,\theta_2\right)S\left(p_2\right)\right) \\ & -n_1p_1-n_2p_2-c^{'}\left(a\right)]=0, \end{aligned} \tag{4}$$

$$\frac{\partial SWF}{\partial p_1}=an_1\frac{\partial\pi\left(p_1,\theta_1\right)}{\partial p_1}[(U_D-U_H)-V(\alpha(p_1)]-\pi\left(p_1,\theta_1\right)V^{'}(\alpha(p_1))\alpha^{'}(p_1)$$

$$-\mu a n_1\left[1+\pi\left(p_1,\theta_1\right)S^{'}\left(p_1\right)+\frac{\partial\pi\left(p_1,\theta_1\right)}{\partial p_1}S(p_1)\right]=0, \tag{5}$$

$$\frac{\partial SWF}{\partial p_2}=an_2\frac{\partial\pi\left(p_2,\theta_2\right)}{\partial p_2}[(U_D-U_H)-V(\alpha(p_2)]-\pi\left(p_2,\theta_2\right)V^{'}(\alpha(p_2))\alpha^{'}(p_2)$$

$$-\mu a n_2\left[1+\pi\left(p_2,\theta_2\right)S^{'}\left(p_2\right)+\frac{\partial\pi\left(p_2,\theta_2\right)}{\partial p_2}S(p_2)\right]=0. \tag{6}$$

## 4.3 Interpretation

### 4.3.1 Share of population tested

Equation (4) shows that increasing the testing rate $a$ has a several positive effects. First, it increases expected utility $[EU\left(p_i,\theta_i\right)-EU\left(0,\theta_i\right)]$ for $i=1,2$ of the elderly because the proportion of the population who can benefit from targeted prevention increases. Second it increases the expected utility of caregivers (decreases their expected disutility) by $[\pi\left(0,\theta_i\right)V(\overline{\alpha})-\pi\left(p_i,\theta_i\right)V(\alpha(p_i)]$ for $i=1,2$. Increasing tests mean more targeted prevention and decreases the probabilities of dependency and thus the need for informal care. Third, expected health expenditures decrease as measured by $n_i\left(\pi\left(0,\theta_i\right)\overline{S}-\pi\left(p_i,\theta_i\right)S\left(p_i\right)\right)$ for $i=1,2$. Finally there is a negative effect due to the testing costs as measured by $n_1p_1+n_2p_2+c^{'}\left(a\right)$.

The optimal level of $a$ is determined by trading off these benefits and costs, and an interior solution requires equalizing the marginal benefit to the marginal cost. Note that when the cost is linear with $c^{'}(a)=c_a$ we have a corner solution for $a=0$ or $a=1$ depending on costs and benefits. This is because all the other terms do not depend on $a$. With $a=1$ testing is universal. Similarly, we can obtain $a=1$ when $c(a)$ is not too convex. In words, when the cost of testing is not too large and/or the benefits of targeted prevention sufficiently large, it is optimal to test the entire population.

### 4.3.2 Expenditures on preventive care

Equations (5) and (6) show that increasing expenditures on prevention on type $i=1,2$, $p_i$, has several positive effects on welfare welfare effects. First, by reducing the probability of dependency by $\partial\pi\left(p_i,\theta_i\right)/\partial p_i<0$, it increases the expected utility of the elderly as measured by $-\left(an_i\partial\pi\left(p_i,\theta_i\right)/\partial p_i\right)\left(U_H-U_D\right)$. In other words, prevention makes the utility loss associated with dependency less likely. Second, the reduction of the probability also increases the utility of the caregivers (decreases their expected utility cost of caregiving) as measured by $-an_i\partial\pi\left(p_i,\theta_i\right)/\partial pV(\alpha(p_i)$. Third, the expected utility cost of caregivers is further increased by $-\pi\left(p_i,\theta_i\right)V^{'}(\alpha(p_i))\alpha^{'}(p_i)$ because $\alpha^{'}(p_i)<0$ so that the amount of care needed is reduced because prevention decreases the severity (or duration) of the dependency. Fourth, it decreases the cost due to lower health expenditures (in case of dependency) as measured by

$a\left[n_i\pi\left(p_i,\theta_2\right)S'\left(p_i\right)+S(p_i)\partial\pi\left(p_i,\theta_i\right)/\partial p_i\right]$.

To sum up, increasing prevention expenditures reduces both the probability of dependency and its cost (for the elderly and for the caregivers).

Finally, there is an increase in cost measured by $an_i$ which corresponds to the share of the population for which $p_i$ is relevant.

As for $a$, the optimal level of $p_i$ is determined by trading off benefits and costs so that an interior solution implies equalizing the marginal benefit to the marginal cost. Unlike for $a$, our assumptions ensure that the objective is *strictly* convex in $p_i$ so that the solution can be expected to be interior.

### 4.3.3 The levels of $p_1$ and $p_2$

We prove in the appendix that absent of informal care ($\alpha = 0$) the solution implies $p_2 > p_1$. In other words, the prevention level should be higher for high risk individuals. This does not come as a surprise. Intuitively the results can be explained as follows. First, as discussed in subsection 4.3.2 an increase in $p_i$ decreases the probability of being dependent for type $i$ which (i) increases welfare by an amount $u_H - u_D$ and (ii) decreases health expenditures. Furthermore, because of assumption (1) $p_2$ has a larger effect on the probability of becoming dependent than $p_1$. Consequently, these two effects are larger for expenditures on individuals of type $2$ than for those on type $1$ individuals. A third effect is that *for a given level of risk to be dependent*, the increase in prevention decreases health expenditures by an amount that is larger for type $2$ individuals since their probability to become dependent is larger.

Note that this result also shows that a uniform policy with $p_1 = p_2$ is never optimal which shows the benefits of targeting prevention via the tests.

## 5 Measuring gains and losses

Currently, the potential role of prevention of dependence has not yet been assessed through any rigorous medical experiment. The ICOPE experiment will allow to measure the key parameters of the model.

In Health Care, often used methods to evaluate utility gains with medicines/equipment/procedures is Cost effectiveness analysis (CEA): net costs in euros per unit of effect, usually in terms of quality adjusted life year index (QALY). These studies are usually useful when comparing different treatments, but are quite agnostic about the social value (in monetary units) they bring to the society. In the case of prevention, one has to construct first a Quality Adjustment life Year (QALY) index reflecting the health status due to intrinsic capacity impairment. This is done by assessing (again with self-assessed measures as well as objective measures carried out by professionals) a weight between $0$ and $1$ reflecting the health status of the individual ($1$ is the status in perfect health like $U_H$ in the model while $U_L$ would be the score when having disability). This health status is then monetized by using the value of statistical life (VSL). The ICOPE experiment would also allow to measure the marginal improvement in the probability to become dependent (i.e., $\partial\pi\left(p,\theta\right)/\partial p$).

Regarding health care saved costs as measured by $S'\left(p\right)$, the ICOPE experiment will allow to determine the immediate decrease in health care costs (e.g. due to the reduction of falls thanks to prevention). There are however some very few measures that relate the medical cost implied by intrinsic capacity impairment among the elderly. As shown by Pagès *et al.* (2020), persistent impairment of intrinsic capacity (as measured by locomotor problems) implies immediate additional annual healthcare cost of 1,092 euros per patient. Psychological impairment impliesy additional annual healthcare cost of 817 euros per patient.

Measuring the burden imposed on informal caregivers is difficult. An important part of LTC is currently provided informally either by spouses when still alive or, more significantly, by a person's children. Precise estimates of informal care provision and associated costs are hard to obtain because, by definition, they do not refer to a formal transaction. Still, the extent of informal caregiving is believed to be enormous; see Bonsang and Schoenmaeckers (2015) for an overview of the relevant empirical studies.

The cost of prevention $p$ depends upon the implementation of the prevention program. It is expected to be low since it mainly involves non medical procedures.

Finally, the cost of an audit $a$ is expected to be low since it can be made by non-professionals. Moreover it can be optimized by relying on existing human networks covering an entire country like those of the NPOs.

# 6 Laissez-faire

So far we have assumed that prevention is provided and financed by a public authority like the national health service. We have studied the design of this policy but we have not justified the need for public intervention as a way to deal with possible inefficiency of a more decentralized solution. To do this, we consider as a benchmark an alternative arrangement in which prevention decisions would be left to individuals who are assumed to know their own type.[2] We refer to it as *laissez-faire* for simplicity even though it assumes that (curative) care continues to be covered by social insurance.

We first study the individual's prevention decisions to characterize the resulting equilibrium allocation. We then determine social welfare achieved in this equilibrium to study if and how it differs from the optimal allocation.

Let $e_i$ denote individuals' expenditures on prevention (the counterpart to $p_i$ in the preceding sections). An individual's problem is then given by

$$\max_{e_i} EU\left(e_i,\theta_i\right)=\pi\left(e_i,\theta_i\right)u_D+\left(1-\pi\left(e_i,\theta_i\right)\right)u_H-e_i$$

which yields

$$\frac{\partial\pi\left(e,\theta_i\right)}{\partial e}\left(U_D-U_H\right)-1=0 \text{for} i=1,2. \tag{7}$$

This expression defines $e_i^*$ the level of prevention chosen by individuals $i$. Social welfare in equilibrium is given by

$$\begin{aligned}SWF=&\left[n_1(EU\left(e_1^*,\theta_1\right)-\pi\left(e_1^*,\theta_1\right)V(\alpha(e_1^*))+n_2(EU\left(e_2^*,\theta_2\right)-\pi\left(e^*,\theta_2\right)V(\alpha(p_2^*)\right]\\&-n_1e_1^*-n_2e_2^*-\lambda n_1\pi\left(p_1,\theta_1\right)S\left(p_1\right)+n_2\pi\left(p_2,\theta_2\right)S\left(p_2\right)],\end{aligned} \tag{8}$$

[2] This assumption was not necessary in the preceding sections. It is debatable and one could consider a generalization where individuals can get tested to discover their risk but have to pay for the test. This would complicate the model without affecting the basic tradeoffs considered here.

where $\lambda$ is the cost of public funds. In Section 4 there is an explicit budget constraint of the public sector and the Lagrange multiplier $\mu$ associated with this constraint measures the shadow cost of public funds. Here public policy decisions are not modeled but since the (curative and long-term care) health expenditures are financed by the government we have to account for the cost of public funds to make welfare levels comparable.[3]

To assess the properties of the equilibrium we compare expression (7) for $i=1,2$ to its counterpart in Section 4 namely expressions (5) and (6) evaluated at $a=1$. This shows that when choosing $e_i$, the individual does not take into account: *(i)* the direct reduction of the cost imposed on informal caregivers $\pi\left(e_i,\theta_i\right)V'(\alpha(e_i))\alpha'(e_i)$ and of health expenditures, $\pi\left(e_i,\theta_i\right)S'\left(e_i\right)$ and *(ii)* the indirect decreases in caregivers' and health care costs via a decrease in the probability to become dependent $(\partial\pi\left(e_i,\theta_i\right)/\partial e_i)[V(\alpha(e_i))+S\left(e_i\right)]$. All these effects go in the same direction and will lead to a level of prevention that is lower than optimal.

Note that the misperception of the effects on caregivers is mitigated when individuals are altruistic. Furthermore, they can be induced to take part of the cost effect into account by introducing a reimbursement system with some out-of-pocket expenses, but as long as part of health expenditures would be reimbursed by the social security sytem, the effect will only be mitigated.

To sum up, a policy intervention is necessary to achieve the optimal level of prevention and the testing is necessary to insure an adequate targeting of prevention expenditures.

# 7 Practical implementation: an opportunity for national postal operators?

A coherent public policy in the field of autonomy and health needs to rely on infrastructure elements ensuring its deployment, management, evaluation, and therefore the best possible use of public funds. One of the obstacles currently encountered by prevention policy is its deployment at large scale. Relying on a pre-existing infrastructure covering the whole territory could be an efficient and quick solution to implement.

In particular, to deploy at a large scale, throughout the whole territory, the step 1 of the ICOPE program, public authorities could rely on NPOs. Indeed, as shown in section 2, the screening can be assessed by non health professionals. Self-assessment via digital tools are available but as explained in Piau et al. (2020), the intervention of a person will be required in many cases to accompany and guide the respondent. NPOs, often in charge of the universal postal service and sometimes of other SGEIs, have a pre-installed human network deployed throughout the whole territory, able to reach each citizens at home. Mutualizing the provision of postal services with such screening and prevention activities could be cost effective.

Such a cooperation has already been experimented in France. Health professionals implementing the ICOPE program in Occitanie (a region of France) and La Poste Groupe, set up an experiment in three cities in the Toulouse agglomeration in order to carry out step 1 by specially trained employees. This experiment took place successfully in November 2020 during 6 weeks. A mailing was sent to 7,368 seniors over 60 to inform them about the program and announce the visit of a specially trained mail carrier. This led to 1,130 assessments and showed encouraging results. Because of these positive results, La Poste Groupe extended its action at

[3] When the tax system is fully optimized we have $\mu=\lambda$, but this is a strong assumption and we remain agnostic about the comparison between $\mu$ and $\lambda$ as it plays no role for the arguments presented here.

the request of the Gérontopôle of Toulouse and the regional agency of health (ARS Occitanie).

# 8 Conclusion

We have studied a simple model wherein a certain proportion of the relevant age group is screened for their dependency risk. This screening involves a cost but makes it possible to target prevention according to the individual risk. Prevention reduces both the probability of dependence and its cost which includes that of formal and informal care.

We have shown that when the marginal cost of a test is constant (or does not increase too strongly) the optimal policy involves a corner solution (either no testing or universal testing). When the benefits of prevention outweigh the cost of testing, a universal testing program is optimal.

The optimal prevention policy applied to a specific risk group is determined by trading off the marginal benefits and costs of prevention. Not surprisingly, prevention levels are larger for high risk individuals.

We have also shown that absent of a targeted prevention policy individuals will choose levels of prevention that are too small. In other words the policy will lead to an increase in social welfare.

An example of such a testing and prevention policy is provided by the ICOPE program. Prevention actions begin after a step 1 screening test assessing whether the individual is at risk or not. These preventive actions are then implemented for individuals at risk and are declined in 4 steps (from step 2 to step 5) by health care professionals. The ICOPE step 1 screening tool proposed by the WHO is a simple tool that can be implemented by actors who are not necessarily health professionals. Concerning step 1, one could rely on national postal operators because (i) their human network is already connected with the whole population and optimally organized (cost effectiveness) and (ii) as just said, the screening can be assessed by non health professionals such as specially trained mail carriers.

This program is currently at an experimental stage in the Occitane region and an experiment with 5 specifically trained mail carriers from La Poste Groupe took place successfully in November 2020 during 6 weeks, enabling 1,130 screening tests to be carried out on behalf of the Gérontopôle of Toulouse. Our analysis has documented the economic foundations of such a policy. In the process, it has provided a precise description of costs and benefits of testing and of providing preventive care. This provides a framework for the empirical assessment of the policy. Currently, the data that are available are not sufficient, but the ICOPE experiments will provide additional evidence, in particular on the impact of prevention on the incidence of dependence. In the meantime only rough " back of the envelope" calculations are possible. However, it is well documented that the cost of dependence to society, the patients and the caregivers is huge. Prevention, on the other hand, does not appear to involve a prohibitive cost. Consequently, it appears likely that a coherent prevention policy is desirable, but its fine tuning will require further empirical and theoretical studies.

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# A Appendix

## A.1 Proof of $p_2 > p_1$

Assume that $\alpha = 0$ and assume that $p_2 < p_1$. Combining $(5)$ and $(6)$ yields:

$$\frac{\frac{\partial \pi(p_1,\theta_1)}{\partial p_1}}{\frac{\partial \pi(p_2,\theta_2)}{\partial p}} = \frac{1+\pi(p_1,\theta_1)S'(p_1)+\frac{\partial \pi(p_1,\theta_1)}{\partial p_1}S(p_1)}{1+\pi(p_2,\theta_2)S'(p_2)+\frac{\partial \pi(p_2,\theta_2)}{\partial p_2}S(p_2)}, \tag{9}$$

where

$$1+\pi(p_i,\theta_i)S'(p_i)+\frac{\partial \pi(p_i,\theta_i)}{\partial p_i}S(p_i) > 0 \text{ for } i = 1,2.$$

- Then the LHS of $(9)$ yields

$$\frac{\frac{\partial \pi(p_1,\theta_1)}{\partial p_1}}{\frac{\partial \pi(p_2,\theta_2)}{\partial p_2}} < 1,$$

so that using $(9)$ implies:

$$\frac{1+\pi(p_1,\theta_1)S'(p_1)+\frac{\partial \pi(p_1,\theta_1)}{\partial p_1}S(p_1)}{1+\pi(p_2,\theta_2)S'(p_2)+\frac{\partial \pi(p_2,\theta_2)}{\partial p_2}S(p_2)} < 1. \tag{10}$$

which can be rewritten as

$$\left[\pi(p_1,\theta_1)S'(p_1)-\pi(p_2,\theta_2)S'(p_2)\right]+\left[\frac{\partial \pi(p_1,\theta_1)}{\partial p_1}S(p_1)-\frac{\partial \pi(p_2,\theta_2)}{\partial p_2}S(p_2)\right] < 0 \tag{11}$$

- To sign the first term in bracket of (11), note that

$$\pi(p_1,\theta_1) < \pi(p_2,\theta_1),$$

and

$$0 > S'(p_1) > S'(p_2),$$

so that

$$\pi(p_1,\theta_1)S'(p_1)-\pi(p_2,\theta_2)S'(p_2) > 0. \tag{12}$$

- Turning to the second term in bracket of (11). Further note that using

$$0 > \frac{\partial \pi(p_1, \theta_1)}{\partial p_1} > \frac{\partial \pi(p_2, \theta_2)}{\partial p_2},$$

and

$$S(p_1) < S(p_2),$$

it follows that

$$\frac{\partial \pi(p_1, \theta_1)}{\partial p_1} S(p_1) - \frac{\partial \pi(p_2, \theta_2)}{\partial p_2} S(p_2) > 0. \tag{13}$$

• Now combining (12) and (13) yields

$$\left[\pi(p_1, \theta_1) S'(p_1) - \pi(p_1, \theta_1) S'(p_1)\right] + \left[\frac{\partial \pi(p_1, \theta_1)}{\partial p_1} S(p_1) - \frac{\partial \pi(p_2, \theta_2)}{\partial p_2} S(p_2)\right] > 0,$$

which contradicts (11).