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Old age risks, consumption, and insurance

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Abstract

In the U.S, after age 65, households face income and health risks and a large fraction of these risks are transitory. While consumption significantly responds to transitory income shocks, out-of-pocket medical expenses do not. In contrast, both consumption and out-of-pocket medical expenses respond to transitory health shocks. Thus, most U.S. elderly keep their out-of-pocket medical expenses close to a satiation point that varies with health. Consumption responds to health shocks mostly because adverse health shocks reduce the marginal utility of consumption. The effect of health on marginal utility changes the optimal transfers due to health shocks.

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1 Introduction

What risks do households face and to what extent are they insured by the government, themselves, their family, and their community? Previous work mainly studies the effects of income shocks on consumption for people of working age. Because people are living longer, studying older people is becoming more important; and because health shocks are prevalent at older ages, broadening the analysis to both income and health shocks is becoming essential.

For working-age people, the response of consumption to income shocks is typically used to measure the degree of insurance against these shocks. But, when health shocks are another important source of risk, because they might affect both resources and ability to derive utility from consumption, the interpretation of consumption fluctuations as lack of insurance is no longer straightforward. Hence, to better understand the extent to which people are exposed to risks, it is necessary both to measure income and health risks, and to disentangle the effects of health shocks on resources and marginal utility of consumption.

We develop a semi-structural approach, new identification techniques, and use high-quality-data to measure the effects of income and health shocks on consumption among U.S. households over age 65. We also propose a novel methodology to decompose the consumption response to a transitory health shock into its effect on resources and on the marginal utility of consumption. More specifically, we estimate income and health risks and the pass-through of transitory risks to consumption and out-of-pocket medical expenses. We do so by using a flexible specification for the policy functions determining consumption and medical expenses. We also use a rich structural model to derive novel implications that allow us to disentangle the effects of transitory health shocks on resources and medical expenses.

In terms of data, we use the Health and Retirement Survey (HRS) and its Consumption and Activities Mail Survey (CAMS). The HRS is a longitudinal panel study that, starting in 1994, is conducted every other year and is representative of the U.S. population over the age of 50 and their spouses. Since 2001, CAMS collects detailed data on non-durable consumption and out-of-pocket medical expense sub-categories. Hence, it allows us to analyze both consumption and out-of-pocket medical expenses and their sub-categories.

Our analysis yields several important and novel findings. First, after age 65 households are subject to significant temporary fluctuations in both income and health. In terms of magnitudes, the variance of the current transitory component of income explains 41% of the variance of changes in income, and the variance of the current transitory component of health explains 31% of the variance of changes in health (after we detrend income and health from the effect of observed demographic characteristics). The bulk of these shocks cannot be attributed to measurement error for two reasons: first, the HRS has been documented to be of excellent quality[1] and, second, we find that these transitory shocks have a significant impact on households' decision variables.

Second, transitory income shocks have sizeable and statistically significant effects on non-durable consumption. In contrast, they have statistically insignificant effects on out-of-pocket medical expenses.

More specifically, our estimated average pass-through of transitory income shocks implies that a 10% increase in transitory income is associated with a 1.3% increase in current non-durable consumption. This magnitude is comparable to the results obtained using working-age households. Among the lower-wealth households (that we define as those in the bottom quintile of the wealth distribution), the effect is twice as large.

Turning to the effects income shocks on out-of-pocket medical expenses, because these expenses make up for a small fraction of total expenses, our estimated pass through coefficient implies that the level of out-of-pocket medical expenses fluctuates little with transitory income shocks. The same finding applies for the lower-wealth households. This small response suggests that, for the existing level of insurance, most U.S. elderly are satiated in their consumption of out-of-pocket medical expenses.

Third, transitory health shocks affect both non-durable consumption and out-of pocket medical expenses. Our estimated average pass-through of transitory health shocks to consumption implies that a one standard deviation transitory decrease in one's health index is associated with a 2.4% decrease in non-durable consumption. This effect is larger among lower-wealth households, for whom the same decrease in health implies a 5.6% decrease in consumption. Our estimated average pass-through of transitory health shocks to out-of-pocket medical expenses implies that a one stan-

[1]Hurd and Rohwedder (2009) discus the CAMS data quality and show that spending totals are close to those measured in the Consumer Expenditures Survey (CEX) and the age profiles of wealth changes implied by spending and after-tax income are similar to the wealth change in the HRS data. French, Jones, and McCauley (2017) find that the HRS data are of high quality.

dard deviation decrease in one's health index translates into an 7% increase in medical expenses. The corresponding number for lower-wealth households is 21.3%. These findings indicate that people's satiation point for medical goods and services varies with their health.

Fourth, in our overall sample, 98.3% of the response of consumption to transitory health shocks is due to the fact that health shocks change the marginal utility of consumption, while only 1.7% is due to its effect on resources (through a change in medical expenses). For lower-wealth households, these numbers are 94.1% and 5.9%, respectively. Both effects are significant for both samples. For lower-wealth households, the resource effect is larger because, when they are hit by a negative health shock, their out-of-pocket medical expenses increase more, and because, for them, a given decrease in resources leads to a larger decrease in consumption.

To better understand the mechanisms behind our findings, we also examine the responses of various consumption subcategories. Here, we find that the subcategories that respond to a transitory income shock are different from those that respond to a transitory health shock. More specifically, in our overall sample, necessities (food, utilities, car-related expenses) and luxuries (leisure activities, equipment) both respond to an income shock. In contrast, only luxuries respond to a health shock. This is consistent with our finding that the shift in marginal utility plays an important role in the response of consumption to a transitory health shock because if the response of consumption to a health shock were caused by its resources effect, a health shock should affect the same consumption subcategories as an income shock—since a health shock is equivalent to a loss in resources.

We also use these subcategories to estimate a demand system. This methodology evaluates how consumption and medical expenses react to total health and income changes (which thus include both transitory and permanent shocks), while holding spending constant. Our estimated demand system yields two main findings. First, it reveals that a change in health generates a reallocation across consumption goods sub-categories. That is, even absent any variation in resources, sick people do not consume the same goods as healthy people. This indicates that people's marginal utility of certain goods changes with their health (else, holding resources constant, a change in health would have no effect on the allocation of consumption across subcategories). It therefore confirms our finding that the marginal utility channel is important to understand the consumption response to health shocks. Second, it highlights that even the sum of permanent and transitory health shocks affects the marginal utility of consumption.

Finally, after having shown that transitory income shocks only affect resources and that transitory health shocks mostly impact the marginal utility of consumption, we examine their qualitative implications in terms of optimal insurance. While shocks to resources result in less resources in some states than in others, shocks to marginal utility generate a mismatch between resources and the ability to take advantage of resources across states. That is, people might end up with a relatively large amount of resources while they are in bad health and have low marginal utility of consumption, or low resources while they are in good health and have high marginal utility of consumption. While a benevolent planner insuring households against income shocks allocates the same level of consumption and medical expenses to all, a planner insuring households against marginal utility shocks allocates more medical expenses to households experiencing an increase in their marginal utility of medical expenses and more consumption to households who do not experience a reduction in their marginal utility of consumption.

In sum, our main contribution is showing that older households face substantial transitory income and health risks, that they react to these risks, and that transitory health shocks have important effects on households' marginal utility of consumption. Our contribution has implications for both the positive and normative literature on households savings and insurance. That is, positive models should include transitory income and health risks and should imply responses to health shocks that are consistent with our findings. Normative analysis should include health shocks and account for their effects on the marginal utility of consumption.

Our paper relates to the literature studying the impact of a specific one-time (and hence transitory) resource shock on consumption and finding that transitory shocks such as tax rebates, lottery gains, or changes in current assets, significantly affect consumption.[2] It also relates to the literature on consumption insurance, the literature on savings and risks during retirement, and the literature testing whether the utility from consumption depends on health.[3] We contribute to these branches of

[2]See, for instance, Fagereng, Holm, and Natvik (2018), Mian, Rao, and Sufi (2013), and Cloyne, Huber, Ilzetzki, and Kleven (2019)).

[3]For some important contributions on consumption insurance, see Cochrane (1991), Attanasio and Davis (1996), Blundell, Pistaferri, and Preston (2008), Heathcote, Storesletten, and Violante (2009), Kaplan and Violante (2010), Blundell, Low, and Preston (2013), Farhi and Werning (2013),

the literature by focusing on the retirement period, by showing that both transitory income and health shocks are large, and that adverse transitory health shocks reduce the marginal utility of consumption in a quantitatively important way. Our findings thus suggest that, even though households over age 65 are covered by Medicare, the income and health risks that they face during old age are large, and there might be scope to rethink the current insurance scheme to take into account the effects of health on the marginal utility of consumption.

2 The model

We are able to measure the effects of transitory income and health shocks on consumption and medical expenses by making minimal assumptions. In contrast, disentangling the sources of these effects necessitates a structural model.

To make the logic of our analysis more cohesive, in this section we develop a structural framework for our analysis. In the next section we examine the implications for the consumption and medical expenses responses to transitory shocks. We then turn to identification and explain which parameters of our analysis can be recovered with fewer assumptions than in the full structural model outlined here.

Our structural model is fairly general and embeds the majority of models used in the structural literature on health risks and savings. We generalize previous work by allowing for two important features. First, we allow for both transitory income and health shocks and, second, we let household's utility to flexibly depend on consumption, total medical expenses, and health status.

$$\max_{\{c_t,m_t\}_{t=0}^T} \quad E_0 \sum_{t=0}^{T} \beta^t \left\{ s_t\Big(\{\pi^h\}_t\Big) \Big[u\Big(c_t, \tilde{m}(m_t), h_t\Big) \Big] \right\} \tag{1}$$

and Golosov, Troshkin, and Tsyvinski (2016). Important works on savings and risks, including during retirement include Hubbard, Skinner, and Zeldes (1994) and (1995), Palumbo (1999), Brown and Finkelstein (2008), Love, Palumbo, and Smith (2009), De Nardi, French, and Jones (2010), Blundell, Crawford, French, and Tetlow (2016), De Nardi, French, and Jones (2016), Braun, Kopecky, and Koreshkova (2016), De Nardi, Pashchenko, and Porapakkarm (2017), Poterba, Venti, and Wise (2018), and Ameriks, Briggs, Caplin, Shapiro, and Tonetti (2020). For testing for health-dependence in utility, see for instance Viscusi and Evans (1990), Evans and Viscusi (1991), Finkelstein, Luttmer, and Notowidigdo (2009), Finkelstein, Luttmer, and Notowidigdo (2013).

subject to:

$$p_{t+1}a_{t+1} = (1+r_t)p_t a_t + p_t y_t - p_t^m m_t - p_t^c c_t \qquad \forall 0 \leq t \leq T \tag{2}$$

$$a_T \geq 0 \tag{3}$$

$$ln(y_t) = \pi_t^y + \varepsilon_t^y, \qquad \pi_t^y = \pi_{t-1}^y + \eta_t^y \tag{4}$$

$$h_t = \pi_t^h + \varepsilon_t^h, \qquad \pi_t^h = \pi_{t-1}^h + \eta_t^h \tag{5}$$

$$\text{with } cov(\eta_t^y, \eta_t^h) \neq 0, cov(\varepsilon_t^y, \varepsilon_t^h) = 0,$$

Starting from age 66 (which we re-normalize as period 0) and until age T, a household chooses its consumption c_t and out-of-pocket medical expenses, m_t, to maximize its expected utility.

Health affects both one's survival probability and marginal utility of consumption. The term $s_t\Big(\{\pi^h\}_t\Big) = \Pi_{l=0}^t \tilde{s}_l(\pi_l^h)$ denotes the cumulative survival probability of a household at age t, conditional on being alive at age 66. It is a function of the history of the permanent health component $\{\pi^h\}_t$. The rationale for excluding transitory shocks from it is that people recover fully from transitory shocks after at most two years. Hence, they should not be affecting their survival probability.

The within-period utility function, u, is a function of consumption c_t, total medical expenses $\tilde{m}(m_t)$ (which relate to out-of-pocket medical expenses m_t through the function $\tilde{m}(.)$), and health h_t during that period. The utility function can be non-separable in its arguments and the expected value of future utility is taken with respect to uncertain income and health. Within-period utility is twice differentiable in its arguments, and strictly increasing and concave in its first argument: $u_c(., \tilde{m}, h) > 0$ and $u_{cc}(., \tilde{m}, h) < 0$. Utility is time additive and β is the discount factor. We drop demographics from our model's exposition to simplify notation, but our framework allows for utility to be influenced by demographic characteristics. Our empirical strategy accounts for demographics.

The timing is the following. At the beginning of each period, income and health shocks are realized, income is received, and households optimally choose consumption, medical expenses and savings. At the end of the period, mortality risk is realized.

Our maximization problem is subject to four constraints. Equation (2) is the budget constraint. The household can use an asset, a_t, to store its wealth from one period to the next at a possibly stochastic rate of return r_t. During each period, the household receives stochastic income $p_t y_t$, and spends $p_t^m m_t$ and $p_t^c c_t$ on out of-pocket medical expenses and on consumption, where p_t the price index for output, p_t^m the one for medical expenses, and p_t^c the one for consumption. The terminal condition on wealth states that households cannot hold negative assets during their last period, when they die with certainty.

Equations (4) and (5), govern the evolution of the **log-income and health** (net of the effect of demographics, that we purge in our empirical strategy), which are the sum of a permanent component π that evolves as a random walk, and of a transitory component ε that is an MA(0) process. The shocks are not required to be drawn from normal distributions and are centered around zero. Hence, many households might receive small positive shocks, while a few might be hit by large negative shocks. In addition, different households might draw shocks from different distributions and the same household might draw shocks from different distributions over time.[4] A positive health shock is not necessarily an absolute increase in health. Rather, it is a health increase relatively to what health would have been absent the shock (for instance, health deteriorates less than demographics would predict).

For each household, we allow the health and income permanent shocks η^y and η^h to be correlated within a period. We can also let the contemporaneous transitory income and health shocks ε^y and ε^h to be correlated with each other. Yet, because we estimate that correlation to be small and statistically not significant (see Table 3), we set it to zero in our main analysis. Online Appendix E relaxes this assumption and shows that our results are unaffected by it.

Our transitory-permanent specifications are consistent with the observed autocovariances of log-income growth and health growth. In contrast, several alternative statistical models are ruled out: the observed autocovariances reject that the transitory components are more persistent than an MA(0) in biennial data, and suggest that the permanent component evolves as a random walk rather than an AR(1). We detail this in Section 5.2, Table 1.[5]

Our model assumes that medical expenses during retirement generate utility during the current period and are endogenously chosen by the household, but that medical

[4] This point is detailed in Commault (2022) in Section I.A, Footnote 5.

[5] We also conduct robustness checks in which our income process is an AR(1). Online Appendix J shows that the results are very similar.

expenses do not affect one's future health, which evolves exogenously. The papers on health and medical expenses that we mention earlier in this section make either more restrictive or similar assumptions.

Importantly, our modeling of health is also consistent with much empirical evidence showing that the effects of medical expenses on health and mortality are small for U.S. retirees. Two reasons can explain this finding. First, the medical expenses that we are considering are supplementing Medicaid, Medicare, and insurance-provided medical goods and services, which cover most life-threatening conditions. Second, the stock of health carried by an older person is in large part determined by health investments that were made in the past, including those made by the person's parents during their childhood, and even before birth. Hence, the effects of additional health investments for people aged 66 and older are not as large as in earlier stages of life.

In terms of empirical evidence, many papers find that medical expenses have small effects on health and mortality. To start with, in the RAND Health Insurance Experiment, a random set of individuals were given co-payment-free health insurance over a 3–5-year period, while a control group faced standard co-payments. Brook et al. (1983) found that even though the group with free health care utilized medical services much more intensively than the control group, the additional treatments had only a minor effects on subsequent health outcomes. Moreover, some empirical studies show that even programs such as Medicare, which sometimes help pay for critical treatments, do not significantly increase life expectancy (Fisher, Wennberg, Stukel, Gottlieb, Lucas, and Pinder (2003), Finkelstein and McKnight (2008)). Card, Dobkin, and Maestas (2009) find that Medicare caused a small reduction in mortality among 65-year-old admitted through emergency rooms for what they refer to as "nondeferrable" conditions. Using a different method that compares uninsured individuals between age 50-61 with matched uninsured individuals, Black, Espín-Sánchez, French, and Litvak (2017) show that the uninsured consume less health care services but that their health (while alive) does not deteriorate relative to that of the insured, and that their mortality is similar. Khwaja (2010) estimates a structural model in which medical expenses both provide utility and improve health and finds that 80% of medical utilization is mitigative, in the sense of just increasing current utility, while the remaining 20% is curative, in the sense that it does improve one's health. Blau and Gilleskie (2008) reach similar conclusions. Given that the existing evidence indicates that the effect of additional medical spending on subsequent health and life expectancy is small, and that we study older people, we focus on the utility effects of medical expenses.

3 The consumption and medical expenses responses to shocks

The goal of this section is to formalize the intuition of the channels through which permanent and transitory shocks affect decisions and to use our structural model to decompose the consumption and medical expenses responses to transitory shocks into quantities that we can estimate.

3.1 The transmission channels

To start, note that the policy functions (and their partial derivatives) are informative about the total effects of income and health shocks on consumption and medical expenses but say little about the channels at play. Indeed, the problem described by (1)-(5) implies the following policy functions for c_t and m_t:

$$c_t = c_t(a_t, \pi_t^y, \pi_t^h, \varepsilon_t^y, \varepsilon_t^h) \tag{6}$$

$$m_t = m_t(a_t, \pi_t^y, \pi_t^h, \varepsilon_t^y, \varepsilon_t^h). \tag{7}$$

In these expressions, the partial derivatives with respect to ε_t^y and ε_t^h capture a combination of channels. To make them explicit, we start from the Euler equation. It relates the marginal utility of current consumption (which depends on current consumption, current medical expenses, and current health) to the expected marginal utility of future consumption (which depends on future consumption, future medical expenses and future health), weighted by the future survival probability

$$u_c(c_t, \tilde{m}(m_t), h_t) \geq E_t[u_c(c_{t+1}, \tilde{m}(m_{t+1}), h_{t+1})\tilde{s}_{t+1}(\pi_{t+1}^h)R_{t+1}], \tag{8}$$

where $R_{t+1} \equiv \beta(1 + r_{t+1})$ is a factor capturing all inter-temporal substitution motives other than the survival probability.

We substitute c_{t+1} and m_{t+1} in Eq. (8) using the policy functions (6) and (7), and use $a_{t+1} = ((1+r_t)p_t a_t + p_t y_t - p^m_t m_t - p^c_t c_t)/p_{t+1}$, $\pi^y_{t+1} = \pi^y_t + \eta^y_{t+1}$, and $\pi^h_{t+1} = \pi^h_t + \eta^h_{t+1}$

$$\begin{aligned}
&u_c(c_t, \tilde{m}(m_t), h_t) \geq \\
&\quad E_t\Bigg[u_c\Bigg(c_{t+1}\big(((1+r_t)p_t a_t + p_t y_t - p^m_t m_t - p^c_t c_t)/p_{t+1}, \pi^y_t + \eta^y_{t+1}, \varepsilon^y_{t+1}, \pi^h_t + \eta^h_{t+1}, \varepsilon^h_{t+1}\big), \\
&\quad \tilde{m}\big(m_{t+1}\big(((1+r_t)p_t a_t + p_t y_t - p^m_t m_t - p^c_t c_t)/p_{t+1}, \pi^y_t + \eta^y_{t+1}, \varepsilon^y_{t+1}, \pi^h_t + \eta^h_{t+1}, \varepsilon^h_{t+1}\big)\big), \\
&\quad \pi^h_t + \eta^h_{t+1} + \varepsilon^h_{t+1}\Bigg)\tilde{s}_{t+1}(\pi^h_t + \eta^h_{t+1})R_{t+1}\Bigg]. \qquad (9)
\end{aligned}$$

The resulting expression is an optimality condition relating current consumption c_t to m_t and to the state variables at t (a_t, $h_t = \pi^h_t + \varepsilon^h_t$, $y_t = \pi^y_t + \varepsilon^y_t$) in a way that makes explicit the following effects at play:

(i) out-of-pocket medical expenses and health change the marginal utility of current consumption (in red),

(ii) assets, income, and medical expenses determine the resources that will remain after consumption at the current period, which affects consumption at the next period—thus the value of current consumption that equalizes the current and expected future marginal utilities—(in blue),

(iii) independently of the resources passed on to next period, the current permanent components of income and health influence the value of income and health at the next period, thus consumption at the next period (in green), and

(iv) independently of the resources passed on to next period and of the distribution of income and health at the next period, the current permanent component of health determines the next survival probability (in orange).

While, for simplicity of exposition, we abstract from specifying borrowing constraints in our model, and hence the Euler equation always holds at equality, we write it here as an inequality for generality. In the case in which there are binding borrowing constraints, the Euler equation holds as an inequality because the Lagrange multiplier on resources is positive. The value of this multiplier depends on whether future resources (our first channel, in blue) are below a certain threshold. Hence, currently binding borrowing constraints play a similar role to that of the terms in blue and manifests through one of the four main channels in (10).

Because this optimality condition implicitly defines consumption (and therefore log-consumption) as a function of these four channels, it is convenient to write it as

$$ln(c_t) = f^{c,t}(\underbrace{m_t, \quad h_t}_{\substack{\text{affect } c_t \text{ through} \\ \text{marginal utility} \\ u_c(.,\tilde{m}(m_t),h_t)}}, \underbrace{(1+r_t)p_t a_t + p_t y_t - p_t^m m_t}_{\substack{= R_t \text{ affect } c_t \text{ through} \\ \text{the budget constraint}}}, \underbrace{\pi_t^y, \quad \pi_t^h}_{\substack{\text{affect } c_t \text{ through} \\ \text{the distribution of} \\ y_{t+1} \text{ and } h_{t+1} \text{ (holding} \\ \tilde{s}_{t+1}(\pi_{t+1}^h) \text{ constant)}}}, \underbrace{\pi_t^h}_{\substack{\text{affects } c_t \\ \text{through survival} \\ \text{probability} \\ \tilde{s}_{t+1}(\pi_{t+1}^h)}}). \tag{10}$$

A similar expression holds for log-medical expenses, with $f^{m,t}$ the function determining $ln(m_t)$. In these expressions, the partial derivatives of $f^{c,t}$ and $f^{m,t}$ with respect to each argument correspond to the effect of each channel holding the rest constant (e.g. the partial derivative of $f^{c,t}$ with respect to the first argument corresponds to the effect of a change in medical expenses through the marginal utility channel only, holding the budget constraint, the distributions of future income and health, and the next survival probability constant).

3.2 Decomposing the response to transitory shocks

Because transitory shocks have no effects on the future distribution of income and health, nor on people's survival probability, they only influence consumption and medical spending through two channels: the marginal utility channel and the resources channel. We now turn to studying the case of transitory shocks and the factors determining the magnitude of these two channels.

When we take the derivative of Equation (10) with respect to transitory income and health shocks, only the first three derivatives of the function $f^{c,t}$ appear. We denote them as $f_m^{c,t}$, $f_h^{c,t}$ (which both correspond to the marginal utility channel) and $f_R^{c,t}$ (which correspond to the resources channel).[6] Hence the partial derivatives with

[6] To ease notation, we denote $f_m^{c,t}(m_t, h_t, (1+r_t)p_t a_t + p_t y_t - p_t^m m_t, \pi_t^y, \pi_t^h, \pi_t^h)$ as $f_m^{c,t}$, and similarly for $f_h^{c,t}$ and $f_R^{c,t}$.

respect to transitory shocks are

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^y}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t\frac{dy_t}{d\varepsilon_t^y} - p_t^m\frac{dm_t}{d\varepsilon_t^y}\right\}}_{\text{Resources}} \tag{11}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}\frac{dh_t}{d\varepsilon_t^h}}_{\text{Marginal utility}} - \underbrace{f_R^{c,t}p_t^m\frac{dm_t}{d\varepsilon_t^h}}_{\text{Resources}} \tag{12}$$

where we have used the lack of correlation between the transitory shocks to set $\frac{dh_t}{d\epsilon_t^y} = 0$ (and hence the term containing $f_h^{c,t}$ drops out) and also $\frac{dy_t}{d\epsilon_t^h} = 0$ (and hence available resources to consume and save only change in response to a health shock because of the change in medical expenses).

Because our income and health processes imply $\frac{dy_t}{d\varepsilon_t^y} = \frac{dln(y_t)}{d\varepsilon_t^y} \times y_t = 1 \times y_t$ and $\frac{dh_t}{d\varepsilon_t^h} = 1$, and we have that $\frac{dm_t}{d\varepsilon_t^h} = \frac{dln(m_t)}{d\varepsilon_t^h}m_t$, we can simplify (11) and (12) as

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^y}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t y_t - p_t^m\frac{dm_t}{d\varepsilon_t^y}\right\}}_{\text{Resources}} \tag{13}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}}_{\text{Marginal utility}} - \underbrace{f_R^{c,t}p_t^m\frac{dln(m_t)}{d\varepsilon_t^h}m_t}_{\text{Resources}}. \tag{14}$$

Finally, we assume that, after age 65, people do not adjust their level of out-of-pocket medical expenses when experiencing transitory income changes (that is, $\frac{dm_t}{d\varepsilon_t^y} \approx 0$). Two points are important here. To start, not only the response of out-of-pocket medical expenses is statistically insignificant but, because out-of-pocket medical expenses are low, they fluctuate little with income, given our estimated pass through coefficient. In addition, in what follows, we discuss the consequences of relaxing this assumption.

We obtain:

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{\overbrace{f_R^{c,t}}^{\text{Multiplier}} \quad p_t y_t}_{\text{Resources}} \tag{15}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}}_{\text{Marginal utility}} - \underbrace{\overbrace{f_R^{c,t}}^{\text{Multiplier}} \quad p_t^m \frac{dln(m_t)}{d\varepsilon_t^h} m_t}_{\text{Resources}}. \tag{16}$$

Hence, the elasticity of consumption to a transitory income shock only depends on the strength of the resource channel. It is the product of the change in resources caused by the shock $p_t\frac{dy_t}{d\varepsilon_t^y} = p_t y_t$ (by construction a one unit transitory income shock corresponds to 100% income change) and the multiplier $f_R^{c,t}$—which measures how much the pass-through of a shock to consumption increases when the shock raises resources by one unit. In contrast, the elasticity of consumption to a transitory health shock depends on both the marginal utility channel and the resources channel. The latter is, again, the product of the shock-induced resources change ($p_t^m\frac{dm_t}{d\varepsilon_t^h} = p_t^m\frac{dln(m_t)}{d\varepsilon_t^h}m_t$) and the multiplier $f_R^{c,t}$.

Online Appendix D relaxes the assumption that income shocks do not affect medical expenses. It shows that if medical expenses do respond to transitory income shocks, ignoring this effect leads to underestimating the share of the consumption response that is due to a shift in marginal utility. Hence, our estimate of the effects of health on the marginal utility of consumption, which is an important contribution of our paper, is conservative in this regard.

It is worth noting that an alternative condition that yields a similar expression, but does not require imposing that income shocks do not affect medical expenses to obtain it, is assuming that $f_m^{c,t} = 0$. That is, that, conditional on health, the marginal utility of consumption is unaffected by medical expenses. Indeed, the marginal utility channel of the transitory income pass-through $f_m^{c,t}\frac{dm_t}{d\varepsilon_t^y}$ is zero either when $\frac{dm_t}{d\varepsilon_t^y} = 0$ (which we estimate to be the case) or when $f_m^{c,t}$. Note that under the alternative case of separability, the interpretation of the marginal utility channel is different. Instead of capturing both the effects of health on marginal utility and the (potentially counterbalancing) effect of the response of medical expenses on marginal utility $f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}$, it only relates to the effect of health on marginal utility $f_h^{c,t}$, because $f_m^{c,t} = 0$.

For completeness, online Appendix L provides the exact mapping between the marginal utility and resources channels expressed in terms of partial effects on consumption $f_m^{c,t}$, $f_h^{c,t}$ and $f_R^{c,t}$ (that we present here) and expressed in terms of partial effects on the marginal utility of consumption (u_{cc}, u_{cm}, u_{ch}).

4 Identification and implementation

We now turn to discussing how we identify the partial derivatives with respect to transitory shocks and, within them, the resources and marginal utility channels that compose them, and how we implement this identification strategy.

4.1 Identification

Variance of the income and health shocks. Transitory shocks are not directly observed in our data, which reports income and health. Assuming a transitory-permanent specification allows us to identify the variances and covariances of the transitory and permanent components of income and health by using moment conditions. For transitory shocks, as Meghir and Pistaferri (2004) and Blundell, Pistaferri, and Preston (2008) (BPP), we use equations (4) and (5) to derive $\Delta ln(y)$ and Δh and obtain moment conditions that we can estimate

$$cov(\Delta ln(y_t), -\Delta ln(y_{t+1})) = var(\varepsilon_t^y) \tag{17}$$

$$cov(\Delta h_t, -\Delta h_{t+1}) = var(\varepsilon_t^h) \tag{18}$$

$$cov(\Delta h_t, -\Delta ln(y_{t+1})) = cov(\varepsilon_t^y, \varepsilon_t^h) \tag{19}$$

$$cov(\Delta ln(y_{t+1}), -\Delta h_t) = cov(\varepsilon_t^y, \varepsilon_t^h) \tag{20}$$

Intuitively, these moments identify the variances of transitory shocks because future growth (at $t+1$) filters out the permanent component of current growth (at t): a current transitory shock generates current positive growth and future negative growth, while a current permanent shock generates current positive growth and no growth afterwards. This identification only requires that income and health evolve as in Equations (4) and (5)).

We also estimate the variances and covariances of *permanent shocks* for the purpose of comparing them with those of transitory shocks. For this, as Meghir and Pistaferri (2004) and BPP, we use that $cov(\Delta ln(y_t), \Delta ln(y_{t-1}) + \Delta ln(y_t) + \Delta ln(y_{t+1})) = var(\eta_t^y)$ and $cov(\Delta h_t, \Delta h_{t-1} + \Delta h_t + \Delta h_{t+1}) = var(\eta_t^h)$.

Pass-through coefficients. To identify the partial derivatives with respect to transitory shocks, $\frac{dln(c_t)}{d\varepsilon}$—which we refer to as the pass-through coefficients—we linearize log-consumption. It makes sense to do so because the pass-through captures the total effect of a shock.

Because the consumption policy function states that log-consumption is determined by household's assets, permanent and transitory income, and permanent and transitory health, we linearize it around the point where all these variables are at their average sample values (we denote with $|_0$ any variable taken at this approximation point)

$$\begin{aligned} ln(c_t) \approx\ & ln(c_t)|_0 + (a_t - E[a_t])\frac{dln(c_t)}{da_t}|_0 + (\pi_t^y - E[\pi_t^y])\frac{dln(c_t)}{d\pi^y}|_0 \\ & + (\pi_t^h - E[\pi_t^h])\frac{dln(c_t)}{d\pi_t^h}|_0 + (\varepsilon_t^y - E[\varepsilon_t^y])\frac{dln(c_t)}{d\varepsilon_t^y}|_0 + (\varepsilon_t^h - E[\varepsilon_t^h])\frac{dln(c_t)}{d\varepsilon_t^h}|_0 \end{aligned} \tag{21}$$

We then take the covariance of both sides of (21) with ε_t^y (or ε_t^h), and divide both sides by $var(\varepsilon_t^y)$ (or $var(\varepsilon_t^h)$). The linearization implies that the ratios $\frac{cov(ln(c_t),\varepsilon_t^y)}{var(\varepsilon_t^y)}$ and $\frac{cov(ln(c_t),\varepsilon_t^h)}{var(\varepsilon_t^h)}$ coincide with the pass-through coefficients of the transitory income and health shocks at the approximation point $\frac{dln(c_t)}{d\varepsilon_t^y}|_0$ and $\frac{dln(c_t)}{d\varepsilon_t^h}|_0$.[7] Now, the covariance between log-consumption and transitory shocks is the same as the covariance between log-consumption *growth* and transitory shocks: this is because shocks at t are true shocks, and thus orthogonal to variables at $t-1$. We denote these key ratios $\frac{cov(\Delta ln(c_t),\varepsilon_t^y)}{var(\varepsilon_t^y)}$ and $\frac{cov(\Delta ln(c_t),\varepsilon_t^h)}{var(\varepsilon_t^h)}$ as ϕ_c^y and ϕ_c^h. As a result we have

$$\phi_c^y = \frac{cov(\Delta ln(c_t), \varepsilon_t^y)}{var(\varepsilon_t^y)} = \frac{cov(ln(c_t), \varepsilon_t^y)}{var(\varepsilon_t^y)} \approx \frac{dln(c_t)}{d\varepsilon_t^y}|_0 \tag{22}$$

$$\phi_c^h = \frac{cov(\Delta ln(c_t), \varepsilon_t^h)}{var(\varepsilon_t^h)} = \frac{cov(ln(c_t), \varepsilon_t^h)}{var(\varepsilon_t^h)} \approx \frac{dln(c_t)}{d\varepsilon_t^h}|_0. \tag{23}$$

Similarly, the ratios of the covariance between growth in medical expenses and

[7] Commault (2022) shows that the same equality between the ratios $\frac{cov(ln(c_t),\varepsilon_t)}{var(\varepsilon_t)}$ and the pass-through coefficients $\frac{dln(c_t)}{d\varepsilon_t}$ holds in the case of a second-order approximation when the shocks have zero skewness—which we find to be the case empirically.

the transitory shocks over the variance of the shocks, denoted ϕ_m^y and ϕ_m^h, coincide with the pass-through of transitory shocks to medical expenses at the approximation point.

As we already identify the variances of our transitory shocks from moments (17)-(18), we now only need to identify some covariances to obtain these ratios. To do so, we use the same insight as in the identification of the variances: we filter out the effect of permanent shocks on current log-consumption growth by taking its covariance with future income growth

$$cov(\Delta ln(c_t), -\Delta ln(y_{t+1})) = cov(\Delta ln(c_t), \varepsilon_t^y) = \phi_c^y \; var(\varepsilon_t^y) \tag{24}$$

$$cov(\Delta ln(c_t), -\Delta ln(h_{t+1})) = cov(\Delta ln(c_t), \varepsilon_t^h) = \phi_c^h \; var(\varepsilon_t^h) \tag{25}$$

Similarly

$$cov(\Delta ln(m_t), -\Delta ln(y_{t+1})) = cov(\Delta ln(m_t), \varepsilon_t^y) = \phi_m^y \; var(\varepsilon_t^y) \tag{26}$$

$$cov(\Delta ln(m_t), -\Delta ln(h_{t+1})) = cov(\Delta ln(m_t), \varepsilon_t^h) = \phi_m^h \; var(\varepsilon_t^h). \tag{27}$$

This identification strategy is the same as in Commault (2022)'s robust version of the BPP estimator: because it only uses the covariances between current and future growth, it identifies the pass-through of transitory shocks without imposing a particular specification on log-consumption.

The identification of the ratios ϕ_m^y and ϕ_m^h thus only requires that the law of motion for income and for health are well specified (equations (4) and (5)) and that consumption is orthogonal to future shocks (at the next period). This orthogonality means that the shocks are unanticipated, and thus uncorrelated with the variables in the previous period. Online Appendix J discusses how people, anticipating changes in their income or health at the next period, induce a downward bias in our pass-through estimates.

To interpret these ratios as approximations of the pass-through coefficients $\frac{dln(c_t)}{d\varepsilon_t^y}|_0$ and $\frac{dln(c_t)}{d\varepsilon_t^h}|_0$, we additionally need log-consumption to be approximately linear in transitory shocks ε_t^y and ε_t^h—but we do not need log-consumption to be linear in its other determinants.

In contrast, if one wants to identify the pass-through of *permanent shocks*, one needs stronger assumptions about consumption. For example, BPP impose that log-consumption is a random walk. Note that in equations (21), although we take a first order approximation around the state variables, we do not impose random walk behavior. In particular, log-consumption growth and log-medical expenses growth depends on assets growth, which in general depends on past assets (except in the absence of uncertainty). It is also worth noting that, even if we were willing to make strong assumptions about the specification of log-consumption to identify the pass-through of *permanent shocks*, we could not decompose their values into different channels, as we do for the pass-through of transitory shocks. This is because permanent shocks influence consumption through all channels, and not just by changing the current resources and current marginal utility of consumption.

Thus, our focus on transitory shocks provides two important advantages: (i) it makes it possible first to *identify* the pass-through coefficient with a relatively small set of assumptions while the identification of the pass-through of permanent shocks would require much stronger hypotheses; (ii) it makes it possible to *interpret* the results since the transitory shocks only affect consumption and medical expenses through two channels into which we can decompose the pass-through coefficients.

Decomposition of the pass-through coefficients. Applying the decomposition derived in (15) and (16) to the pass-through coefficients at the approximation point yields

$$\phi_c^y \approx \frac{dln(c_t)}{d\varepsilon_t^y}|_0 = \overbrace{f_R^{c,t}|_0}^{\text{Multiplier}} \; p_t \; \underbrace{y_t|_0}_{E[y_t]} \tag{28}$$

$$\phi_c^h \approx \frac{dln(c_t)}{d\varepsilon_t^h}|_0 = \overbrace{f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0 + f_h^{c,t}|_0}^{\substack{\text{Contribution of} \\ \text{marginal utility}}} - \overbrace{f_R^{c,t}|_0}^{\text{Multiplier}} \; p_t^m \underbrace{\frac{dln(m_t)}{d\varepsilon_t^h}|_0}_{\approx \phi_m^h} \; \underbrace{m_t|_0}_{\approx E[m_t]} \tag{29}$$

Indeed, at the approximation point, y_t equals its average sample $E[y_t]$ and m_t approximately equals its average value $E_t[m_t]$.[8] Hence, in these expressions we have only two unobserved components that need to be identified, $f_R^{c,t}|_0$ and $(f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0 + f_h^{c,t}|_0)$ and two expressions to identify them. Expression (28) makes it possible to recover the

[8] More precisely $m_t|_0 = m_t(E_t[a_t], E_t[\pi_t^y], E_t[\pi_t^h], E_t[\varepsilon_t^y], E[\varepsilon_t^h]) \approx E_t[m_t]$. Note that we could choose an approximation point $|_0$ at which we have both $y|_0 = E[y_t]$ and $m_t|_0 = E[m_t]$.

value of $f_R^{c,t}|_0$, which measures by how much a transitory reduction in resources affects the pass-through of this transitory shock to consumption. This value can in turn be plugged in (29), to obtain $(f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0 + f_h^{c,t}|_0)$, which measures the contribution of the shift in the marginal utility of consumption to the pass-through of transitory health shocks. More precisely, this term the sum of the effect of a change in health on the marginal utility of consumption $f_h^{c,t}|_0$, plus the effect of the endogenous adjustment in medical expenses caused by the change in health on the marginal utility of consumption $f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0$

$$f_R^{c,t}|_0 = \frac{\phi_c^y}{p_t E[y_t]} \tag{30}$$

$$(f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0 + f_h^{c,t}|_0) = \phi_c^h - \phi_h^m p_t^m E[m_t] \frac{\phi_c^y}{p_t E[y_t]} \tag{31}$$

The intuition for our identification is as follows. In our model, a transitory shock only affects consumption through two channels: the resources that can be devoted to current and future consumption, and the ability to derive utility from current consumption. Holding the ability to derive utility constant, the effect of resources on consumption is the same whether the change in resources comes from a change in medical expenses or from a change in income. That is, the multiplier $f_R^{c,t}$ on the change in resources is the same in (28) and (29). Intuitively, having to pay a \$1000 hospital bill is equivalent to earning \$1000 less in net income for non-medical consumption if the hours spent at the hospital do not change your ability to enjoy it. As a result, when income and health shocks are uncorrelated and income does not affect medical expenses (so an income shock only affects consumption through its impact on resources), we can measure this multiplier $f_R^{c,t}|_0$ from the pass-through of a transitory income shock to consumption. Knowing both this multiplier and the effect of a transitory health shock on medical expenses (which we have estimated previously as ϕ_m^h), we can predict the pass-through of a transitory health shock to consumption that would take place if marginal utility were unaffected and only the resource channel was at play. We can then recover the contribution of the shift in marginal utility as the difference between the pass-through that we measure and the pass-through that would take place if only the resources channel was at play.

4.2 Implementation

We construct "detrended" health and income variables, that is, net of observed demographic characteristics (see online Appendix C for details). We then use equations (17)-(20), (45)-(27) and (30)-(31) and the Generalized Method of Moments (GMM) to jointly estimate the variances and covariances of our income and health processes, the pass-through coefficients, the multiplier $f_R^{c,t}|_0$, and the marginal utility contribution $(f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^h}|_0)$. We also estimate the average change in resources caused by a transitory health shock. This is not subject to any additional identification problem as it is given by the product of the pass-through of health to medical expenses and of the average sample value of medical expenses $\phi_h^m p_t^m E[m_t]$.[9]

When estimating, we pool observations for all years. Our identification strategy requires that the transitory and permanent shocks are not serially correlated. In estimation we allow for the errors in the moment conditions, which may come from measurement error, to be serially correlated within households. To accommodate this, we cluster at the individual level, which allows for general serial correlation of the residuals. Because of this clustering, our GMM weighting matrix is robust to heteroskedasticity.

5 Key facts about our variables of interest

We use the Health and Retirement Study (HRS) data, a longitudinal survey representative of the U.S. population over the age of 50 and their spouses. It contains rich information on health, income, demographics, and many other variables. We combine information from the HRS core interviews and its Consumption and Activities Mail Survey (CAMS), a supplementary study collecting data on household spending that is administered to a subset of HRS respondents.

Both surveys are biennial. The CAMS is conducted on the years in between the HRS surveys, but the information lines up well because income questions refer to the past year, while consumption questions refer to current consumption.[10] Our merged sample covers the years 2001 to 2013 and drops Medicaid recipients, who make up

[9]We estimate the variances of the permanent shocks separately because they require a sample of households observed for four consecutive periods, which reduces our sample size.

[10]The health questions refer to current health, so the overlap between health and consumption is only partial. We discuss the consequences of this feature of the data in online Appendix J.

for 9.6% of our observations. Online Appendix A describes our sample selection in detail.

The rest of this section starts by detailing the construction of our variables of interest, continues by describing their first moments and percentiles, and concludes by discussing their variances.

5.1 Variables construction

Consumption includes food at home and away from home, utilities, car-related expenses, leisure, and equipment. Medical expenses include out-of-pocket costs for drugs, medical services, and medical supplies. Each category is deflated by the corresponding item-specific price index of the Bureau of Labor Statistics (BLS).

Our health index is constructed as follows. We attribute a numerical value from 5 to 1 to the answers to the following survey question: "Would you say your health is excellent, very good, good, fair, or poor?" Then, we predict its value by regressing the resulting variable on dummies for reporting difficulties in activities of daily living (ADLs) or for being diagnosed with certain health conditions. This procedure eliminates both changes in self-reported health that are not caused by any change in objective health measures and changes in objective measures that do not translate into changes in self-reported health (Blundell Britton Costa-Dias and French (2017) follow a similar strategy).

We construct our health measure so that a higher health index corresponds to better health. A one-unit change in our health index has the same interpretation as a one-unit change in self-reported health (although by taking the predicted value we limit ourselves to the changes driven by our regressors). That is, a one unit change in the index corresponds to a change from one level of response to the next.

By treating the possible self-reported health statuses as incremental numbers, we assume that changes are homogeneous, so that, for instance, the change from "excellent" to "very good" corresponds to the same quantitative decrease in health than the change from "good" to "fair". As a result, a 0.1 increase in our health index corresponds to a health improvement of one tenth of the health difference between "good" and "very good" (or any other two consecutive levels). In the case of households composed of a head and spouse, the health index is the average of their predicted values. Hence, a one unit change captures any combination of $1-x$ change in the health of one spouse and x change in the health of the other.

Net worth is the sum of all assets less all liabilities. We deflate it with the Consumer Price Index (CPI) for total consumption. We take family size into account by dividing the wealth of couples by the square root of two. We define as "lower-wealth households" those with equivalized wealth below 75,000 dollars and as "higher-wealth households" the rest. This breakdown splits the bottom quintile of households in terms of equivalized wealth from the other four wealth quintiles. Because we are focusing on older people who are wealthier than the general population, even people with positive net worth are part of the bottom quintile.

Our measure of income is net income. This is because we want to measure the response of consumption to income shocks after engaging in self-insurance (through both labor supply and savings) and receiving government insurance. More specifically, net income includes earnings (wages, salaries, bonuses), capital income (business or farm income, self-employment, rents, dividend and interest income, and other asset income), private pensions (income from employer pension or annuity), benefits (social security retirement income, income from transfer programs and workers' compensations), and other income (alimony, other income, lump sums from insurance, pension, and inheritance), of both household's head and spouse, if present, net of taxes and transfers. We deflate it with the BLS price index for total consumption. We report more details about our variables' construction and some descriptives on their distributions in online Appendix B.

5.2 Autocovariances of income and health growth and their cross-covariances with consumption growth

For brevity, in the remainder of the paper, we refer to our main income measure—that is the natural logarithm of detrended net income—simply as "income", and to our detrended health index simply as "health index", or "health". Similarly, we refer to the natural logarithm of detrended real non-durable consumption expenses as "consumption" and to the natural logarithm of detrended real out-of-pocket medical expenses as "medical expenses".

To support our assumptions on the income and health processes, Table 1 presents the autocovariances of income and health growth, and the cross-covariances of consumption growth with income growth and health growth.

	$\Delta ln(y_t)$	$\Delta ln(y_{t+1})$	$\Delta ln(y_{t+2})$	$\Delta ln(y_{t+3})$
$cov(\Delta ln(y_t), .)$	.213***	-.087***	-.008	-.002
	(.007)	(.005)	(.005)	(.006)
$cov(\Delta ln(c_t), .)$	.017***	-.011***	-.001	.005
	(.003)	(.003)	(.004)	(.006)
Obs.	4,999	4,999	3,094	1,915
	Δh_t	Δh_{t+1}	Δh_{t+2}	Δh_{t+3}
$cov(\Delta h_t, .)$	.064***	-.020***	-.003	.002
	(.002)	(.001)	(.002)	(.002)
$cov(\Delta ln(c_t), .)$	.005***	-.003*	.004**	-.004
	(.002)	(.002)	(.002)	(.003)
Obs.	4,999	4,999	3,045	1,882

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 1: Covariance of current income, health, and consumption growth with current and future income and health growth.

The first lines of the top and bottom panel of Table 1 report the autocovariances of income growth and health growth. They show that both income and health can be well represented by the sum of a random walk permanent component and of a transitory component that is an MA(0). More specifically, the first two lines of the top panel show that the covariance between income growth at t and $t+1$ is statistically significant at the 1% level, while it is not significant between t and $t+2$. This is consistent with transitory income being i.i.d. In fact, if transitory income were an MA(k) process with $k > 0$, the covariance between income growth at t and $t+2$ would be significant. In addition, if the permanent component of income were an AR(1) with a coefficient different from one, rather than a random walk, the covariance between income growth at t and all future periods would be significant, while we fail to find evidence of this. Given the first two lines of the bottom panel, the same reasoning implies that health is also well represented by the sum of a random walk and an MA(0) component.

The third and fourth lines in the top and bottom panel of Table 1 report the covariances between consumption growth and current and future income and health growth. These covariances imply that consumption co-varies significantly and positively with transitory income and health shocks, and that permanent health shocks are partly anticipated, at most two periods ahead. More specifically, the first column indicates that the covariances of consumption growth with contemporaneous income growth and health growth are significant and positive. Under a transitory-permanent specification of income and health, they correspond to $cov(\Delta ln(c_t), \eta_t^x + \varepsilon_t^x - \varepsilon_{t-1}^x), x \in y, h$. Thus, a positive value already suggests that permanent and transitory income and health shocks both have a positive impact on contemporaneous consumption.

The second column indicates that the covariances of consumption growth with income growth and health growth at the next period are significant and negative. Although the covariance between $\Delta ln(c_t)$ and Δh_{t+1} displays only one star, the p-value of the test that it is zero is 0.051. Hence this moment is very close to being significant at the 5% level. Under a transitory-permanent specification of income and health, these covariances correspond to $cov(\Delta ln(c_t), \eta_{t+1}^x + \varepsilon_{t+1}^x - \varepsilon_t^x), x \in y, h$. The fact that these covariances are negative indicates that contemporaneous transitory income and health shocks ε_t^x raise consumption by more than future (and possibly anticipated) shocks $\eta_{t+1} + \varepsilon_{t+1}$.

The third column indicates that the covariance between consumption growth and income growth two periods later is small and not significant, while the covariance between consumption growth and health growth two periods later is significant and positive. Under a transitory-permanent specification of income and health, these covariances are given by $cov(\Delta ln(c_t), \eta_{t+2}^x + \varepsilon_{t+2}^x - \varepsilon_{t+1}^x), x \in y, h$. The fact that the covariance with income ($x = y$) is small suggests that income shocks are not anticipated. The fact that the covariance with health ($x = h$) is positive and significant suggests that households partly anticipate the realization of their future permanent health shocks η^h (at most two periods ahead since the covariance after $t + 2$ is small and not significant) and that the effect of this anticipation on current consumption is positive.[11] Online Appendix J discusses that the presence of anticipation tends to reduce our estimated pass-through of transitory health shocks to consumption. Intuitively, when people receive advance signals about their future health, the value of our main estimating moment, $cov(\Delta ln(c_t), -\Delta h_{t+1})$, is attenuated: consumption does not increase as much with a decrease in future health $-\Delta h_{t+1}$ because such a decrease captures both a positive transitory health shock at t, ε_t^h, and a negative

[11]Note that this covariance is unlikely to be driven by one of the transitory shocks ε in $\Delta h_{t+2} = \eta_{t+2}^h + \varepsilon_{t+2}^h - \varepsilon_{t+1}^h$ since (i) Δh_{t+2} co-varies negatively with medical expenses while it would co-varies positively if $-\varepsilon_{t+1}^h$, a negative health shock, were the variable causing a significant reaction at t, and (ii) Δh_{t+3} no longer co-varies significantly with $\Delta ln(c_t)$ while it would if ε_{t+2}^h were the variable causing a significant reaction at t. However, our reasoning also holds when people partly anticipate the realization of future transitory shocks.

signal about future permanent health at $t + 1$. Since one important message of our paper is that consumption responds to transitory health shocks, this remains true when people partly anticipate future health changes.

To further validate our assumptions, we compute additional moments which we report in online Appendix C. They show that the covariances between health growth and subsequent income growth are small (between 0.002 and 0.003) and not significant. The same is true of the cross-covariances between income growth and subsequent health growth. This is consistent with our assumption that transitory income and health shocks are uncorrelated (although we relax this assumption in online Appendix E). Moreover, none of the cross-covariances between medical expenses growth and current and future income growth are statistically significant. In addition, the point estimate of the contemporaneous covariance is small (0.007). In contrast, for consumption the contemporaneous covariance with income growth is significant and equal to 0.017. Furthermore, the cross-covariances of medical expenses growth and current and future health growth suggest that medical expenses respond to transitory health shocks and that these health shocks are partly anticipated (these cross-covariances are similar to the cross-covariances of (non-medical) consumption growth and health growth so the same reasoning applies). These results are consistent with our baseline assumption that people adjust their medical expenses in response to transitory changes in their health but not in response to transitory changes in their income (although we now show that we can relax this assumption in online Appendix D).

5.3 Variances of the income and health shocks

Table 2 highlights that, even at advanced ages, households face substantial income risk. More precisely, the first line of this table reports the variance of the changes in income, $var(\Delta ln(y_t))$, across households and periods in our sample. It turns out to be 0.213 and significant. The second line reports the variance of transitory income shocks, $var(\varepsilon_t^y)$. It has a point estimate of 0.087 and it is significant. This means that current transitory shocks explain 41% of the variance of income growth. The third line reports the variance of permanent shocks, $var(\eta_t^y)$, which has a point estimate of 0.029 and is also significant. Current permanent shocks thus explain about 14% of the variance of income growth. Past transitory shocks explain the remainder of this

	All	Lower wealth	Higher wealth
$var(\Delta ln(y_t))$	.213***	.165***	.225***
	(.007)	(.013)	(.008)
$var(\varepsilon_t^y)$	.087***	.066***	.093***
	(.005)	(.009)	(.005)
Obs.	4999	970	4029
$var(\eta_t^y)$	.029***	.017*	.031***
	(.006)	(.01)	(.006)
Obs.	3401	623	2778

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 2: Variance of the transitory and permanent income shocks.

variance.[12]

Lower-wealth households face less income risk than higher-wealth households, in particular in terms of permanent income risk. This is consistent with a larger fraction of their income coming in from benefits.

We do not assume that our shocks are normal, but we estimate the third and fourth moments of the transitory shocks distribution to better understand its characteristics. The third moment is small and not significant, suggesting the distribution of shocks to income displays little skewness. The fourth moment is large and significant, and its point estimate is more than four times what a normal distribution would imply. This suggests that the distribution of shocks to our income measure has fat tails. Online Appendix C, section "Skewness and kurtosis of the shocks" presents additional results on this.

Given that we find that older households face substantial income risk, one might wonder what are its sources, especially since previous papers assume that there is no such risk. To further explore this question, we compute the standard deviation of each (detrended) income component in the population. Benefits (including social security retirement income) is the income category that displays the smallest variations. The standard deviations of pensions income, earnings and other income (including inheritances or insurance claims) are relatively similar and twice as large as the standard deviation of benefits. Capital income (including business income) is the category that displays the highest standard deviation. We report these results in detail in online Appendix C, section "Standard deviations of the different components of income".

[12]Indeed, with a transitory-permanent income process, the variance of the changes in income is $var(\Delta lny_t) = var(\varepsilon_t^y) + var(\varepsilon_{t-1}^y) + var(\eta_t^y)$.

	All	Lower wealth	Higher wealth
$var(\Delta h_t)$	.064***	.098***	.056***
	(.002)	(.006)	(.002)
$var(\varepsilon_t^h)$	.02***	.033***	.017***
	(.001)	(.004)	(.001)
$cov(\varepsilon_t^y, \varepsilon_t^h)$	.002	.003	.002
	(.001)	(.003)	(.001)
Obs.	4999	970	4029
$var(\eta_t^h)$	.02***	.026***	.018***
	(.002)	(.005)	(.002)
$cov(\eta_t^y, \eta_t^h)$	.002	-.003	.004*
	(.002)	(.004)	(.002)
Obs.	3401	623	2778

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 3: Variance of transitory and permanent health shocks.

Turning to our results for health shocks, Table 3 highlights that households face substantial health risk. More precisely, the first line of this table reports the variance of the changes in health, $var(\Delta h_t)$, across households and periods in our sample. It turns out to be 0.064 and significant. The second line reports the variance of transitory health shocks, $var(\varepsilon_t^h)$. It has a point estimate of 0.020 and is significant. This means that current transitory shocks explain one third of the variance of health growth. The fourth line reports the variance of permanent shocks, $var(\eta_t^h)$, which has a point estimate of 0.020 and is also significant. Current permanent shocks thus explain another third of the variance of health growth. Past transitory shocks explain the remainder.

A variance of 0.020 implies that, overall in the population and across periods, the shocks are drawn from a distribution with a standard-deviation of 0.141. This means that a transitory health shock corresponding to a one standard-deviation change is a change in health index by 0.141—that is a change in health corresponding to 14.1% of the health difference between two health levels, for example from “good” to “very good”.

The third line of the table indicates that there is a very small covariance (0.002) between transitory income and health shocks, which is not significant. Because this correlation is tiny and not significant, in most of our analysis, we assume that temporary income and health shocks are uncorrelated. Still, we relax this assumption in online Appendix E. In it, we posit the existence of underlying “pure income” and "pure health" transitory shocks that are uncorrelated but can affect the transitory components of both income and health, resulting in a covariance between the two. The results from this alternative approach show that the variances of the underlying shocks are almost indistinguishable from the variances of our transitory components, and that, more generally, relaxing this assumption changes our results very little.

The magnitude of the covariance between the permanent shocks is similar to that of the covariance between the transitory shocks (although because variance of the permanent shocks is smaller, in relative terms, the covariance between permanent shocks could be more important), and its estimate is not statistically significant. Note that our identification strategy would be robust to this covariance being non-zero.

Unlike in the case of income shocks, lower-wealth households face higher variances of both transitory and permanent health shocks. The variance of the transitory health shocks is twice as large among lower-wealth households than among higher-wealth households, at 0.033 versus 0.017. Permanent health risk is also larger among lower-wealth households than among higher-wealth households.

Thus, Table 3 and the right-hand-side graph of Figure 4 shows that lower-wealth households are less healthy than higher-wealth households and experience more health fluctuations, both transitory and permanent. These results are not inconsistent with our assumption that the stock of health carried by an older person is in large part determined by its past life events: people who arrive in old age with lower wealth likely had less means and time (and possibly had parents with less means and time) to build their health stock earlier in life.

Here too, we do not need to assume that the shocks are normally distributed, but we estimate the third and fourth moments of the distribution of the transitory income shocks because it is interesting. The point estimate of the third moment is zero and not significant, suggesting the distribution is not substantially skewed. The fourth moment is large and significant, and the point estimate is more than five times what a normal distribution would imply, suggesting the distribution has fat tails. Online Appendix C, section "Skewness and kurtosis of the shocks" presents these additional results. It is also worthwhile noticing that, because shocks are centered around zero, some people are subject to positive health shock. However, because these are shocks to detrended health, a positive health shock is best interpreted not as an actual increase in health, but as health not deteriorating as fast as its trend would predict, either permanently or temporarily.

Change in health index	Coefficient	Standard deviation
Diff. walk several blocks - head	-.201***	(.016)
Diff. walk one black - head	-.053**	(.022)
Diff. sit two hours - head	-.032*	(.016)
Diff. get up from chair - head	-.009	(.015)
Diff. climb several fleet stair - head	-.056***	(.011)
Diff. climb one flight stair - head	-.103***	(.017)
Diff. climb stoop/kneel/crouch - head	-.049***	(.013)
Diff. lift/carry 10 lbs - head	-.066***	(.016)
Diff. pick up a dime - head	.007	(.027)
Diff. extend arms - head	-.003	(.019)
Diff. push/pull large obj. - head	-.119***	(.013)
Diff. walk several blocks - spouse	-.145***	(.024)
Diff. walk one black - spouse	-.097**	(.034)
Diff. sit two hours - spouse	-.054**	(.021)
Diff. get up from chair - spouse	-.035*	(.021)
Diff. climb several fleet stair -spouse	-.077***	(.016)
Diff. climb one flight stair - spouse	.032	(.024)
Diff. climb stoop/kneel/crouch - spouse	-.036**	(.018)
Diff. lift/carry 10 lbs - spouse	-.019	(.019)
Diff. pick up a dime - spouse	.014	(.043)
Diff. extend arms - spouse	-.085***	(.027)
Diff. push/pull large obj. - spouse	-.051***	(.016)
Observations	3,261	

Table 4: Temporary health changes and the health index.

To further investigate the determinants of a change in our health index, Table 4 presents the results from a regression of our detrended health index over changes in the reported difficulty to perform instrumental activities of daily living.[13] As we would expect, the results show that all kinds of difficulties have either a negative and significant impact on our health index or an insignificant one, but no positive and significant impact. In terms of magnitudes, the first line, for instance, indicates that if the household head reports a decreased ability to walk for several blocks (from this activity being "not at all difficult" to "very difficult/can't do"), everything else being equal, its health index decreases by 0.201 (statistically significant at the 1% level), which is a bit more than one standard deviation of a transitory health shock. The

[13]The way we obtain Table 4 is by regressing changes in the health index, over changes in the reported difficulties in instrumental activities of daily living. We thus select households for whom difficulties are observed at two consecutive periods. In the absence of spouse, the changes to the spouse variables are set to zero.

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.127***	.202**	.115***	.173**	.306**	.112
	(.036)	(.1)	(.038)	(.088)	(.132)	(.114)
Medical exp. ϕ_m^ε	.132	.234	.114	-.493**	-1.171***	-.177
	(.102)	(.288)	(.107)	(.232)	(.364)	(.286)
Obs.	4999	970	4029	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 5: Pass through estimates.

coefficients of the spouse are of similar magnitude and significance as those of the head.

6 Estimated pass-through and their decomposition

How do non-durable consumption and out-of-pocket medical expenses respond to temporary shocks in income and health? The first row of Table 5 reports the effects of transitory income and health shocks on non-durable consumption, while the second row displays their effect on out-of-pocket medical expenses.

Transitory income shocks imply significant changes in consumption. In particular, the average pass-through coefficient of income shocks to non-durable consumption is 0.127, significant at the 1% level. Hence, a 10% transitory decrease in current income leads to a 1.27% decrease in non-durable consumption (and vice-versa for an increase). This estimate implies that a one hundred dollar decrease in income reduces non-medical consumption by 6.45 dollars at the average levels of income and consumption.[14]

The response of consumption among lower-wealth households is more than twice as large than for all households (0.202) and is statistically significant at the 5% level. This suggests that poorer households find it more difficult to self-insure against transitory income shocks. Perhaps surprisingly, even the consumption of higher-

[14]One can translate our pass-through coefficient $\frac{dln(c_t)}{dln(y_t)}$, which is an elasticity, into the change in the level of consumption that is implied by a change in the level of income $\frac{dc_t}{dy_t}$. We can do so by using that $\frac{dc_t}{dy_t} = \frac{dln(c_t)}{dln(y_t)}\frac{c_t}{y_t}$. At the average levels of income and consumption in our sample, this corresponds to $\frac{dc_t}{dy_t} = 0.127\frac{24{,}279}{47{,}825} = 0.0645$.

wealth households responds to transitory income shocks. Their pass-through is 0.115 and it is statistically significant. Further disaggregating households in this group into those with low-liquid wealth (or "hand-to-mouth") and those with high-liquid wealth reveals that the pass through is largest (0.232) and significant at the 1% level for the former group, but much smaller (0.070) and only significant at the 10% level for the latter group (see online Appendix F).

While transitory income shocks have statistically insignificant effects on out-of-pocket medical expenses, their pass-through coefficient is 0.132, which is not very different from that of consumption. But because the level of out-of-pocket medical expenses is small, a pass-through coefficient of this magnitude implies only small fluctuations in the level of medical expenses—and substantially smaller than the consumption fluctuations implied by a pass-through of the same magnitude. More specifically, because average out-of-pocket medical expenses are 10% of total consumption, our estimates imply that a one hundred dollar decrease in income lowers non-medical consumption by 6.45 dollars but reduces medical expenses by only 0.66 dollars at average income, consumption, and medical expenses.[15] This is important because it is the change in the level of medical expenses that matters for our identification strategy of the channels decomposition (we set this change to zero in our baseline case, although we relax this assumption in online Appendix D).

Our pass through estimates of income to medical expenses are also not statistically significant within the groups of lower- and higher-wealth households. Again, the point estimates are not very different from those of consumption, but because the level of out-of-pocket medical expenses is small in both groups (and smaller among lower-wealth households, at $2,515 compared with $3,024 for all households as given in online Appendix B, Table 14), the change in the level of medical expenses generated by a change in income is small for these two groups as well.

Transitory health shocks also imply significant changes in consumption. The right-hand-side panel of the top row of Table 5 shows that the point estimate of this pass-through is 0.173, statistically significant at the 5% level. This means that a 0.1 transitory decrease in our health index generates a 1.73% decrease in consumption, that is, a $420 decrease for a household with the average consumption. A one-standard

[15] The computation of the change in the level of medical expenses is similar to that of consumption. At the average levels of income and medical expenses in our sample, this corresponds to $\frac{dm_t}{dy_t} = 0.127 \frac{2{,}515}{47{,}825} = 0.0066$.

deviation decrease in health, that is, a 0.141 decrease, implies a $0.173 \times 0.141 = 2.4\%$ decrease in consumption, that is, a \$592 decrease for a household with the average consumption level.

The breakdown by wealth shows that, among the lower-wealth households, the pass-through of transitory health shocks to consumption (0.306) is almost twice as large as in our overall sample. In this group, a one standard deviation transitory decrease in health, that is, a 0.182 decrease, is associated with a $0.306 \times 0.182 = 5.6\%$ decrease in non-durable consumption. Among the higher-wealth households, the point estimate of the health pass-through is not significant.

Transitory health shocks imply significant changes in medical expenses. The right-hand-side panel of the bottom row of Table 5 shows that the pass-through of transitory health changes to medical expenses is negative, large (-0.493), and statistically significant at the 5% level. This means that a 0.1 decrease in our health index generates a 4.93% increase in medical expenses. At the average medical expenses level of $\$3,024$, this corresponds to a $0.1 \times 0.493 \times \$3,024 = \$149$ increase in medical expenses. A transitory decrease in health by one standard deviation, that is, a 0.141 decrease, is associated with a $0.493 \times 0.141 = 7.0\%$ increase in medical expenses, which corresponds to a \$210 increase at their average level.

Importantly, we find that the effect of transitory health shocks on medical expenses is heterogeneous by wealth. The average pass through coefficient is more than twice as large (-1.171) and statistically significant at the 1% level among lower-wealth households than in the whole sample. Because their average medical spending is $\$2,515$, their medical expenses change by $0.1 \times 1.171 \times 2,515 = \$295$ when the health index changes by 0.1, twice as much as in the whole sample. A one standard deviation decrease in health, that is, a 0.182 decrease, is associated with a $1.171 \times 0.182 = 21.3\%$ increase in medical expenses, which corresponds to a \$536 increase at their average level.

Among higher-wealth households, this effects is much lower (-0.177) and not statistically significant, even at the 10% level. This finding is consistent with the fact that lower-wealth households, on average, spend only half as much in medical insurance than higher-wealth households, even after removing the effect of demographics.[16] This suggests that, despite Medicare, the medical expenses of people with less pri-

[16] The net expense in medical insurance is on average 1,698 (2015 \$) among older lower-wealth households and 2,914 (2015 \$) among older higher wealth. See online Appendix B, Table 14).

vate insurance are less insured against transitory health shocks: their out-of-pocket medical expenses increase with a temporary decline in their health.

The observation that medical expenses are little impacted by transitory income shocks but do respond to transitory health shocks suggests that most people tend to be close to satiation in their consumption of medical goods and services but that this satiation point varies with their health. The presence of Medicare is likely important in generating this result because it tends to make the level of extra out-of-pocket expenses required to stay at one's satiation point relatively small. As a result, even lower-wealth households with less private insurance can afford to stay close to their medical consumption satiation point, even if, for them, a health shock implies a significant change in resources.

Marital status. In online Appendix G, we also break down our sample in two subsamples: that of single households (2,255) and that of couples (2,744). Separately looking at couples and singles is interesting because being in a couple is both a source of risks (the health and resource risks of one's partner) and insurance (pooling risks, economies of scale, and potentially being able to help each other in case of sickness). The point estimates of the pass-through coefficients for income shocks to consumption are 0.143 for singles and 0.113 for couples. Those for health shocks are 0.183 for singles and 0.160 for couples. This is consistent with couples' consumption being less affected by transitory income and health shocks. However, breaking down the sample reduces statistical power. As a result, the differences between the coefficients of couples and singles are not statistically significant. In line with the results in our overall sample, the pass-through of income to medical expenses are small and not significant for both singles and couples. Finally, the pass-through of health shocks to medical expenses is -0.342 for singles and -0.704 for couples, which indicates that couples react to transitory health shocks by spending more in medical goods and services compared with singles. The coefficient for couples is significant but the estimates for singles and couples are not statically different. We report these results in online Appendix G.

Robustness. In our baseline framework, we assume that income shocks are discrete events occurring at the same time every year,[17] that there is no measurement error in income and health, that people do not anticipate future health shocks, and that there

[17]We do not need to make this assumption about health shocks, which we compute by comparing the stocks of health at two points in time. In contrast, income is a flow that we observe every other year, so we need an assumption about the point in time when a change in the flow occurs to determine the magnitude of the change from the difference in yearly flow.

is a complete overlap between the consumption and health periods of observation. Relaxing the first three of these assumptions would lead to a modest downward bias in our pass-through estimates, while the effects of the fourth one is ambiguous (See online Appendix J).

Comparison with existing estimates. There is a large literature that relies on natural experiments to measure the effects of transitory income shocks on consumption. It suggests that, among working age households, the average marginal propensity to consume (MPC) is around 0.25 over the next quarter (see e.g. the review by Kaplan and Violante 2018). Few of these studies examine the behavior of people in old age, but age seems to be negatively associated with the MPC (sometimes weakly): using lottery wins, Fagereng, Holm, and Natvik 2018 find that, while the average MPC of total—not just nondurable—consumption out of a lottery win is 0.59 over the next year, it drops to 0.44 among people above age 63 and that the difference between the two is significant. Johnson, Parker, and Souleles 2006 and Parker, Souleles, Johnson, and McClelland 2013, exploit the 2001 and 2008 tax rebates and break down the sample into different age categories but find no significant differences.

Commault (2022) focuses on the comparison between the pass-through estimates obtained with semi-structural methods and the MPCs obtained from natural experiments. She shows that the robust semi-structural methods that we use here yield results that are consistent with those from natural experiments, but that one needs to be careful when comparing results from studies in which the data are measured at different frequencies—for instance quarterly in the natural experiments, and biennial in our case. In particular, the pass-through estimated on biennial data turns out to be smaller than the one from annual data. Commault (2022) also shows that the biennial pass-through is 0.125 in the more recent waves of the Panel Study of Income Dynamics (PSID) and among working age households. Our finding of a pass-through of transitory income shocks to consumption is based on the robust estimator. It yields a pass-through of 0.127 which is thus close to the one estimated from the PSID.

Our findings thus show that temporary changes in income and health affect consumption in old age but do not address our main question: to what extent do consumption fluctuations later in life reflect lack of insurance against fluctuations in one's resources as opposed to fluctuations in one's needs to consume? We now turn to these results.

Decomposing the impact between marginal utility and resources. Table

6 reports the results of the decomposition of the pass-through of transitory health shocks to consumption into the two channels that compose it in our structural model. Over our whole sample, the contribution of the resources channel is significant at the 10% level but its point estimate is only 0.003. This means that, if health and medical expenses had no effect on the marginal utility of consumption, the pass-through of a transitory health shock to consumption would be 0.003 instead of 0.173, that is only 1.7% of its actual value.

More precisely, equation (29) shows that the resources channel comprises the product of the change in medical expenses caused by a transitory health shock and a multiplier parameter. This multiplier determines how much larger (or smaller) is the pass-through of a shock when this shock increases (or decreases) resources by an extra dollar. We compute the changes in medical expenses caused by a transitory health shock as the product of the average pass-through of a health shock to medical expenses times their average amount. Our estimates show that both terms are significant: the change in medical expenses caused by a one unit transitory health shock has a point estimate of \$-1,118, and the multiplier has a point estimate of $3.093e^{-6}$.

The rest of the pass-through is explained by the marginal utility channel, which is significant at the 10% level as well. If a transitory health shock had no impact on the budget constraint but still influenced the utility function (through both changes in health and in medical goods and services consumed), the pass-through of a transitory health shock to consumption would be 0.170, very close to its true value of 0.173.

Among lower-wealth households, the overall pass-through coefficient is larger than in the whole sample, with a point estimate of 0.306. The decomposition shows that this comes from both the resources and the marginal utility channels being larger. The contribution of resources is 0.018, significant at the 10% level (despite the small sample size), and six times as large as in the whole sample. This resources channel is larger for two reasons: first, among lower-wealth households a one unit decrease in health raises medical expenses by more (\$2,137 instead of \$1,118 in the whole sample).[18] Second, among lower-wealth households, a given dollar decrease in resources is passed on more strongly to consumption so the multiplier is larger. The result

[18]As shown in the formal expressions, we use non-deflated medical expenses in this analysis to account for changes in the price of medical expenses over time: if for instance our pass-through estimate implies that a given health generates an increase in real medical expenses of one box of pills, the resources effect of that health shock is incorrectly measured as larger if we use deflated values and convert the price of the box of pills in 2015\$, the year when drugs are more expensive.

	All	Lower wealth	Higher wealth
Consumption ϕ_c^h	.173**	.306**	.112
	(.088)	(.132)	(.114)
Resources channel	.003*	.018*	.001
	(.002)	(.011)	(.002)
Change in med. exp. $-\phi_m^h E[mp_m]$	-1117.91**	-2137.017***	-420.397
	(528.194)	(690.707)	(679.599)
Multiplier $f_3^c\|_0$ (10^{-6})	3.093***	8.382**	2.53***
	(.874)	(4.12)	(.84)
Marginal utility channel $f_1^c \frac{dm_t}{d\varepsilon_t^h} + f_2^c$	.17*	.288**	.111
	(.088)	(.132)	(.114)
Obs.	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 6: Decomposition.

is that, among lower-wealth households, the resources channel explains 5.9% of the overall pass-through, versus 1.7% in the whole sample. The marginal utility channel contributes the remaining 94.1%. If this channel was the only one at play, the pass-through coefficient would be 0.288, significant at the 5% level. The converse holds true for higher-wealth households for whom both channels are smaller than in the whole sample. Among higher-wealth households, the overall pass-through coefficient is not statistically significant, although its point estimate is substantial, at 0.112. The contribution of both the resources channel and the marginal utility channel are weaker.

Why is the magnitude of the marginal utility channel different between lower and higher-wealth households? The contribution of the marginal utility channel can vary across households (e.g. by wealth) even when they have the same marginal utility function, if their consumption levels are different. Indeed, a shift in utility does not affect consumption uniformly along the marginal utility function. For instance, if consumption is close to a satiation point, a multiplicative shift in the ability to derive utility from consumption is not going to affect consumption too much, because consumption might remain close to its satiation point even after the value of consuming today has decreased. In contrast, before that satiation point is reached, there can be consumption levels around which a shift in marginal utility will strongly shift one's consumption decision. We graphically illustrate this point in online Appendix H.

The observation that the contribution of the marginal utility channel is larger among lower-wealth households could thus be due to their consumption being on a portion of the marginal utility where it is more sensitive to shifts in marginal utility.

7 Estimated pass-through coefficients and their decomposition for finer spending categories

We write our model in terms of total consumption and medical expenses because this formulation relates to many previous studies and provides an important benchmark. Given the richness of our data we are also able to examine more disaggregated consumption and medical expense categories which provides further insights.

To estimate the pass-through of the shocks to these disaggregated categories, we do not make further assumptions: as for the pass-through to consumption and medical expenses, we only need income and health to be transitory-permanent processes and their future shocks not to be anticipated. To decompose these pass-through coefficients, the underlying model is very similar to that in Section 2, except that households now derive utility from N different categories of goods: $c_t^n, n = 1, .., N$. This alternative formulation yields very similar decomposition expressions.

Table 7 reports the effects of transitory income and health shocks on consumption and medical expenses at different levels of disaggregation. Its top left-hand-side panel displays that in our overall sample, as we have seen in the previous section, non-durable consumption responds significantly to a transitory income shock and the point estimate of the pass-through is 0.127. The break down by necessities and luxuries reveals that the pass-through to the two categories are of similar magnitude (0.109 and 0.110). Going one level of disaggregation further, necessities, food (at home and away from home), utilities and car-related expenses (car insurance, repairs and gasoline) have similar pass-through coefficients but only the response of utilities and car-related expenses remain significant. Within luxuries, the pass-through on leisure activities (spending on trips, hobbies and sports equipment) is large (0.219) and significant at the 1% level, but the pass-through to expenses on equipment (clothing, personal care, house and garden supplies and services) is small and not significant.

The breakdown of the responses by wealth reveals that the categories of disaggregated consumption that respond the most to a transitory income shocks are different

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.127***	.202**	.115***	.173**	.306**	.112
	(.036)	(.1)	(.038)	(.088)	(.132)	(.114)
Necessities	.109***	.314***	.075*	.076	.344***	-.046
	(.038)	(.111)	(.04)	(.09)	(.141)	(.112)
Food	.09	.425**	.033	.045	.697***	-.259
	(.062)	(.183)	(.065)	(.152)	(.266)	(.183)
Utilities	.099*	.223*	.077	.044	-.127	.125
	(.053)	(.128)	(.057)	(.128)	(.191)	(.165)
Car-related	.098**	.248**	.073	.285***	.58***	.147
	(.046)	(.125)	(.05)	(.117)	(.184)	(.148)
Luxuries	.11*	-.186	.16**	.366***	.206	.438**
	(.063)	(.178)	(.066)	(.15)	(.22)	(.193)
Leisure activities	.219***	-.19	.29***	.426*	.18	.536*
	(.091)	(.333)	(.086)	(.231)	(.372)	(.282)
Equipment	.023	-.297*	.077	.401***	.115	.536***
	(.068)	(.175)	(.073)	(.159)	(.228)	(.203)
Medical exp. ϕ_m^ε	.132	.234	.114	-.493**	-1.171***	-.177
	(.102)	(.288)	(.107)	(.232)	(.364)	(.286)
Drugs	.063	.134	.05	-.619***	-.936**	-.472
	(.109)	(.285)	(.117)	(.248)	(.409)	(.304)
Med. serv. & suppliest	-.021	-.024	-.022	.098	-.173	.222
	(.144)	(.403)	(.152)	(.343)	(.524)	(.433)
Obs.	4994	966	4028	4994	966	4028

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 7: Pass through estimates.

among lower- and higher-wealth households. For lower-wealth households, spending increases more on necessities, which are food, utilities, and car maintenance. For higher-wealth households, spending increases more on leisure activities. One interpretation is that lower-wealth households are not satiated in their consumption of necessities and thus adjust it when transitory income fluctuations hit, while higher-wealth households are satiated in their consumption of necessities but not in their consumption of luxuries.

Turning to the effect of an income shock on medical expenses, the bottom left-hand-side panel of Table 7 shows that there are no statistically significant effects of a transitory income shock on any medical expense subcategory. This also holds when we split the response by wealth.

The right-hand-side panel of Table 7 reports the effects of a transitory health shock on consumption (top panel) and medical expenses (bottom panel). As we have seen in the previous section, in our overall sample, non-durable consumption responds significantly to a transitory health shock and the point estimate of the pass-through is 0.173. The goods categories breakdown reveals that these effects come from the response of luxuries (their pass-through is 0.366 and significant) rather than of necessities (their pass-through is 0.076 and not significant). Going one level of disaggregation further, among luxuries, both leisure activities and equipment respond. Among necessities, car-related expenses respond.

The breakdown by wealth reveals that, among those with lower wealth, necessities respond more than in the whole sample, but that it is unclear how luxuries respond since both the pass-through estimate and its standard error are large. Among higher-wealth households, necessities do not respond (the pass-through are small and not significant), while leisure activities and equipment respond strongly and significantly (their point estimates are both equal to 0.536).

The bottom-right-hand side of Table 7 reports the response of out-of-pocket medical spending to a transitory health shock. As we saw in the previous section, the pass-through of adverse transitory changes in health to medical expenses is negative and large, at -0.493. Breaking down the effects of a health shock on the components of medical expenses shows that it is the drugs category that significantly responds to transitory health shocks and drives the overall response of medical expenses.

Table 29 in online Appendix K reports the decomposition of the effects coming from marginal utility and resources for our disaggregation by necessities and luxuries. In our overall sample, we find a small and insignificant impact of temporary health shocks on the consumption of necessities. Neither the resources not the marginal utility channel are significant—although some components of the resources channel are. Both the resource channel and marginal utility channel are larger among lower-wealth households, but they are either not significant or barely significant.

For the pass-through to luxuries, which is statistically significant and large (0.366) for our overall sample, the resources channel contributes very little to this pass-through, at 0.001. This means that a change in future resources plays no role in the response of the consumption of luxuries. The shift in marginal utility plays a very large role, as it contributes 0.365 out of the 0.366 pass-through coefficient, significant at the 1% level. Among lower-wealth households, the overall pass-through to luxuries is quite large but with a large standard-deviation, and neither the resources channel nor the marginal utility channels are significant. Among higher-wealth households, the consumption of luxuries respond significantly to temporary health shocks, and the response is also almost entirely driven by the marginal utility channel. Its contribution is 0.434, that is, 99.1% of the overall coefficient. This is consistent with a scenario in which higher-wealth households are close to satiation in necessities but not in luxuries, hence a shift in their ability to derive utility from luxuries has a large impact on their consumption of these goods.

Health and demand system estimation. Previous literature has studied how demand shares change with total expenses and demographics (see for example Banks, Blundell, and Lewbel (1997)). In this section, we generalize the well-established tool of estimating demand systems to include health. We do so by estimating a demand system that captures how different commodities are affected by both health status and total expenditure.

This approach complements our main results by focusing on the impact of resources and health on within period allocations. As we condition on total resources and the health status variable, we do not distinguish between the impact of transitory and permanent shocks to health or resources. Because it is a within period analysis, it ignores any reallocation from current to future consumption when the marginal utility of current consumption decreases. Also, by construction, it does not tell us by how much total consumption changes with health because total resources are kept constant and we only study the allocation among goods. In estimation we specify a functional form for the budget shares. See online Appendix I for more details.

	Food	Utilities	Car	Leisure	Equipment
Budget shares	0.271 ***	0.232 ***	0.159 ***	0.208 ***	0.131 ***
	(0.007)	(0.006)	(0.005)	(0.007)	(0.005)
Budget elasticities	0.777 ***	0.577 ***	0.797 ***	1.864 ***	1.086 ***
	(0.023)	(0.027)	(0.030)	(0.033)	(0.035)
Health elasticities					
Whole sample	-0.117 ***	-0.091 ***	0.104 ***	0.324 ***	-0.235 **
	(0.025)	(0.029)	(0.032)	(0.035)	(0.038)
Lower wealth	-0.121 ***	-0.096 ***	0.200 ***	0.488 ***	-0.203 ***
	(0.023)	(0.027)	(0.033)	(0.067)	(0.041)
Higher wealth	-0.107 ***	-0.207 ***	0.058	0.345 ***	-0.084 ***
	(0.027)	(0.031)	(0.033)	(0.034)	(0.039)

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 8: Budget and health elasticities, for disaggregated categories.

Table 8 reports the budget and health elasticities for our five-commodities demand system. Its top line shows that, on average, food expenses compose 27% of the budget, utilities 23%, car maintenance 16%, leisure 21%, and equipment the remaining 13%. The budget elasticities of the items that we group into necessities (food, utilities and car expenses) are all lower than one, while leisure and equipment, which we group into luxuries, display budget elasticities above one. Hence, our grouping and variable labeling is supported by the data.[19]

The estimated elasticities of demand to health status reveal that an improvement in health does have a differential impact on the marginal utility of different consumption goods since it shifts the budget shares in favor of certain goods and in disfavor of others. This also confirms the non-separability between the disaggregated consumption goods and health. On average, an increase in health has its biggest positive impact on leisure expenses, and its effect is also positive for car maintenance. The health elasticities of other goods are negative.

In online Appendix G, we report estimates of the demand system when breaking down the sample between the households composed of single individuals and those

[19] We also further disaggregate food expenses into food at home and food away, and find that while food at home is a necessity, and has a budget elasticity of 0.6, food away from home is a luxury, and has an estimated budget elasticity of 1.3. However, because food away from home makes up for only 6.7% of the budget for nondurables, and its reaction to health changes is on average zero, we do not disaggregate further to keep the analysis simple.

composed of couples. Singles have in general higher budget elasticities than couples (except for the one on equipment). Their health elasticities are higher, in absolute value, for food and car-related expenses (which are linked to activities that can be easier to be undertaken by one's partner when in a couple).

8 Going from positive to normative implications

We have so far performed a positive analysis, that is, we have measured the magnitude of the shocks that people face, and how and why they react to these shocks, given the insurance system that is already in place. In this section, we turn to a normative analysis and use our findings to study the social planner problem for the household that we described in Section 2.

The social planner optimally allocates consumption and out-of-pocket medical expenses to households, subject to a resource constraint. This formulation is equivalent to letting the planner allocate consumption and total medical expenses (that is, including both out-of-pocket and insured medical expenses), but we find it convenient to solve the problem in terms of what households optimize over in the decentralized economy.

The implications of the presence of transitory income shocks for insurance are straightforward. A social planner using a utilitarian welfare function would completely offset the effect of the shock and allocate the same consumption and medical expenses to people, whether they are hit or not by an income shock.

Now, we want to know how the consumption of someone experiencing a negative transitory health shock changes in a planned economy. Health shocks are different because we established that negative transitory health shocks come with two effects: an increase in the marginal utility of medical expenses (which can lead to an increase in medical expenses thus a decrease in the resources available for consumption in a decentralized economy), and a decrease in the marginal utility of consumption. Let us focus on period t and assume that a negative transitory health shock lowers health below its current value, to $h_t^- = h_t - \Delta h_t$. Following the literature on consumption insurance (for instance, Cochrane 1991 and Attanasio and Davis 1996), the optimal allocation coming from a social planner using a utilitarian welfare function implies that the marginal utility of consumption in the two states is the same

$$u_c(c_t, \tilde{m}_t, h_t) = u_c(c_t + \Delta c_t, \tilde{m}_t + \Delta m_t, h_t - \Delta h_t), \tag{32}$$

where Δc_t and $\Delta \tilde{m}_t$ are the differences in consumption and medical expenses between the bad and normal health states. Taking an approximation of the left hand side of the above expression around the point where $\Delta c_t = 0$, $\Delta \tilde{m}_t = 0$ and $\Delta h_t = 0$, we can write the optimal difference in consumption across health states

$$\begin{aligned} u_c(c_t, \tilde{m}_t, h_t) &\approx u_c(c_t, \tilde{m}_t, h_t) + u^t_{cc}\Delta c_t + u^t_{c\tilde{m}}\Delta \tilde{m}_t - u^t_{ch}\Delta h_t \\ \Delta c_t &\approx \frac{-1}{u^t_{cc}}\big(u^t_{c\tilde{m}}\Delta \tilde{m}_t - u^t_{ch}\Delta h_t\big), \end{aligned} \tag{33}$$

where $u^t_{c\tilde{m}} = u_{c\tilde{m}}(c_t, \tilde{m}_t, h_t)$, $u^t_{ch} = u_{ch}(c_t, \tilde{m}_t, h_t)$ and $u^t_{cc} = u_{cc}(c_t, \tilde{m}_t, h_t)$ are the partial derivatives of $u(c_t, \tilde{m}_t, h_t)$.

Equation (33) states that the optimal change in consumption resulting from a negative transitory health shock depends on the extent to which the negative health shock decreases the marginal utility of consumption (measured by the product of the size of the health loss $-\Delta h_t$ and the effect of health on the marginal utility of consumption u^t_{ch}), and on the extent to which the change in medical expenses already compensates this loss in marginal utility (measured by the product of the extra medical expenses received in the bad health state $\Delta \tilde{m}_t$ and the effect of medical expenses on the marginal utility of consumption $u^t_{c\tilde{m}}$).

We thus consider two subcases. The first, in which there is separability in the utility of consumption and of medical expenses conditional on health ($u^t_{c\tilde{m}} = 0$ and $u^t_{ch} \neq 0$), we use to set out the main ideas. The second, which is our preferred case, allows for non-separability in the utility of consumption, health, and medical expenses ($u^t_{c\tilde{m}} \neq 0$ and $u^t_{ch} \neq 0$).

Separability in the utility of consumption and of medical expenses. Because $u^t_{c\tilde{m}} = 0$, we are left with

$$\Delta c_t \approx \frac{-1}{u^t_{cc}} u^t_{ch}(-\Delta h_t). \tag{34}$$

We show in online Appendix L that the contribution of marginal utility (MU) to the pass-through of transitory health to consumption when $u^t_{c\tilde{m}} = 0$ is given by

$$\text{MU}_t = \left(u^t_{ch}\right)\frac{-1}{c_t\vartheta_t}, \tag{35}$$

where $\vartheta_t = E_t[\frac{1}{p_{t+1}}(c_a^{t+1}u_{cc}^{t+1})\tilde{s}_{t+1}R_{t+1}]$ has the same sign as $u_{cc} < 0$. Table 6 shows that MU $= 0.17 > 0$, which implies $u^t_{ch} > 0$.

Plugging this implication in expression (34), we find that the planner allocates less consumption to those experiencing a negative transitory health shock

$$\Delta c_t \approx \underbrace{\frac{-1}{u^t_{cc}}}_{>0}\underbrace{u^t_{ch}}_{>0}\underbrace{(-\Delta h_t)}_{<0} < 0. \tag{34}$$

Intuitively, everything else being equal, people going through a negative transitory health shock derive less enjoyment from an extra unit of resources and it is thus optimal that they consume less.

While this type of insurance might seem counterintuitive, the rationale is the same as insuring unexpected life expectancy by providing more consumption to people who live longer than they expected: although people prefer to have a long life than a short one, they are happy to enter an insurance scheme giving them more total consumption if their life is long rather than short. Here, although people prefer to live their life in good health—with a high ability to enjoy consumption—than in bad health, they are happy to enter an insurance scheme giving them more consumption when their health state is good.

Our finding that a decrease in health raises out-of-pocket medical expenses, while income changes do not affect them, implies that the response of medical expenses to health is driven by a shift in their marginal utility (rather than from a change in resources coming from a reduction in consumption goods and services). Hence, a utilitarian benevolent social planner would allocate more medical expenses to those experiencing a negative transitory health shock.

As a result, a utilitarian benevolent planner allocates less non-medical consumption and more medical expenses to households in bad health, and more consumption but less medical expenses to households in good health. By doing so, it provides insurance against the risk of not having enough resources to pay for medical expenses while in bad health and the risk of not having as much resources as one would like to consume while in good health.

Relaxing additive separability in the utility of consumption and medical expenses. In this case, an increase in medical expenses can raise the marginal utility of consumption. It is then possible for the planner to use extra medical expenses to partly compensate for the loss in marginal utility of consumption caused by a negative health shock.

Given that we find that most people are at their out-of-pocket medical expenses satiation point—which is hence attainable given available resources—the planner should optimally give households in both the normal and bad health states their satiation level of medical expenses.[20] Hence, the planner should allocate to people experiencing a negative transitory health shock an amount of extra medical expenses equal to the extra amount we estimate they consume in the decentralized economy: $\Delta\tilde{m}_t \approx (d\tilde{m}_t/d\varepsilon_t^h)(-\Delta h_t)$. Plugging this into the expression of optimal consumption change (33), we have

$$\Delta c_t \approx \frac{-1}{u_{cc}^t}\left(\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t + u_{ch}^t\right)(-\Delta h_t). \tag{36}$$

Now, the same term $\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t + u_{ch}^t$ appears in the expression of the contribution of marginal utility to the pass-through of health shocks to consumption that we derive in online Appendix L

$$\text{MU}_t = \left(\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t + u_{ch}^t\right)\frac{-1}{c_t\vartheta_t}, \tag{37}$$

where $\vartheta_t = E_t[\frac{1}{p_{t+1}}(c_a^{t+1}u_{cc}^{t+1} + \tilde{m}_a^{t+1}u_{c\tilde{m}}^{t+1})\tilde{s}_{t+1}R_{t+1}]$ takes the same sign as $u_{cc} < 0$ (because the effect of wealth a on medical expenses $\tilde{m}_a^{t+1}$ is zero, as discussed in online Appendix L). Our empirical finding that MU > 0 then implies that:

$$\left(\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t + u_{ch}^t\right) > 0. \tag{38}$$

In other words, our finding that the marginal utility channel is positive implies that

[20] Indeed, giving more would be inefficient, and giving less than this point in either the normal or bad health state in order to give people more consumption in either the normal or bad health state would violate people's revealed preference that they like to remain close to their satiation point of out-of-pocket medical expenses (even lower-wealth people do).

the increase in medical expenses people get does not fully compensate the decrease in marginal utility that they experience when their health drops. Otherwise, the marginal utility channel would be zero.

Plugging this implication in expression (36), we find again that the planner optimally allocates less consumption to those experiencing a negative transitory health shock

$$\Delta c_t \approx \underbrace{\frac{-1}{u^t_{cc}}}_{>0} \underbrace{\left(\frac{dm_t}{d\varepsilon^h_t} \tilde{m}'(m_t) u^t_{c\tilde{m}} + u^t_{ch} \right)}_{>0} \underbrace{(-\Delta h_t)}_{<0} < 0. \tag{36}$$

Intuitively, even if the loss in marginal utility of consumption is being partly compensated by the extra medical expenses that people consume, people going through a negative transitory health shock still derive less utility from an extra unit of resources, so the planner optimally allocates less consumption to them.

As in the previous case, although the utilitarian planner allocates less consumption to those experiencing a negative transitory health shock, it also allocates them more medical goods and services. The reason why people in bad health state receive more medical expenses is still because they have a higher marginal utility of them and an attainable satiation point exists. However, in that case, there is an extra benefit of giving more in medical expenses to people in bad health, which is that it might partly offset the negative effect of bad health on the marginal utility of consumption.

As a result, our finding that optimal consumption is lower in bad health and higher in good health constitutes at the same time a new risk (a mismatch between one's consumption resources and one's marginal utility of them), and possibly a mitigating mechanism against the risk of increased out-of-pocket medical expenses, and thus reduced consumption resources while in bad health. We stress the importance of studying this force. Figuring out to what extent this affects the design of optimal health insurance and whether the current health insurance system is optimal requires a fully quantitative normative analysis. We discuss this in the concluding section below.

Note that our finding that the marginal utility of consumption decreases in bad health does not only have consequences for the utilitarian planner. Consider a benevolent planner solving a social welfare function which places more weight on people with lower utility levels. In this case our results can induce the planner to compensate more the people hit with a negative health shock because of their lowered ability to derive utility from consumption, and allocate them more consumption because of that.

9 Conclusions and directions for future research

We study the effects of income and health changes on people's consumption and medical expenses in old age and provide several interesting and novel findings. First, we show that transitory income and health shocks are prevalent in old age.

Second, we document the response of consumption to transitory income and health shocks. We find that, even during retirement, consumption responds to income shocks, which indicates that people's consumption is not perfectly insured against shocks to one's resources. This result complements previous work finding that consumption responds to income shocks at younger ages. In terms of the response of consumption to health shocks, we show that consumption significantly decreases with negative health shocks (and increases with positive health shocks). Our data analysis and the implications of a rich structural model allow us to show that the consumption response to negative health shocks mainly takes place because health shocks reduce one's marginal utility from consumption, rather than reducing resources. An important group for whom a health shock does have an effect on resources is that of lower-wealth households.

Third, we evaluate the response of medical expenses to transitory income and health shocks. Here we show that, out-of-pocket medical expenses do not respond to transitory income shocks in a statistically significant way. This suggests that, given the level of insurance provided by the current system after age 65, most people are close to being satiated in their consumption of out-of-pocket medical expenses—when people receive extra income, they do not increase their out-of-pocket medical expenses but they increase their consumption. In contrast, they increase with negative health shocks (and decrease with positive health shocks) in a statistically significant way. This indicates that this satiation point changes with health: people hit by a negative health shock increase their out-of-pocket medical spending.

From a normative standpoint, in the presence of shocks that affect people's resources, a benevolent planner using a utilitarian welfare function fully smooths out their effects and gives the same level of consumption to all, whether hit by a shock or not. In contrast, in the presence of shocks that reduce people's marginal utility, the risk that needs insuring is not a decrease in resources, but a mismatch between people's level of resources and their ability to enjoy them: people in better health than expected might not have enough resources to enjoy their good health, while people suffering from worse health than expected might not have the ability to take full advantage of the resources they accumulated. As a result, a benevolent planner insures shocks that affect people's utility by giving less consumption but more medical expenses in the states associated with increased utility of medical expenses and reduced marginal utility of consumption.

Deriving quantitative normative implications, such as the optimal quantitative compensation associated with a transitory health shock, requires estimating and identifying a structural model that allows for permanent and transitory income and health shocks, and for health to affect the marginal utility of consumption. More precisely, it requires taking a stand on all functional forms and parameter values of one's model. In contrast, this is avoided with our approach. We see a quantitative normative analysis as an important direction for future research, especially given that we find that bad health reduces one's marginal utility from consumption and this is a force that has largely been ignored in the normative literature.

Our analysis holds under general conditions, both about how health and income evolve during retirement, and about how people optimally choose their consumption and medical expenses in the presence of savings and health and income shocks. However, it does assume that health evolution is, at least at the margin, largely predetermined and exogenous during retirement. As we discuss in Section 2, this is a commonly made assumption that is also supported by much empirical evidence. Allowing health to depend on one's spending (and potentially effort), requires fully specifying and parameterizing all aspects of the model, and, very importantly, taking a stand on the health production function and its identification. Also, we do not model that consumption might be produced by using time and requiring good health (sick people might need more time to do the same things and this is why they consume less), which could be a way to further micro-found our findings. We see these as important directions for future research.

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Online Appendix A: The HRS and CAMS data

Our data comes from the Health and Retirement Study (HRS) and its Consumption and Activities Mail Survey (CAMS). The HRS is a longitudinal survey that is representative of U.S. household heads over the age of 50 and their spouses. The CAMS questionnaire is completed by a subset of HRS households every other year since 2001. The same households received the questionnaire in all subsequent waves.

We merge information from CAMS and HRS when they refer to the same household and to the same calendar year. This amounts to merging each CAMS wave to the subsequent HRS wave, because in the HRS income refers to the previous calendar year. In the CAMS, interviews are always conducted in September or October. In the HRS, households are interviewed between March of the regular interview year and March of the next year. This means that a fraction of households are interviewed in the year following the regular interview year. We drop these households with a late interview, because their income cannot be matched to the consumption year in CAMS. Note that, in most years, only about half percent of interviews were conducted in the following year among households interviewed in both CAMS and HRS—wave 10 is an exception, with a higher fraction of late interviews. After the death of a spouse, we consider the remaining single person as a new, different household. Our merged sample is biennial and covers the years 2001 to 2013.

Table 9 presents our sample selection. Combining information from the core interviews (that is the HRS) and from CAMS that refer to the same household and calendar year, we obtain a sample of 24,981 household-year observations. We then remove households whose head is above age 90 or below 50, and observations with missing demographic or health information. After this screening, we are left with 23,172 household-year observations. Of these, about 30% of observations have at least one missing item in consumption. For these, we impute consumption items as described later in this online Appendix. After imputing consumption items, we remove outliers. To do so, we first, we drop observations with non-durable consumption or household income less than 50$ (in 2015 prices) and then drop the top and bottom 1% of the change in log consumption, income, medical expenses, and of the level of wealth. After this cleaning, there were 30 observations with log income growth larger than 6, and we drop those too. We are left with 21,576 observations, 228 of which do not report health information and we thus drop them. Finally, we select households

Sample Selection	**Selected out**	**Selected in**
Answering to CAMS & HRS		24,981
Interview in subsequent year	1,014	23,967
Head's age less than 50 or more than 90	695	23,272
Missing demographic variables	100	23,172
Income, consumption, wealth or medical expense outliers	1,596	21,576
Missing health	228	21,348
Head's age less than 65	8,321	13,255
Medicaid recipient	1,266	11,826
First differencing data		8,124
Future health and income changes not observed	3,942	4,999

Table 9: Sample Selection, after merging to HRS main data.

whose head is 65 or above and who are not Medicaid recipients. Our final sample contains 11,826 observations. After taking first differences and dropping those observations whose future health or income change is not observed, we are left with 4,999 observations that are used in the estimation of the pass-through coefficients.

Since the questions about consumption items change a little in the first year of the CAMS, Table 10 lists which consumption items are observed in which year of the CAMS.

Year	2001	2003	2005-2013	Consumption	Med exp.
Utilities	Yes	Yes	Yes	Included	
Housekeeping Supplies	Combined	Yes	Yes	Combined	
Yard Supplies		Yes	Yes		
Housekeeping Services	n.a.	Yes	Yes	Included	
Gardening/Yard Services	n.a.	Yes	Yes	Included	
Clothing	Yes	Yes	Yes	Included	
Personal care	n.a.	Yes	Yes	Included	
Vacations - tickets	Yes	Yes	Yes	Included	
Hobbies	Combined	Yes	Yes	Combined	
Sports Equipment		Yes	Yes		
Contributions - gifts	Yes	Yes	Yes	Included	
Food/Drink Grocery	Yes	Yes	Yes	Included	
Dining Out	Yes	Yes	Yes	Included	
Health Insurance	Yes	Yes	Yes		Not included
Drugs	Yes	Yes	Yes		Included
Health Services	Yes	Yes	Yes		Included
Medical Supplies	Yes	Yes	Yes		Included
Auto Insurance	Yes	Yes	Yes	Included	
Vehicle Services	Yes	Yes	Yes	Included	
Gasoline	Yes	Yes	Yes	Included	

Table 10: Nondurable categories of consumption and medical expenses in CAMS. Not available (n.a.) items are imputed.

Table 11 shows that almost 70% of the consumption questionnaires were fully completed, 14% have 1 missing item, 5% have 2 missing items, and 9% have 4 or more missing items. Considering the missing patterns over time for the same household, 80-85% of missing values are missing for just one year, while 90-95% are missing for just one or two years for the same household. Hence, it is very unusual that the same household has many missing values over the years on the same item.

Number of missing items	year							
	2001	**2003**	**2005**	**2007**	**2009**	**2011**	**2013**	**Total**
0	66.9	68.3	67.6	70.8	70.9	70.8	71.2	69.5
1	14.6	14.9	14.8	12.9	15.5	14.2	12.1	14.1
2	5.4	5.1	4.6	4.5	4.4	4.6	4.1	4.7
3	2.6	2.7	3.1	2.3	2.7	2.6	2.0	2.6
4+	10.5	9.0	9.9	9.4	6.5	7.8	10.6	9.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 11: Percentage of households by number of missing items by year.

Imputation procedure

We impute each consumption item using fixed-effect regressions. To compute these fixed-effect regressions, we pool all years to estimate, for each item m, $Item^m = z\beta^m + f^m + \epsilon^m$, and compute $\widehat{Item}^m_{it} = z_{it}\hat{\beta}^m + \hat{f}^m_i$, for each household i and year t. We then use the estimated fixed effect to compute the prediction for the same household in a different time period s: $\widehat{Item}^m_{is} = z_{is}\hat{\beta}^m + \hat{f}^m_i$. If a household appears with a non-missing item only once, and no $\hat{f}^m_i$ can be estimated, we impute the missing items with a similar, year by year, OLS regression.

The explanatory variables used in the regressions are: dummies for age of the head, dummies for age of the spouse (if present), self-reported health status, self-reported health status interacted with education of the head, region of residence, region of residence interacted with education of the head, marital status (married, partnered, never married, separated, divorced), marital status interacted with education of the head, total household income (real), social security of the spouse (real), pension of the spouse (real), total household wealth (real), total household income interacted education of the head, total wealth interacted with education of the head and with year, price index for non-durable expenses, price index for the commodity to which the regression refers.

We impute each item separately and construct non-durable expenses as the sum of the relevant items with imputed values replacing missing values. The model predicts a small number of negative expenses amounts, that we set to zero.

Online Appendix B: Our variables and some facts about them

Consumption		
Necessities	Food	Food at home, food away from home
	Utilities	Electricity, water, heat, phone and internet
	Car-related	Car insurance, car repairs, gasoline
Luxuries	Leisure	Trips and vacations, tickets, sport equipment, hobbies equipment, contributions to charities, gifts
	Equipment	House supplies, house services, yard/garden supplies, yard/garden services, clothing, personal care equipment and services
Medical exp.		
	Drugs	Drugs
	Medical serv. and sup.	Medical services Medical supplies

Table 12: Consumption and medical expenses categories.

Non-durable consumption includes 21 items: electricity, water, heating, phone and house supplies, house and garden supplies and services, food, dining out, clothing, vacations, tickets, hobbies, sport equipment, contributions and gifts, personal care, auto insurance, vehicle services, and gasoline. Because the data on personal care, housekeeping services, and gardening services were not collected in 2001, we impute them for that year. The top panel of Table 12 lists these 21 items that we include in non-durable consumption and shows how we construct non-durable consumption subcategories by aggregating the original 21 categories. We deflate expenses on each item by its item-specific price index from the Bureau of Labor Statistics (BLS).

Food is the sum of expenses on food and beverages, including alcoholic, and dining and/or drinking out, and includes take out food.

Leisure activities is the sum of expenses on trips and vacations; tickets to movies, sporting events, and performing arts; sports, including gym, exercise equipment such as bicycles, skis, boats, etc.; hobbies and leisure equipment, such as photography, stamps, reading materials, camping, etc.

Equipment is the sum of expenses on housekeeping supplies, cleaning and laundry products; housekeeping, dry cleaning and laundry services, hiring costs for housekeeping or home cleaning, and amount spent at dry cleaners and laundries; gardening and yard supplies and services; clothing and apparel, including footwear, outerwear, and products such as watches or jewelry; personal care products and services.

Utilities is the sum of expenses on electricity; water; heating fuel for the home; telephone, cable, internet.

Car, gasoline and other is the sum of expenses on vehicle insurance; vehicle maintenance; gasoline; contributions to religious, educational, charitable, or political organizations; cash or gifts to family and friends outside the household.

Medical expenses includes two items: drugs, and medical services and supplies. We construct this variable from the raw CAMS data set. The bottom panel of Table 12 lists these items that we include in out-of-pocket medical expenses and show that we aggregate the last two into a single subcategory. Expenses on each item are deflated by the item-specific index provided by the BLS.

Drugs is expenses on prescription and nonprescription medications: out-of-pocket cost, not including what is covered by insurance.

Medical services and supplies is the sum of expenses on health care services (out-of-pocket cost of hospital care, doctor services, lab tests, eye, dental, and nursing home care) and medical supplies (out-of-pocket cost, not including what is covered by insurance).

Household Income. Income is observed in the core part of the HRS. Our baseline measure of income includes earnings, that is wages, salaries, and bonuses; capital income, which includes business or farm income, self-employment, rents, dividend and interest income, and other asset income; pensions, that is income from employer pension or annuity; benefits, including social security retirement income, income from transfer programs and workers' compensations; and other income, which includes alimony, other income, lump sums from insurance, pension, and inheritance, referring to both the head and the spouse if present. All income variables refer to calendar year prior to the HRS main interview. Income is deflated using the price index for total consumption provided by BLS.

Income Tax is taken from the RAND files, which use the NBER TAXSIM to impute the income tax.

Wealth. Net worth comes from the RAND files and refers to the time of the interview. It includes all assets—primary residence, secondary residence, real estate other than primary and secondary residence, vehicles, businesses, Individual Retirement Account (IRA) and Keogh accounts, stocks, mutual funds, and investment trusts, checking, savings, or money market accounts, Certificate of Deposit (CD), government savings bonds, and T-bills, bonds and bond funds, and all other savings—minus all debts—all mortgages/land contracts on primary and secondary residence, other home loans, other debt—of the head and spouse (if present) of the household. Assets are deflated using the price index for total consumption provided by BLS. For couples, wealth is divided by the square root of 2 to take into account family size.

Demographic and health variables come from the RAND files and refer to the time of the interview.

Health index

To construct our health index, we first attribute a numerical value from five to one to the possible answers on health status, going from excellent to poor health. Then, as Blundell, Britton, Costa Dias, French (2016), we instrument self-reported health with objective measures. More specifically, our health index is the predicted value from a regression of self-reported health status on age dummies, year dummies, education dummies, initial health, health as a child, labor market status, objective health measures such as difficulties in activities of daily living (ADL) or Instrumental Activities of Daily Living (IADL), and illnesses diagnosed by a doctor (the complete list is in Table 13). We impute ADLs and IADLs when their values are missing for just one period by taking the average of the two adjacent values for the same individual. The regressions are run separately for single and married men and women. To obtain a household health index for couples, we average the two instrumented self-reported health indices computed for husbands and wives separately.

Health variables	
Difficulties in ADLs	
	walking across room
	getting dressed
	bathing or showering
	eating
	getting in-out of bed
	using the toilet
Difficulties in IADLs	
	walking several blocks
	walking one block
	sitting for two hours
	getting up from a chair
	climbing several flt of stairs
	climbing one flight of stairs
	stooping, kneeling, crouching
	lifting or carrying 10 lbs
	picking up a dime
	extending arms
	pushing or pulling large objects
Doctor reported	
	cancer
	diabetes
	high blood pressure
	arthritis
	psychiatric problems
	lung disease
	heart problems
	stroke

Table 13: Objective health variables used in the analysis. All variables are 0/1 (No/Yes).

Consumption and medical expenses

	All	Low wealth	High wealth
All nondurables, mean	24279	14944	26857
Food, mean	6478	4770	6949
Food, share	28.7%	32.8%	27.6%
Utilities, mean	5498	4187	5864
Utilities, share	24.7%	28.3%	23.7%
Car maintenance, mean	3466	2507	3718
Car maintenance, share	16.1%	17.5%	15.7%
Leisure activities, mean	6196	1846	7400
Leisure activities, share	20.1%	11.5%	22.5%
Equipment, mean	2678	1725	2948
Equipment, share	11.1%	11.8%	10.8%
All medical expenses, mean	3024	2515	3131
Drugs, mean	1397	1333	1419
Drugs, share	53.8%	59.2%	52.2%
Services and supplies, mean	1633	1188	1717
Services and supplies, share	49.5%	45.9%	50.4%
Medical insurance expenses, mean	2646	1698	2914

Table 14: Consumption and medical expenses composition, means in 2015 dollars and shares in percentages.

Table 14 presents the level and composition of various expenses subcategories. The average level of yearly expenses in nondurable consumption is 24,279 (expressed in 2015 dollars). We break it down into five subcategories, each of which represents at least ten percent of nondurable household expenses. The two largest subcategories make up for a little more than one quarter of nondurable expenses each. They are food and leisure activities.

Among lower-wealth households, expenses in food, utilities, and car maintenance are higher than in the whole sample, which confirms that they are necessities. Among higher-wealth households, expenses in luxuries represent a larger share of the budget than in the whole sample (and that of expenses in equipment is no lower than that in the whole sample), which confirms that they are luxuries.

The middle part of the table reports medical expenses. Their average level is 3,024 dollars per year, and is evenly split between drugs and medical services and supplies.

Finally, the bottom part reports the expenses on medical insurance. Higher-wealth households spend almost twice as much as higher-wealth households on private medical insurance.

Income

We now turn to studying how income components vary by age and wealth. To do so, we categorize as lower-wealth the households whose equivalized wealth is below 75,000 in 2015$. This corresponds to lowest 20 percentiles of the wealth distribution. We categorize as higher-wealth the remaining households. Figure 1 shows the evolution of various income components by age and for our two wealth groups. It highlights that, while benefits (which include social security and other government transfers programs) are the most important income component for households over age 65, earnings and pensions are also substantial, and especially so for higher-wealth households.

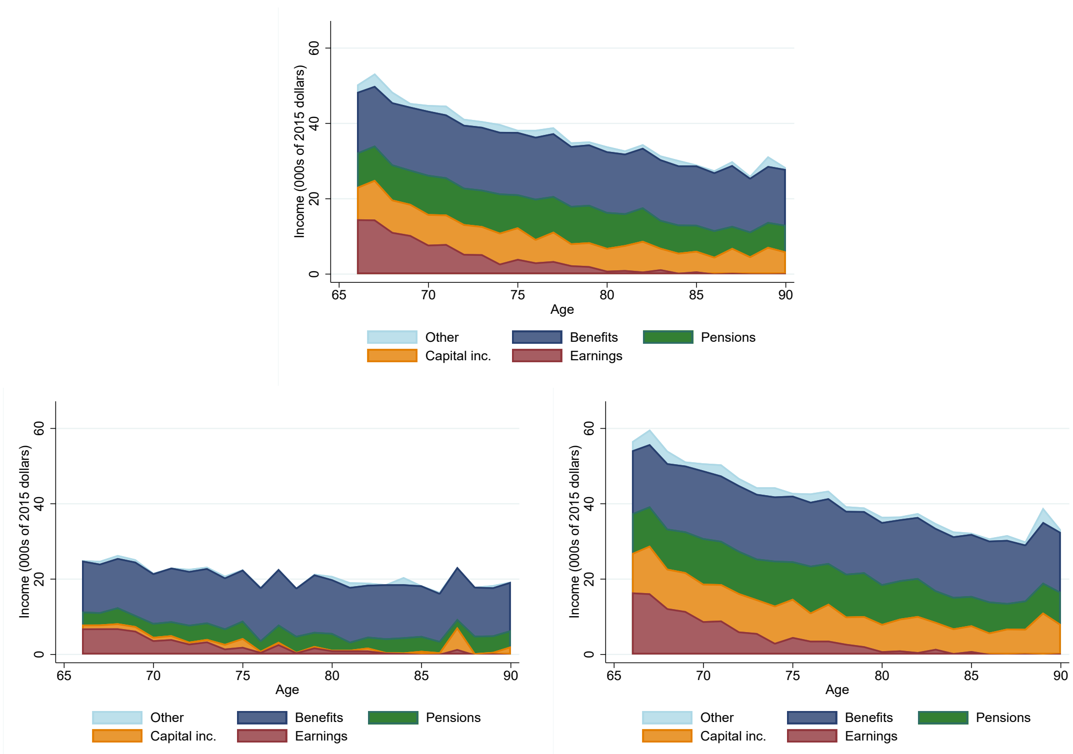

Figure 1: Equivalized income components by age, in thousands of 2015 dollars. Top panel: whole sample. Bottom left panel: lower-wealth households (< 75k equivalized wealth); bottom right panel: higher-wealth households (≥ 75k equivalized wealth).

Some descriptives about our variables

We start with some data descriptives to put our results in context. In this section, for easier interpretation, all variables are equivalized but not detrended.

Figure 2 displays the mean and 25th, 50th and 75th percentiles of equivalized consumption, by age (left graph) and wealth decile (right graph). It shows that consumption decreases with age and increases with wealth. For instance, median consumption declines from 18,000 to 11,000 dollars from age 66 to age 90, but increases from 8,000 to 27,000 dollars from the bottom to the top net worth decile.

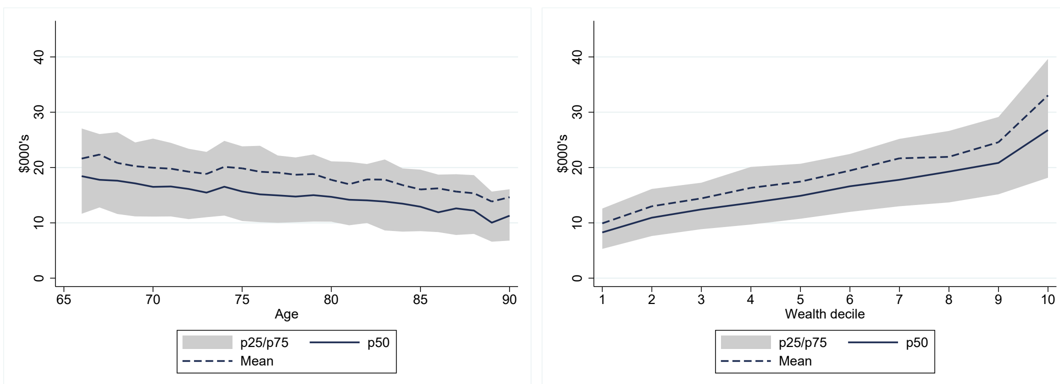

Figure 2: Equivalized consumption by age (left graph) and wealth (right graph). In 2015 dollars.

Figure 3 displays the mean and 25th, 50th and 75th percentiles of equivalized medical expenses, by age (left graph) and wealth decile (right graph). The left graph highlights that equivalized out-of-pocket medical expenses are quite a flat function of age. For instance, their median ranges from 1,200 to 1,500 dollars from age 66 to age 90. This reflects two countervailing effects. On one hand, health deteriorates and medical expenses increase with age. On the other hand, healthier households have lower medical expenses and live longer, hence there are more of them at older ages. The right graph documents that out-of-pocket medical expenses sharply increase with wealth. For instance their median ranges from 600 to 1,700 dollars from the bottom to the top net worth decile. It also shows that average out-of-pocket medical expenses are close to (and sometimes higher than) the 75th percentile, indicating that a few households have large out-of-pocket medical expenses.

Figure 4 reports our health index by age (left graph) and wealth (right graph). To better understand its magnitude, it is worth noting, for instance, that values of 3

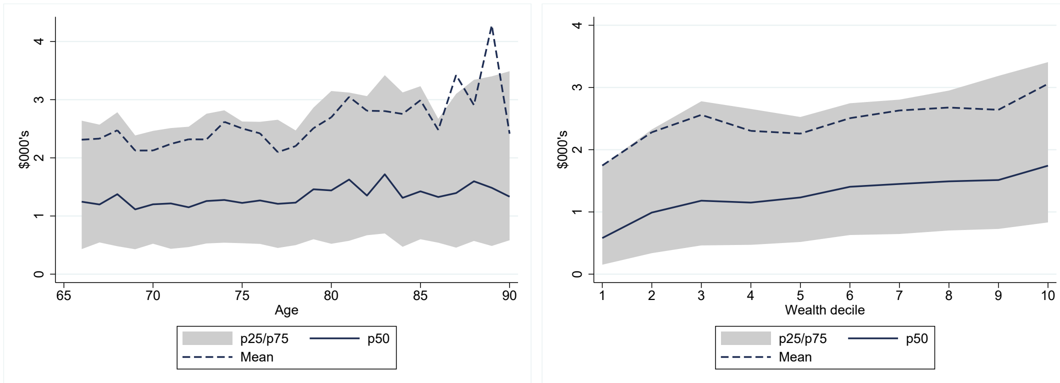

Figure 3: Equivalized out-of-pocket medical expenses by age (left graph) and wealth (right graph). In 2015 dollars.

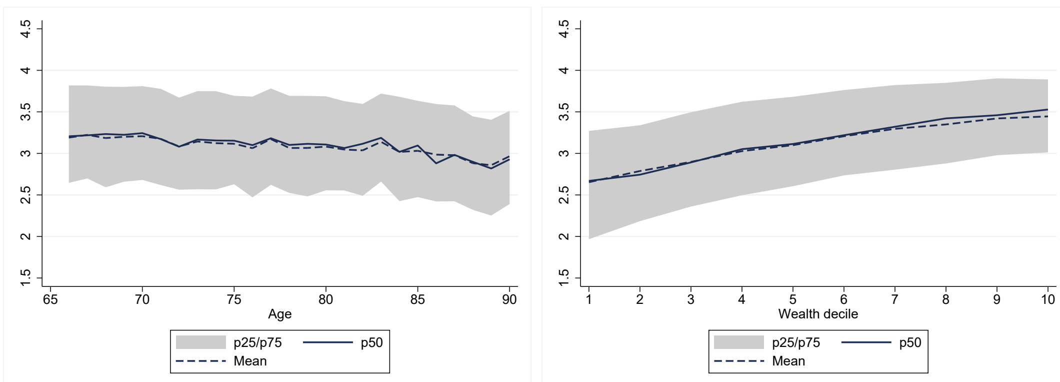

Figure 4: Health index by age (left graph) and wealth (right graph).

and 4 correspond to a self-reported value of being in "good" and "very good" health, respectively.

The left graph of Figure 4 reveals several interesting patterns. First, although there is wide dispersion in health at each age, its distribution is symmetrical, hence its mean and median almost coincide. Second, health only decreases modestly by age. For instance, median health goes from 3.2 at age 66 to 2.9 at age 90. This, again, is partly related to the fact that healthier households live longer, but can also reflect that a large share of the changes in health are transitory, rather than permanent. Hence, they do not contribute to generating a sustained decrease in health over the life-cycle.

The right graph of Figure 4 shows that there is more variation in health with wealth than with age. For instance, median health rises from 2.6 to 3.5 from the bottom to the top wealth decile. This variability and the possibility that poorer households might be less able to self-insure against shocks, highlights the importance of examining whether richer and poorer households respond to shocks differently. This figure also helps us put in context the changes in our health index. That is, a one unit change in health is equivalent to moving from the average health of the bottom wealth decile to that of the top wealth decile.

Figure 5 displays the mean and the 25th, 50th and 75th percentiles of equivalized net income, by age (left graph) and wealth decile (right graph). Similar to the pattern displayed by consumption, income decreases as household age: its median goes from 35,000 to 19,000 dollars from age 66 to age 90. In contrast, net income sharply increases with wealth: it rises from 15,000 to 52,000 dollars from the bottom to the top wealth decile.

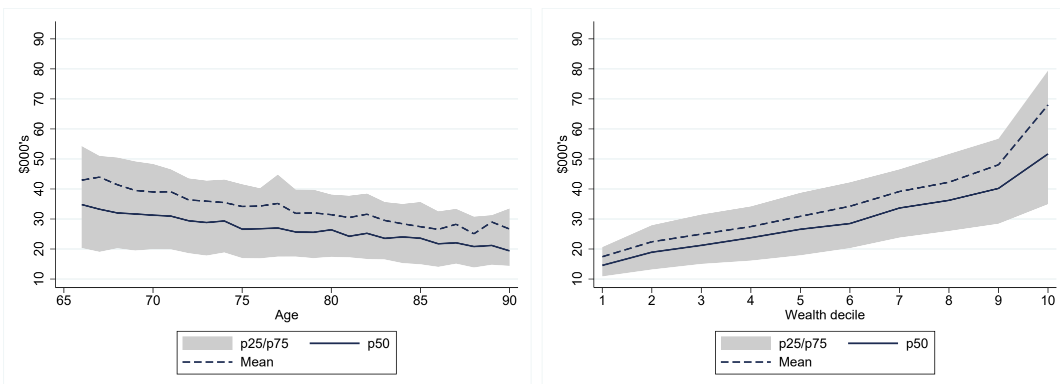

Figure 5: Equivalized net income by age (left graph) and wealth (right graph). In 2015 dollars.

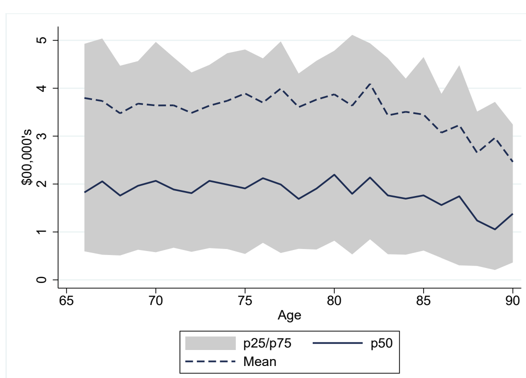

Figure 6: Equivalized wealth by age. In 2015 dollars.

Figure 6 reports the 25th, 50th and 75th percentiles for equivalized wealth by age and shows that they are rather flat until households are in their mid eighties.

Online Appendix C: Detrending and additional moments

For most of our analysis, and with the exception of the descriptives in Section B, we use "detrended" values for health, income, medical expenses, and consumption, and their subcategories whenever appropriate. That is, as standard in the consumption insurance literature, we remove the effects of observed characteristics. We do so, by running ordinary least square (OLS) regressions of each of the these variables on year dummies, year of birth, education, race, employment status, whether there are income recipients other than the head and the spouse in the household, region, marital status, and number of household residents. We also add interactions terms (education and year, race and year, education and employment status) and we interact all variables with a binary variable picking up the age group (less than 65 and above 65). We run the regressions separately for couples, single men, and single women, allowing the effect of the observed characteristics to vary across these categories.

Additional autocovariances

	$\Delta ln(y_{t+1})$	$\Delta ln(y_{t+2})$	$\Delta ln(y_{t+3})$
$cov(\Delta h_t, .)$	-.002	-.002	-.002
	(.002)	(.002)	(.003)
Obs.	4999	3079	1910
	Δh_{t+1}	Δh_{t+2}	Δh_{t+3}
$cov(\Delta ln(y_t), .)$	-.002	.003	.003
	(.002)	(.002)	(.003)
Obs.	4999	3045	1882

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 15: Covariance of current health and income growth with future income and health growth.

The top panel of Table 15 shows that the cross-autocovariances between health growth and subsequent income growth are relatively small and not statistically significant. The bottom panel shows that the same is true of the autocovariances between income growth and subsequent health growth. This is consistent with our assumption that transitory income and health shocks are not correlated.

The top panel of Table 16 reveals no significant covariance between medical expenses growth and contemporaneous and future income growth. In the case in which

	$\Delta ln(y_t)$	$\Delta ln(y_{t+1})$	$\Delta ln(y_{t+2})$	$\Delta ln(y_{t+3})$
$cov(\Delta ln(m_t), .)$	.007	-.011	-.006	.004
	(.009)	(.009)	(.011)	(.014)
Obs.	4999	4999	3079	1910
	Δh_t	Δh_{t+1}	Δh_{t+2}	Δh_{t+3}
$cov(\Delta ln(m_t), .)$	-.012***	.01**	-.01*	.003
	(.005)	(.005)	(.006)	(.007)
Obs.	4999	4999	3045	1882

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 16: Covariance of current medical expenses growth with current and future income and health growth.

transitory income shocks affect medical expenses, the first two of these covariances should be significant and large. The first one (0.07) is also small compared with both the contemporaneous covariance between consumption growth and income growth and the contemporaneous covariance between medical expenses growth and health growth. The second one, while not significant, is not small. For this reason, online Appendix D relaxes the assumption that income shocks do not affect medical expenses and shows this increases the importance of the marginal utility channel.

The bottom panel shows that the covariance between medical expenses growth and contemporaneous health growth is significant and negative. Under a transitory-permanent specification of health, it corresponds to $cov(\Delta ln(m_t), \eta_t^h + \varepsilon_t^h - \varepsilon_{t-1}^h)$. Thus, a negative value is in line with a decrease in health raising medical expenses. The covariance between medical expenses growth and next period's health growth, instead, is significant and positive. Under a transitory-permanent specification of health, it corresponds to $cov(\Delta ln(m_t), \eta_{t+1}^h + \varepsilon_{t+1}^h - \varepsilon_t^h)$. The fact that this moment is positive indicates that a negative transitory health shock $-\varepsilon_t^h$ raises contemporaneous medical expenses, and their effect dominates that of the future (possibly anticipated) shocks $\eta_{t+1} + \varepsilon_{t+1}$ (and conversely that a positive transitory health shock reduces them). The covariance between medical expenses growth and income growth two periods ahead turns negative and significant at the 10% level. Under a transitory-permanent specification of health, it corresponds to $cov(\Delta ln(c_t), \eta_{t+2}^h + \varepsilon_{t+2}^h - \varepsilon_{t+1}^h)$ This is suggestive of an anticipation of future permanent health changes two periods ahead, as also revealed by the cross-covariances of consumption growth and health growth. Online Appendix J shows that this would at most reduce our estimate of the effect of health shocks on consumption growth.

Standard deviations of the different components of income

Table 17 reports the standard deviation of the change of various income components (upper panel) and of total income excluding some income components (bottom panel). In both cases, the income components are detrended from the effect of demographic characteristics (we consider changes in the unexplained part of these income components) and their changes are pooled over all observations with non-zero values. The upper panel of the table shows that benefits display, unsurprisingly, very little variation, and that the vast majority of households in our sample receive them (8,677 out of a total of 8,941). Pensions have more variation than benefits and less than half of our households receive them. Capital income displays the largest variation and is received by over half of our households. The standard deviations of most income sources differ little among lower-wealth and higher-wealth households, except for the "other income" component. This indicates that this "other income" component, which captures lump sums and includes inheritances can be a substantial source of risk for some higher-wealth households. The bottom panel of the table shows that removing various income components one at a time, tends to raise the variation in gross income, with the exception of "other income". This means that the various income components might offset each others' fluctuations. For the rows referring to gross income and gross income net of some income components, we do not report the number of observations, because they are the same as those for total net (and gross) income.

Skewness and kurtosis of the shocks

We estimate the third and fourth moments of the distribution of our transitory shocks following Commault (2022) (online Appendix B, footnote 3).

	Total	Lower wealth	Higher wealth
Benefits	0.42	0.44	0.41
	(8,677)	*(2,308)*	*(6,369)*
Pensions	0.78	0.69	0.80
	(4,170)	*(734)*	*(3,436)*
Capital income	2.28	2.51	2.25
	(5,131)	*(492)*	*(4,639)*
Earnings	1.10	1.03	1.11
	(1,673)	*(362)*	*(1,311)*
Other	1.19	0.46	1.26
	(103)	*(14)*	*(89)*
Total gross income	0.52	0.46	0.54
Gross income excluding Benefits	0.56	0.54	0.57
Gross income excluding Pensions	1.39	1.47	1.36
Gross income excluding Capital	0.51	0.45	0.53
Gross income excluding Earnings	0.66	0.57	0.69
Gross income excluding Other	0.50	0.46	0.52
Net income including capital	0.47	0.43	0.49
	(8,941)	*(2,382)*	*(6,559)*

Table 17: Standard deviation of the change of unexplained (log) income components. Upper panel: income components. Lower panel: gross income minus various income components. Number of observations with non-zero income in parentheses.

	All	Lower wealth	Higher wealth
$E[(\varepsilon_t^y)^2](= var(\varepsilon_t^y))$	.087***	.066***	.093***
	(.005)	(.009)	(.005)
$E[(\varepsilon_t^y)^3]$	.006	.004	.006
	(.004)	(.008)	(.005)
$E[(\varepsilon_t^y)^4]$	.096***	.059***	.103***
	(.008)	(.014)	(.009)
Obs.	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 18: Moments of the transitory income shocks distribution.

The first line of Table 18 reports the variance of the distribution of our transitory income shocks, which is the moment that we present and discuss in the main body of our paper. The second line shows that the third moment of the distribution of transitory income shocks is not significant, hence their distribution is not significantly skewed. The third line shows that the fourth moment is, instead, significant. It is also larger than what would be implied by a normal distribution: under a normal distribution, the fourth moment is $3*E[(\varepsilon_t^y)^2]^2$, which given our estimate of $E[(\varepsilon_t^y)^2]$ is .023. An estimate of .096 is therefore more than four times what a normal distribution would imply (given our variance estimate).

	All	Lower wealth	Higher wealth
$E[(\varepsilon_t^h)^2](var(\varepsilon_t^h))$	.02***	.033***	.017***
	(.001)	(.004)	(.001)
$E[(\varepsilon_t^h)^3]$	0	.002	0
	(.001)	(.003)	(.001)
$E[(\varepsilon_t^h)^4]$	.007***	.015***	.005***
	(.001)	(.003)	(.001)
Obs.	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 19: Moments of the transitory health shocks distribution.

The first line of Table 19 reports the variance of the distribution of our transitory income shocks, which is the moment that we present and discuss in the main body of our paper. The second line shows that the third moment of the distribution of the transitory health shocks is not significant, hence their distribution is not significantly skewed. The third line shows that the fourth moment is significant. It is also larger than what would be implied by a normal distribution: under a normal distribution, the fourth moment is $3*E[(\varepsilon_t^h)^2]^2$, which given the estimate of $E[(\varepsilon_t^h)^2]$ would be .0012. The estimate of .008 is therefore more than five times what a normal distribution would imply.

Online Appendix D: Non-zero effect of transitory income shock on medical expenses

In our data, the pass-through of transitory income shocks to medical expenses is not statistically significant. That is why our baseline identification strategy assumes it is zero. We now relax this assumption and let $\frac{dm_t}{d\varepsilon_t^h}$ be strictly non-zero. As before, the expressions of the consumption pass-through are 13 and 14, but we can no longer simplify them as 15 and 16:

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^y}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t y_t - p_t^m \frac{dm_t}{d\varepsilon_t^y}\right\}}_{\text{Resources}} \tag{13}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}}_{\text{Marginal utility}} - \underbrace{f_R^{c,t} p_t^m \frac{dln(m_t)}{d\varepsilon_t^h} m_t}_{\text{Resources}}. \tag{14}$$

Recall that $f_h^{c,t}$ denotes the effect on consumption of the shift in marginal utility caused by a transitory health shock (holding medical expenses constant), and $f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h}$ the effect on consumption of the shift in marginal utility caused by the response of medical expenses to the transitory health shock (holding health constant): if breaking one's leg decreases the utility of going out (captured by $f_h^{c,t}$), medical expenses on crutches might restore some of that utility (captured by $f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h}$). We denote k their relative sizes, with k such that

$$f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} = -k \times f_h^{c,t}, k \in [0, 1[.$$

When k is positive, the two components of the shift in marginal utility, $f_h^{c,t}$ and $f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h}$, take opposite signs (a decrease in health reduces marginal utility while a decrease in health raises medical expenses, which partly raises back marginal utility). When k is between 0 and 1, medical expenses can soften the decrease in marginal utility caused by an adverse health shock but not compensate it by more than the initial decrease. The equations become

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{-k f_h^{c,t}\left(\frac{dm_t}{d\varepsilon_t^h}\right)^{-1}\frac{dm_t}{d\varepsilon_t^y}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t y_t - p_t^m \frac{dm_t}{d\varepsilon_t^y}\right\}}_{\text{Resources}} \tag{13b}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{(1-k) f_h^{c,t}}_{\text{Marginal utility}} - \underbrace{f_R^{c,t} p_t^m \frac{dln(m_t)}{d\varepsilon_t^h} m_t}_{\text{Resources}}. \tag{14b}$$

Making assumptions on the value of k (which we can vary to test a large range of values), we are back to a situation with two unknowns, $f_h^{c,t}$ and $f_R^{c,t}$ and two identifying equations.

	Baseline	Relaxing the assumption that $\frac{dm_t}{d\varepsilon_t^y}=0$					
		$k=0$	$k=0.15$	$k=0.30$	$k=0.45$	$k=0.60$	$k=0.75$
Resources	.003*	.003*	.003	.003	.002	.002	-.000
	(.002)	(.002)	(.002)	(.002)	(.002)	(.003)	(.004)
Marginal utility	.170*	.170*	.170*	.170*	.171*	.172*	.174*
	(.088)	(.088)	(.089)	(.089)	(.089)	(.089)	(.090)
Obs.	4999	4999	4999	4999	4999	4999	4999

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 20: Decomposition.

Table 20 presents the estimates of the decomposition of the pass-through of transitory health shocks to consumption. The first column shows the results in our baseline case where we impose that transitory income shocks have no effect on medical expenses spending. The following columns show the results in the cases where we relax this assumption, for different values of k. The estimates are all very similar. A comparison of the first two columns indicates that our baseline assumption is virtually identical to the cases in which the ability to use medical expenses to compensate a loss in marginal utility caused by a decrease in health reduces the effect of the loss by 30% or less ($k \leq 0.30$). When the ability to use medical expenses to compensate a loss in marginal utility reduces the effect of the loss by more than 30% ($k > 0.30$), the shift in marginal utility explains a larger share of the pass-through of transitory health shocks to consumption than in the baseline case, and the effect of resources a smaller share. Above $k = 0.75$, the point estimates of the contribution of the shift marginal utility to the pass-through gets even slightly larger than the point estimate of the pass-through itself (the point estimate of the resources channel is slightly negative). Since our main finding is that the shift in marginal utility explains most of the effect of transitory health shocks on consumption, this result appears very robust to relaxing our assumption that transitory income shock have no effect on medical expenses.

Intuitively, when transitory income shocks are allowed to affect medical expenses, it reduces the magnitude of the resources multiplier $f_R^{c,t}$: part of the effect of transitory income on consumption $\frac{dln(c_t)}{d\varepsilon_t^y}$ is now explained by the marginal utility channel (an increase in transitory income raises medical expenses, which increases the marginal utility of consumption). As a result, the resources channel is estimated to be smaller, while the shift in marginal utility channel becomes larger. Since the contribution of the shift in marginal utility to the total value of the pass-through is already very high in the baseline, moving to a framework that makes it bigger barely affects our findings.

Online Appendix E: Correlated income and health shocks

In our data, transitory income and health shocks are essentially uncorrelated (the covariance is small and not statistically significant). But if transitory income and health shocks were highly correlated, the interpretation of the response to income and health shocks would become more difficult. To discuss this more general case, here, we assume that the transitory components of income and health are the results of underlying income-related and health-related events. These events are uncorrelated but the health-related events can affect both health and income, inducing some correlation between the two.

We denote ε^{yy} and ε^{hh} these underlying pure income and pure health events, which are themselves uncorrelated. We assume that

$$\varepsilon_t^y = \varepsilon^{yy} + \alpha\varepsilon^{hh}$$
$$\varepsilon_t^h = \varepsilon^{hh}.$$

Note that we need to take a stand on what part of the covariance between the transitory shocks is explained by pure transitory health events affecting the transitory income component and what part is explained by pure transitory income events affecting the transitory health component. Here we assume that all of the covariance comes from pure health events affecting income. This is because the literature that we cite in Section 2 in the paper suggests that after age 65, conditional on earlier investments and behavior, health resembles an exogenous process that is not much influenced by additional out-of-pocket medical expenses that supplement what social insurance already provides. On the contrary, this literature suggests that health-related events have consequences in terms of earnings (see e.g. Britton and French 2020). However, we could re-estimate the process under different assumptions about the share of the covariance explained by pure health events affecting income versus pure income events affecting health.

We derive consumption with respect to the underlying pure income and health events ε^{yy} and ε^{hh}. In this case, Eq. (11) is unchanged, but Eq. (12) now includes the effect of ε_t^h on y_t

$$\frac{dln(c_t)}{d\varepsilon^{yy}} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon^{yy}}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t\frac{dy_t}{d\varepsilon^{yy}} - p_t^m\frac{dm_t}{d\varepsilon^{yy}}\right\}}_{\text{Resources}} \tag{39}$$

$$\frac{dln(c_t)}{d\varepsilon^{hh}} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon^{hh}} + f_h^{c,t}\frac{dh_t}{d\varepsilon^{hh}}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{p_t\frac{dy_t}{d\varepsilon^{hh}} - p_t^m\frac{dm_t}{d\varepsilon^{hh}}\right\}}_{\text{Resources}} \tag{40}$$

Noting that $\frac{dy_t}{d\varepsilon^{yy}} = \frac{dln(y_t)}{d\varepsilon^{yy}} \times y_t = 1 \times y_t$, that $\frac{dy_t}{d\varepsilon^{hh}} = \frac{dln(y_t)}{d\varepsilon^{hh}} \times y_t = \alpha \times y_t$, that $\frac{dh_t}{d\varepsilon_t^{hh}} = 1$, and that $\frac{dm_t}{d\varepsilon_t^h} = \frac{dln(m_t)}{d\varepsilon_t^h}m_t$, as well as using the result that $\frac{dm_t}{d\varepsilon_t^{yy}} \approx 0$, we can then simplify (39) and (40) as

$$\frac{dln(c_t)}{d\varepsilon^{yy}} = \underbrace{f_R^{c,t}p_t y_t}_{\text{Resources}} \tag{41}$$

$$\frac{dln(c_t)}{d\varepsilon^{hh}} = \underbrace{f_m^{c,t}\frac{dm_t}{d\varepsilon^{hh}} + f_h^{c,t}}_{\text{Marginal utility}} + \underbrace{f_R^{c,t}\left\{\alpha p_t y_t - p_t^m\frac{dln(m_t)}{d\varepsilon_t^h}m_t\right\}}_{\text{Resources}} \tag{42}$$

Around the same approximation point as in the uncorrelated case, we have:

$$\phi_c^{yy} \approx \frac{dln(c_t)}{d\varepsilon^{yy}}|_0 = \overbrace{f_R^{c,t}|0}^{\text{Multiplier}}\ p_t\ \underbrace{y|_0}_{E[y_t]} \tag{43}$$

$$\phi_c^{hh} \approx \frac{dln(c_t)}{d\varepsilon_t^{hh}}|_0 = \overbrace{f_m^{c,t}|_0\frac{dm_t}{d\varepsilon_t^{hh}}|_0 + f_h^{c,t}|_0}^{\text{Contribution of marginal utility}} + \overbrace{f_R^{c,t}|0}^{\text{Multiplier}}\left\{\alpha p_t\ \underbrace{y|_0}_{E[y_t]} - p_t^m\ \underbrace{\frac{dln(m_t)}{d\varepsilon_t^h}|_0}_{\approx\phi_m^{hh}}\ \underbrace{m_t|_0}_{\approx E[m_t]}\right\} \tag{44}$$

As before, we have two unknown terms to measure, $f_R^{c,t}|0$ and $f_m^{c,t}|_0\frac{dm_t}{d\varepsilon_t^{hh}}|_0 + f_h^{c,t}|_0$, and two expressions.

The identification of the variance of the underlying events ε^{yy} and ε^{hh} and of the effect α of health on income is

$$cov(\Delta ln(y_t), -\Delta ln(y_{t+1})) = var(\varepsilon_t^{yy}) + \alpha^2 var(\varepsilon_t^{hh}) \quad (17)$$

$$cov(\Delta h_t, -\Delta h_{t+1}) = var(\varepsilon_t^{hh}) \quad (18)$$

$$cov(\Delta h_t, -\Delta ln(y_{t+1})) = \alpha var(\varepsilon_t^{hh}) \quad (19)$$

$$cov(\Delta ln(y_{t+1}), -\Delta h_t) = \alpha var(\varepsilon_t^{hh}) \quad (20)$$

The identification of the pass-through of the underlying events on consumption is from

$$cov(\Delta ln(c_t), -\Delta ln(y_{t+1})) = cov(\Delta ln(c_t), \varepsilon_t^{yy} + \alpha\varepsilon_t^{hh}) = \phi_c^{yy} var(\varepsilon_t^{yy}) + \alpha\phi_c^{hh} var(\varepsilon_t^{hh}) \quad (45)$$

$$cov(\Delta ln(c_t), -\Delta ln(h_{t+1})) = cov(\Delta ln(c_t), \varepsilon_t^{hh}) = \phi_c^{hh} var(\varepsilon_t^{hh}) \quad (46)$$

Finally, the identification of the two unknown terms $f_R^{c,t}|_0$ and $f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^{hh}}|_0 + f_h^{c,t}|_0$ in the decomposition is

$$f_R^{c,t}|_0 = \frac{\phi_c^{yy}}{p_t E[y_t]} \quad (47)$$

$$f_m^{c,t}|_0 \frac{dm_t}{d\varepsilon_t^{hh}}|_0 + f_h^{c,t}|_0 = \phi_c^{hh} + \frac{\phi_c^{yy}}{p_t E[y_t]} \Big(\alpha p_t E[y_t] - \phi_m^{hh} p_t^m E[m_t] \Big) \quad (48)$$

	All	Lower wealth	Higher wealth
$var(\Delta ln(y_t))$	.213***	.165***	.225***
	(.007)	(.013)	(.008)
$var(\varepsilon_t^y)$	.087***	.066***	.093***
	(.005)	(.009)	(.005)
Obs.	4999	970	4029
$var(\eta_t^y)$	.029***	.017*	.031***
	(.006)	(.01)	(.006)
Obs.	3401	623	2778

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 21: Variance of the transitory and permanent income shocks.

Tables (21) and (22) show that the estimates of the variance of the underlying transitory shocks are very close to those the of transitory components (differences only appear at the 4th digit). This is because the estimate of the effect of a transitory

	All	Lower wealth	Higher wealth
$var(\Delta h_t)$	.064***	.098***	.056***
	(.002)	(.006)	(.002)
$var(\varepsilon_t^h)$	.02***	.033***	.017***
	(.001)	(.004)	(.001)
α	.096	.097	.096
	(.063)	(.09)	(.081)
Obs.	4999	970	4029
$var(\eta_t^h)$	.02***	.026***	.018***
	(.002)	(.005)	(.002)
Obs.	3401	623	2778

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 22: Variance of the transitory and permanent health shocks.

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.124***	.189*	.113***	.175**	.304***	.114
	(.036)	(.1)	(.038)	(.088)	(.13)	(.113)
Medical exp. ϕ_m^ε	.142	.289	.116	-.492**	-1.173***	-.177
	(.102)	(.27)	(.107)	(.232)	(.364)	(.286)
Obs.	4999	970	4029	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 23: Pass through estimates.

health shock on the transitory component of income is $\alpha = 0.096$, not significant. This magnitude means that, after age 65, on average, 10% of a shock to health converts into a transitory income change. Since the variance of the transitory health shocks is four times smaller than that of the transitory income component, this effect generates very small changes to the variance of transitory income.

Tables (23) shows that the correlation-adjusted pass-through estimates are very similar to the baseline results as well. The pass-through of income shocks is now 0.124 pass-through (compared with 0.127 in our baseline model). The pass-through of health shocks is now 0.175 pass-through (compared with 0.173 in our baseline model).

Online Appendix F: Results by liquid wealth

Table 24 reports the results when we further decompose the group of higher-wealth households into those with low liquid wealth and those with high liquid wealth (in

	Income shock			Health shock		
	Higher w.	Low liq.	High liq.	Higher w.	Low liq.	High liq.
Consumption ϕ_c^ε	.115***	.232***	.07*	.112	.022	.197
	(.038)	(.076)	(.042)	(.114)	(.15)	(.169)
Medical exp. ϕ_m^ε	.114	.034	.144	-.177	.101	-.442
	(.107)	(.2)	(.124)	(.286)	(.41)	(.394)
Obs.	4029	1354	2675	4029	1354	2675

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 24: Pass through estimates by liquid wealth.

the spirit of distinguishing between the wealthy-hand-to-mouth and the non-hand-to-mouth). It shows that the higher-wealth households with low liquid wealth are those driving the response of this category: their pass-through is significant at 1% and the point estimate is 0.232. In contrast, among the higher-wealth households with high liquid wealth, the pass-through is only significant at the 10% level and the point estimate is small, at 0.070.

Online Appendix G: Results by marital status

In this online appendix, we break down our sample in two sub-samples: that of single households (2,255) and that of couples (2,744). Separately looking at couples and singles is interesting because being in a couple is both a source of risks (the health and resource risks of both partners) and insurance (pooling risks, economies of scale, and potentially being able to help each other in case of sickness). Table 25 shows that the point estimates of the pass-through coefficients for income shocks to consumption are 0.143 for singles and 0.113 for couples. Those for health shocks are 0.183 for singles and 0.160 for couples. This is consistent with couples's consumption being a little less affected by transitory income and health shocks. However, breaking down the sample reduces statistical power. As a result, we cannot reject that they are statistically different for couples and singles. Consistent with our overall sample, the pass-through of income to medical expenses is small and not significant. Finally, the pass-through of health shocks to medical expenses is -0.342 for singles and -0.704 for couples, which indicates that couples react to transitory health shocks by spending more in medical goods and services compared with singles. Only the latter pass-through coefficient is statically significant and the two are not statistically different.

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Singles						
Consumption ϕ_c^ε	.143***	.184	.133***	.183	.3*	.119
	(.052)	(.129)	(.055)	(.121)	(.179)	(.161)
Medical exp. ϕ_m^ε	.147	.516	.049	-.342	-1.318***	.193
	(.14)	(.351)	(.146)	(.306)	(.46)	(.394)
Obs.	2255	639	1616	2255	639	1616
Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%						
Couples						
Consumption ϕ_c^ε	.113**	.238	.101*	.16	.317*	.103
	(.049)	(.153)	(.051)	(.127)	(.177)	(.159)
Medical exp. ϕ_m^ε	.118	-.329	.163	-.704**	-.899	-.634
	(.146)	(.451)	(.153)	(.352)	(.605)	(.412)
Obs.	2744	331	2413	2744	331	2413
Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%						

Table 25: Pass through estimates for singles and couples.

Tables 26 and 27 report the results of our demand system estimation for singles and couples. Singles have in general higher budget elasticities than couples (except for the one on equipment). Their health elasticities are higher, in absolute value, for food and car-related expenses (which are linked to activities that can be easier to be undertaken when in a couple because, if one is sick, the other one can drive and take the lead).

	Food	Utilities	Car	Leisure	Equipment
Budget shares	0.270 ***	0.255 ***	0.149 ***	0.180 ***	0.146 ***
	(0.010)	(0.010)	(0.007)	(0.010)	(0.007)
Budget elasticities	0.794 ***	0.614 ***	0.958 ***	1.906 ***	0.977 ***
	(0.033)	(0.035)	(0.045)	(0.049)	(0.046)
Health elasticities					
Whole sample	-0.165 ***	-0.070 ***	0.210 ***	0.329 ***	-0.192 **
	(0.038)	(0.040)	(0.052)	(0.056)	(0.053)
Lower wealth	-0.177 ***	-0.089 ***	0.349 ***	0.491 ***	-0.207 ***
	(0.034)	(0.039)	(0.054)	(0.091)	(0.059)
Higher wealth	-0.159 ***	-0.172 ***	0.205 ***	0.338 ***	-0.082 *
	(0.041)	(0.042)	(0.053)	(0.053)	(0.053)

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 26: Predicted shares, budget and health elasticities, for disaggregated categories. Singles.

	Food	Utilities	Car	Leisure	Equipment
Budget shares	0.272 ***	0.209 ***	0.169 ***	0.235 ***	0.116 ***
	(0.008)	(0.008)	(0.006)	(0.009)	(0.005)
Budget elasticities	0.774 ***	0.545 ***	0.611 ***	1.838 ***	1.221 ***
	(0.033)	(0.042)	(0.039)	(0.045)	(0.053)
Health elasticities					
Whole sample	-0.086 ***	-0.127 ***	0.025	0.338 ***	-0.292 **
	(0.034)	(0.043)	(0.040)	(0.046)	(0.055)
Lower wealth	-0.085 ***	-0.076 *	0.032	0.563 ***	-0.242 ***
	(0.031)	(0.035)	(0.034)	(0.093)	(0.057)
Higher wealth	-0.134 ***	-0.181 ***	-0.056 *	0.395 ***	-0.134 ***
	(0.035)	(0.045)	(0.041)	(0.045)	(0.055)

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 27: Predicted shares, budget and health elasticities, for disaggregated categories. Couples.

Online Appendix H: Differentiated impact of a shift in marginal utility at different levels of consumption

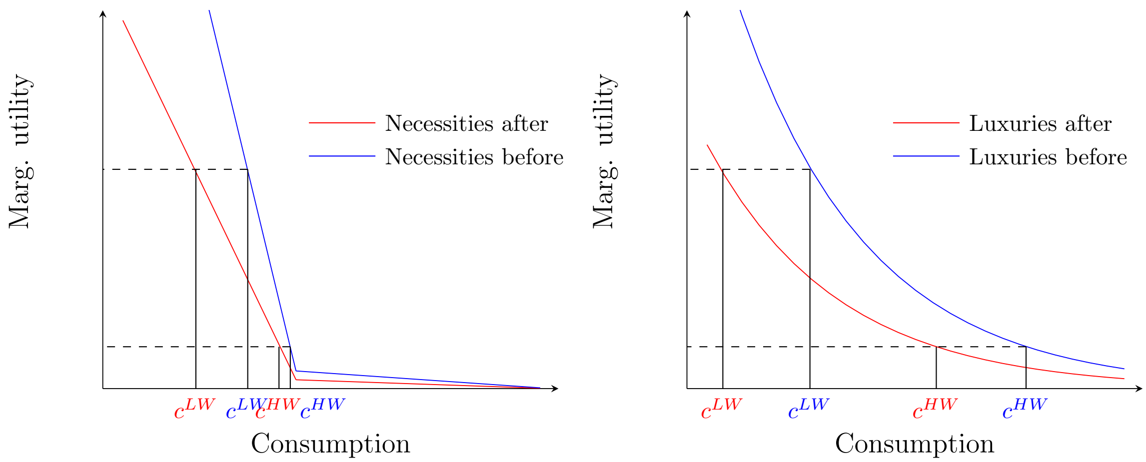

Figure 7: Effect of a shift in the weight put on utility for a linear and an exponential utility functions and for low-wealth and high-wealth households.

Figure 7 illustrates that the effect of a shift in marginal utility can be different at different levels of consumption and for different types of utility functions.

The panel on the left considers a piecewise linear marginal utility function, with a kink that can be interepreted as a satiation point. The blue line presents the initial marginal utility function, and the red line the marginal utility function following a negative health shock that multiplies the marginal utility function by a constant smaller than one. The figure shows that, with this linear marginal utility function, a multiplicative shift implies that consumption must adjust much more at low levels of consumption than at high levels of consumption, to keep marginal utility the same. This can explain why, for instance, the contribution of the shift in marginal utility, and not just the contribution of the resources effect, is larger for lower-wealth households, whose consumption is relatively low, than for the higher-wealth households.

The panel on right considers an exponential utility function. The blue line is the initial function, while the red line is the same function multiplied by a constant smaller than one. With this type of utility, contrary to the one on the left, a multiplicative shift implies that consumption must adjust by exactly the same amount at low levels of consumption and at high levels of consumption to keep marginal utility the same. Thus, if for instance the marginal utility of luxury goods is closer to an exponential function than to a linear function with a kink, the contribution of the shift in marginal utility can be large for both lower-wealth and higher-wealth households.

Online Appendix I: Demand system

We use the quadratic almost-ideal demand system (QUAIDS) introduced by Banks, Blundell, and Lewbel (1997). It is a flexible specification that also allows for non-separabilities in preferences. More specifically, we estimate its linearized version, conditional to a Stone price index and restricting the coefficients on expenses and expenses squared to be independent of prices, as done by Blundell, Pashardes, and Weber (1993). Our estimating equation is given by

$$w_k^i = \boldsymbol{\alpha}_{0k}' \boldsymbol{s_i} + \alpha_{1k} h^i + \boldsymbol{\gamma}_k' \boldsymbol{p} + \beta_{0k} \tilde{x}^i + \beta_{1k} h^i \tilde{x}^i + \lambda_{0k} (\tilde{x}^i)^2 + \lambda_{1k} h^i (\tilde{x}^i)^2 + u_k^i \tag{49}$$

where w_k^i is the budget share for good $k = 1, ..., K$ and household $i = 1, ..., N$, x^i is log expenses; $\boldsymbol{s}_i$ is a set of demographic variables (which include age and age squared, a time trend, dummies for race, education, marital status, labor force status, and the number of household members), and h^i is the health index for individual i. The term $\tilde{x}^k = x^k - a(.)$ refers to real log expenses, where the Stone price index given by $a(.) = \bar{\mathbf{w}}'\mathbf{p}$ and $\bar{\mathbf{w}}$ is the K-vector containing the sample average budget shares and $\mathbf{p}$ is the vector of prices.

To account for endogeneity, we instrument total expenses with the logarithm of income and its square, the logarithm of the consumer price index (CPI), also interacted with log income, and all demographic characteristics included the system of Equations (49) and then include the residuals of this regression in our demand system in Equations (49).

The demand elasticities with respect to expenses are given by

$$e_k = \left(\frac{\partial w_k}{\partial \tilde{x}} \frac{1}{w_k}\right) + 1$$

where, from Equation (49), we have

$$\frac{\partial w_k}{\partial \tilde{x}} = \beta_{0k} + \beta_{1k} h + 2(\lambda_{0k} + \lambda_{1k} h)\tilde{x},$$

and $\tilde{x}$ is average real log expenses in the sample, h is average health and w_k is the average budget share of item k. Health elasticities are computed conditionally on total expenses, where

$$\frac{\partial \tilde{X} w_k}{\partial h}\frac{h}{\tilde{X} w_k} = (w_k \frac{\partial \tilde{X}}{\partial h} + \tilde{X}\frac{\partial w_k}{\partial h})\frac{h}{\tilde{X} w_k},$$

$\tilde{X}$ is the average level of real expenses. Assuming $\partial \tilde{X}/\partial h = 0$, then

$$e_{hk} = \frac{\partial w_k}{\partial h}\frac{h}{w_k},$$

where, from 49

$$\frac{\partial w_k}{\partial h} = \alpha_{1k} + \beta_{1k}\tilde{x} + \lambda_{1k}\tilde{x}^2$$

where, as before, $\tilde{x}$, h and w_k are sample averages.

Online Appendix J: Robustness

In this online appendix, we discuss the effects of relaxing some key assumptions.

With AR(1) permanent component ($\rho = 0.98$)

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.127***	.201**	.114***	.173**	.306**	.112
	(.036)	(.101)	(.038)	(.088)	(.132)	(.114)
Medical exp. ϕ_m^ε	.133	.234	.116	-.493**	-1.171***	-.177
	(.103)	(.291)	(.109)	(.232)	(.364)	(.286)
Obs.	4999	970	4029	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

With measurement error $\xi_{i,t}$ ($var(\xi_{i,t}^y) = 0.46 * var(\varepsilon_{i,t}^y)$, $var(\xi_{i,t}^h) = 0.46 * var(\varepsilon_{i,t}^h)$)

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.186***	.295**	.167***	.253**	.447**	.163
	(.052)	(.146)	(.055)	(.129)	(.192)	(.166)
Medical exp. ϕ_m^ε	.192	.342	.166	-.719**	-1.71***	-.258
	(.149)	(.42)	(.157)	(.338)	(.532)	(.417)
Obs.	4999	970	4029	4999	970	4029

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

With uniformly distributed shocks

	Income shock			Health shock		
	Total	Lower w.	Higher w.	Total	Lower w.	Higher w.
Consumption ϕ_c^ε	.19***	.222*	.185***	.429***	.545***	.387***
	(.044)	(.114)	(.047)	(.095)	(.163)	(.115)
Medical exp. ϕ_m^ε	.15	.38	.11	-1.047***	-1.957***	-.719**
	(.112)	(.279)	(.121)	(.261)	(.449)	(.309)
Obs.	3401	623	2778	3401	623	2778

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 28: Pass-through estimates under different hypotheses.

AR(1) permanent income

Following Kaplan and Violante (2010), we examine whether our results are robust to assuming that permanent income evolves as an AR(1) process instead of a random walk. Indeed, although our data seem to supports the random walk assumption, it could be that the true process evolves as an AR(1) with a coefficient close to one and that the data cannot detect it as being different from one (because it cannot detect the correlation between income growth at t and at $t+2$ or $t+3$ as being different from zero). We denote with ρ the AR(1) coefficient of the permanent income process. Under the assumption that $\rho \neq 1$, we obtain identification by substituting income growth $\Delta ln(y_t)$ with quasi-differenced income growth $ln(y_t) - \rho ln(y_{t-1})$. The top panel in Table 28 presents the results for $\rho = 0.98$. They shows almost no difference compared to our baseline estimates.

Measurement error

The presence of classical measurement error ξ in income, health, and consumption (not serially correlated nor correlated between income, health, and consumption) would result in the typical attenuation effect. Indeed, it would lead to overestimate the variance of the transitory shocks and thus to underestimate the true pass-through coefficients:

$$\widehat{\phi}_c^{\varepsilon^h} = \frac{cov(\Delta ln(c_{i,t}), -\Delta h_{i,t+1})}{cov(\Delta h_{i,t}, -\Delta h_{i,t+1})} = \phi_c^{\varepsilon^h} \underbrace{\frac{var(\varepsilon_{i,t}^h)}{var(\varepsilon_{i,t}^h) + var(\xi_{i,t}^h)}}_{\leq 1} < \phi_c^{\varepsilon^h} \tag{50}$$

$$\widehat{\phi}_c^{\varepsilon^y} = \frac{cov(\Delta ln(c_{i,t}), -\Delta ln(y_{i,t+1}))}{cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+1}))} = \phi_c^{\varepsilon^y} \underbrace{\frac{var(\varepsilon_{i,t}^y)}{var(\varepsilon_{i,t}^y) + var(\xi_{i,t}^y)}}_{\leq 1} < \phi_c^{\varepsilon^y} \tag{51}$$

The middle panel in Table 28 presents the estimates obtained assuming that $var(\xi_{i,t}^y) = 0.46 * var(\varepsilon_{i,t}^y)$ (which is the ratio implied by the results of Meghir and Pistaferri (2004) in the PSID), and correcting for such a degree of measurement error. The pass-through of transitory income shocks in this case is 0.186 instead of 0.127. If we were to assuming that the ratio of variance of measurement error over the variance of the shocks is the same for health, and correct for it, the true pass-through of transitory health shocks would be 0.253 instead of 0.173.

Uniformly distributed income shocks

We now consider a situation in which shocks no longer occur at one deterministic point in time every year. Rather, we follow Crawley (2020) in assuming that income shocks are uniformly distributed. Hence, they can occur at any point in time within a year (although the reality probably lies in between the two assumptions: they occur with a higher probability at certain periods). In that case, our identification strategy underestimates the true pass-through. Indeed, given that we observe variables every two years, the moment that we use to identify the pass-through of transitory income shocks becomes:[21]

$$\widehat{\phi}_c^{\varepsilon^y} = \frac{cov(\Delta ln(c_{i,t}), -\Delta ln(y_{i,t+1}))}{cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+1}))} = \phi_c^{\varepsilon^y} - \frac{1}{2}\frac{(3\phi_c^{\eta^y} - \phi_c^{\varepsilon^y})var(\eta_t^y)}{6var(\varepsilon_t^y) - var(\eta_t^y)} < \phi_c^{\varepsilon^y} \tag{52}$$

Thus, this gives rise to a downward bias. For given values (or given ranges of values) of the pass-through of permanent shocks we can re-estimate our pass-through of transitory shocks under this assumption of uniformly distributed shocks. The bottom panel in Table 28 presents the estimates obtained under the assumption that $\phi_c^{\eta^y} = 0.338$ (as in Crawley (2020)), $\phi_c^{\eta^h} = 0.520$ (chosen to keep equal the ratios $\frac{\phi_c^{\eta^y}}{\phi_c^{\varepsilon^y}} = \frac{\phi_c^{\eta^h}}{\phi_c^{\varepsilon^h}}$), $\phi_m^{\eta^y} = 0.241$ (chosen to keep equal the ratios $\frac{\phi_c^{\eta^y}}{\phi_c^{\varepsilon^y}} = \frac{\phi_m^{\eta^y}}{\phi_m^{\varepsilon^y}}$), and $\phi_m^{\eta^h} = 1$. With this radically different assumption about the distribution of the shocks over time, the estimates increase. The pass-through to transitory income shocks becomes 0.190 instead of 0.127, and the pass-through to transitory health shocks is 0.429 instead of 0.173.

Imperfect overlap of health and consumption

So far we have considered that a period, the difference between t and $t+1$, is two years. To allow for an imperfect overlap of health and consumption, we now shift notation. We consider that one period is one year and we assume that health is observed one year after consumption, rather than at the same point in time. This is because while, in our data, consumption is observed around October, health is typically observed between April and December of the following year, that is 6 to 14 months later.

Given that the transitory component of health is an MA(0) process when a period is two years, we assume that it is an MA(1) process when a period is one year: $h_{i,t} = \pi_{i,t}^h + \varepsilon_{i,t}^h + \theta\varepsilon_{i,t-1}$

The estimator of the pass-through coefficient of transitory health shocks to con-

[21]This corresponds to Eq. (9) Crawley (2020), except for the $\frac{1}{2}$ coefficient in front of the bias, because we only aggregate income over one of the two year periods that we use.

sumption that we use rewrites as

$$\widehat{\phi}_c^{\varepsilon^h} = \frac{cov\big(ln(c_{i,t}) - ln(c_{i,t-2}), -(h_{i,t+3} - h_{i,t+1})\big)}{cov\big(h_{i,t+1} - h_{i,t-1}), -(h_{i,t+3} - h_{i,t+1})\big)} = \frac{cov\big(ln(c_{i,t}) - ln(c_{i,t-2}), \theta\varepsilon_{i,t}\big)}{var\big(\varepsilon_{i,t+1} + \theta\varepsilon_{i,t}\big)} \tag{53}$$

$$\neq \frac{cov\big(ln(c_{i,t}) - ln(c_{i,t-2}), \varepsilon_{i,t} + \theta\varepsilon_{i,t-1}\big)}{var\big(\varepsilon_{i,t} + \theta\varepsilon_{i,t-1}\big)} = \phi_c^{\varepsilon^h} \tag{54}$$

The exact sign of the bias is ambiguous. On the one hand, $cov\big(ln(c_{i,t}) - ln(c_{i,t-2}), \varepsilon_{i,t}\big)$ is indexed by θ (likely to be smaller than one) in our estimator, and it does not include the term $cov\big(ln(c_{i,t-1}) - ln(c_{i,t-2}), \varepsilon_{i,t-1}\big)$ (likely to be positive). On the other hand, it does not include the term $cov\big(ln(c_{i,t}) - ln(c_{i,t-1}), \varepsilon_{i,t-1}\big)$, that is, the effect of the shock in between the two years on subsequent consumption growth (likely to be negative because of precautionary behavior: a good shock reduces precautionary needs thus subsequent consumption growth).

Anticipation

Because Table 1 and Table 16 show that people may have some advance information about future permanent health shocks, we now allow those shocks to be partly anticipated as follows

$$\eta_t^h = \eta_t^{h,ant,t-2} + \eta_t^{h,ant,t-1} + \eta_t^{h,surp}, \tag{55}$$

where $\eta_t^{h,ant,t-2}$ denotes the part of η_t^h that is anticipated two periods ahead, $\eta_t^{h,ant,t-1}$ the part anticipated one period ahead, and $\eta_t^{h,surp}$ the surprise part, which is not anticipated.

To determine how this anticipation affects our estimate of the pass-through of transitory health shocks to consumption, recall its definition and replace the expression for η_t^h from the previous equation in it, as follows

$$\widehat{\phi}_c^{\varepsilon^h} = \frac{cov(\Delta ln(c_t), -\Delta h_{t+1})}{cov(\Delta h_t, -\Delta h_{t+1})} = \frac{cov(\Delta ln(c_t), -\eta_{t+1}^{h,ant,t-1} - \eta_{t+1}^{h,ant,t} + \varepsilon_t)}{cov(\Delta h_t, -\Delta h_{t+1})} < \phi_c^{\varepsilon^h} \tag{56}$$

To justify the direction of inequality in this equation, and thus show that this anticipation effects reduce our estimated pass through coefficient, we use the information in Table 1 in the paper. Indeed, Table 1 implies that the anticipation of a negative future permanent health shock decreases consumption. Thus

$$cov(\Delta ln(c_t), -\eta_{t+1}^{h,ant,t-1}) < 0. \tag{57}$$

In addition, when the extent to which consumption responds does not change from one period to the next, we have

$$cov(\Delta ln(c_{t-1}), -\eta_{t+1}^{h,ant,t-1}) \approx cov(\Delta ln(c_t), -\eta_{t+1}^{h,ant,t}). \tag{58}$$

Equation (56) thus becomes

$$\begin{aligned}
\widehat{\phi}_c^{\varepsilon^h} &= \frac{cov(\Delta ln(c_t), -\eta_{t+1}^{h,ant,t-1} - \eta_{t+1}^{h,ant,t} + \varepsilon_t)}{cov(\Delta h_t, -\Delta h_{t+1})} \\
&= \frac{cov(ln(c_t), -\eta_{t+1}^{h,ant,t-1}) \overbrace{-cov(ln(c_{t-1}), -\eta_{t+1}^{h,ant,t-1}) + cov(ln(c_t), -\eta_{t+1}^{h,ant,t})}^{\approx 0} + cov(\Delta ln(c_t), \varepsilon_t)}{cov(\Delta h_t, -\Delta h_{t+1})} \\
&\approx \frac{\overbrace{cov(ln(c_t), -\eta_{t+1}^{h,ant,t-1})}^{<0} + cov(\Delta ln(c_t), \varepsilon_t)}{cov(\Delta h_t, -\Delta h_{t+1})} \\
&< \frac{cov(\Delta ln(c_t), \varepsilon_t)}{cov(\Delta h_t, -\Delta h_{t+1})} = \phi_c^{\varepsilon^h}
\end{aligned}$$

This means that our estimate of the pass through of a transitory health shock to consumption is a lower bound on the true pass through. Intuitively, consumption does not increase as much with a decrease in health next period $-\Delta h_{t+1} = -\eta_{t+1}^{h,ant,t-1} - \eta_{t+1}^{h,ant,t} + \varepsilon_t$ because such a decrease now captures both a positive realization of the transitory health shock at t (the term ε_t) but also negative signals about future permanent health at $t+1$ (the terms $-\eta_{t+1}^{h,ant,t-1}$ and $-\eta_{t+1}^{h,ant,t}$).

A similar reasoning applies when transitory shocks are anticipated. In that case, our estimate of the pass-through of transitory shock to consumption is given by

$$\widehat{\phi}_c^{\varepsilon^h} = \frac{cov(\Delta ln(c_t), -\varepsilon_{t+1}^{h,ant,t-1} - \varepsilon_{t+1}^{h,ant,t} + \varepsilon_t + \varepsilon_t^{h,ant,t-1} + \varepsilon_t^{h,ant,t-2})}{cov(\Delta h_t, -\Delta h_{t+1})} < \phi_c^{\varepsilon^h}. \tag{59}$$

The terms $-\varepsilon_{t+1}^{h,ant,t-1} - \varepsilon_{t+1}^{h,ant,t}$ can be thought of in the same way as the anticipated component of permanent shocks. The new terms $\varepsilon_t^{h,ant,t-1} + \varepsilon_t^{h,ant,t-2}$ correspond to past signals about the current transitory health shock. Theoretically, their effect on consumption growth should be zero in the absence of precautionary savings and negative in its presence. Empirically, Commault (2022) finds past transitory shocks to negatively affect subsequent consumption growth among working age households.

Online Appendix K: Decomposition for finer subcategories

	All	Lower wealth	Higher wealth
Necessities $\phi^h_{necessities}$	.076	.344***	-.046
	(.09)	(.141)	(.112)
Resources channel	-.005	.019	-.007
	(.004)	(.016)	(.005)
Change in med. exp. $-\phi^h_m E[p_m m]$	-1117.91**	-2137.017***	-420.397
	(528.194)	(690.707)	(679.599)
Change in luxuries $-\phi^h_{luxuries} E[p_{lux} luxuries]$	3074.428***	679.949	4219.22**
	(1271.419)	(730.863)	(1863.372)
Multiplier $f_3^{necessities}\|_0$ (10^{-6})	2.707***	12.656***	1.712*
	(.96)	(4.498)	(.924)
Marginal utility channel	.081	.326**	-.04
	(.091)	(.142)	(.113)
Luxuries $\phi^h_{luxuries}$	.366***	.206	.438**
	(.15)	(.22)	(.193)
Resources channel	0.001	.01	.004
	(.004)	(.017)	(.006)
Change in med. exp. $-\phi^h_m E[p_m m]$	-1117.91**	-2137.017***	-420.397
	(528.194)	(690.707)	(679.599)
Change in necessities $-\phi^h_{necessities} E[p_{nec} necessities]$	977.49	3297.646***	-634.37
	(1159.97)	(1342.11)	(1533.279)
Multiplier $f_3^{luxuries}\|_0$ (10^{-6})	2.775*	-8.782	3.612***
	(1.588)	(8.386)	(1.495)
Marginal utility channel	.365***	.196	.434***
	(.151)	(.218)	(.194)
Obs.	4994	966	4028

Standard errors in parentheses. * at 10%, ** at 5%, *** at 1%

Table 29: Decomposition of pass through estimates (Appendix).

Table 29 presents the decomposition of the pass-through of transitory health shocks to necessities and luxuries into the resources and marginal utility channel. The method is the same as the one we use to decompose the pass-through of transitory health shocks to total non-durable consumption. However, the underlying assumption is now that period utility is separable in the consumption of necessities and luxuries. Thus, the consumption of one only affects the other by reducing the resources available to consume it. Note that resources available for the consumption of one category of goods and services can now be reduced by a health shock because of two things: a change in the consumption of medical expenses, and a change in the consumption of the other category of consumption.

Results are less precise but the Table suggests that, among lower-wealth households, the resources channel seems more important for necessities than for luxuries. Among higher-wealth households, the resources channel is close to zero in both cases, and only the marginal utility channel for luxuries explains their response.

Online Appendix L: Mapping between partial derivatives of the consumption function and of the utility function

Derivation of the marginal utility. Here, we express the pass-through of transitory shocks to consumption in terms of the partial derivatives of the utility function (instead just in terms of the partial effects f_m, f_h, and f_R that we define in Section 2). Let us start from the same Euler equation

$$\begin{aligned}
&u_c(c_t, \tilde{m}(m_t), h_t) \geq \\
&\quad E_t\Bigg[u_c\Bigg(c_{t+1}\big(((1+r_t)p_t a_t + p_t y_t - p_t^m m_t - p_t^c c_t)/p_{t+1}, \pi_t^y + \eta_{t+1}^y, \varepsilon_{t+1}^y, \pi_t^h + \eta_{t+1}^h, \varepsilon_{t+1}^h\big), \\
&\quad \tilde{m}\big(m_{t+1}\big(((1+r_t)p_t a_t + p_t y_t - p_t^m m_t - p_t^c c_t)/p_{t+1}, \pi_t^y + \eta_{t+1}^y, \varepsilon_{t+1}^y, \pi_t^h + \eta_{t+1}^h, \varepsilon_{t+1}^h\big)\big), \\
&\quad \pi_t^h + \eta_{t+1}^h + \varepsilon_{t+1}^h\Bigg)\tilde{s}_{t+1}(\pi_t^h + \eta_{t+1}^h)R_{t+1}\Bigg]. \qquad (9)
\end{aligned}$$

Because transitory shocks have no effects on the future distribution of income and health, nor on people's survival probability, they only influence consumption and medical spending through the first two channels: the marginal utility channel and the resources channel. To see this, note that when we take the derivative of the Euler equation (9) with respect to transitory income and health shocks, only the terms in red and blue are affected. More precisely, deriving both sides with respect to a transitory income shock and rearranging yields

$$\frac{dc_t}{d\varepsilon_t^y}u_{cc}^t + \frac{dm_t}{d\varepsilon_t^y}\tilde{m}'(m_t)u_{c\tilde{m}}^t + \frac{dh_t}{d\varepsilon_t^y}u_{ch}^t = \left(\frac{d((1+r_t)p_t a_t + p_t y_t - p_t^m m_t)}{d\varepsilon_t^y} - p_t^c\frac{dc_t}{d\varepsilon_t^y}\right)\xi_t$$

$$\frac{dc_t}{d\varepsilon_t^y} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^y}\tilde{m}'(m_t)u_{c\tilde{m}}^t - \frac{dh_t}{d\varepsilon_t^y}u_{ch}^t\right)\frac{1}{\vartheta_t}}_{\text{Marginal utility (=0 when } u_{c\tilde{m}}^t = u_{ch}^t = 0)} + \underbrace{\left(p_t\frac{dy_t}{d\varepsilon_t^y} - p_t^m\frac{dm_t}{d\varepsilon_t^y}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}},$$

and deriving both sides with respect to transitory health shock similarly yields

$$\frac{dc_t}{d\varepsilon_t^h}u_{cc}^t + \frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t + \frac{dh_t}{d\varepsilon_t^h}u_{ch}^t = \left(\frac{d((1+r_t)p_t a_t + p_t y_t - p_t^m m_t)}{d\varepsilon_t^h} - p_t^c\frac{dc_t}{d\varepsilon_t^h}\right)\xi_t$$

$$\frac{dc_t}{d\varepsilon_t^h} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t - \frac{dh_t}{d\varepsilon_t^h}u_{ch}^t\right)\frac{1}{\vartheta_t}}_{\text{Marginal utility (=0 when } u_{c\tilde{m}}^t = u_{ch}^t = 0)} + \underbrace{\left(p_t\frac{dy_t}{d\varepsilon_t^h} - p_t^m\frac{dm_t}{d\varepsilon_t^h}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}},$$

with $u_{cc}^t = u_{cc}(c_t, \tilde{m}(m_t), h_t)$, $u_{c\tilde{m}}^t = u_{c\tilde{m}}(c_t, \tilde{m}(m_t), h_t)$ and $u_{ch}^t = u_{ch}(c_t, \tilde{m}(m_t), h_t)$ the partial derivatives of u_c, $\xi_t \equiv E_t\left[\frac{1}{p_{t+1}}\left(c_a^{t+1}u_{cc}^{t+1} + \tilde{m}_a^{t+1}u_{c\tilde{m}}^{t+1}\right)\tilde{s}_{t+1}R_{t+1}\right]$[22] the effect of a one dollar change in current resources on the right hand side of the Euler equation (holding other terms constant), $\vartheta_t \equiv u_{cc}^t + p_t^c\xi_t$ the effect of a change in consumption on the left hand side of the Euler equation, so that $\frac{\xi_t}{\vartheta_t}$ measures by how much current consumption should change to absorb the effect of a change in resources in the Euler equation, holding constant the $\tilde{m}_t$ and h_t in the marginal utility function. Using the lack of correlation between the transitory shocks to set $\frac{dh_t}{d\varepsilon_t^y} = 0$ and also $\frac{dy_t}{d\varepsilon_t^h} = 0$ (i.e. noting that available resources to consume and save only change because of the impact of the health shock on medical expenses but not on income), using the definitions of our shocks which imply $\frac{dy_t}{d\varepsilon_t^y} = \frac{dln(y_t)}{d\varepsilon_t^y}y_t = y_t$ and also $\frac{dh_t}{d\varepsilon_t^h} = 1$ and rearranging

$$\frac{dc_t}{d\varepsilon_t^y} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^y}\tilde{m}'(m_t)u_{c\tilde{m}}^t\right)\frac{1}{\vartheta_t}}_{\text{Marginal utility}} + \underbrace{\left(p_t y_t - p_t^m\frac{dm_t}{d\varepsilon_t^y}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}}$$

$$\frac{dc_t}{d\varepsilon_t^h} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t - u_{ch}^t\right)\frac{1}{\vartheta_t}}_{\text{Marginal utility}} + \underbrace{\left(-p_t^m\frac{dm_t}{d\varepsilon_t^h}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}}$$

[22]In that expression, c_a^{t+1} and $\tilde{m}_a^{t+1}$ are the partial derivatives of $c^{t+1}(a_{t+1}, \pi_{t+1}^y, \pi_{t+1}^h, \varepsilon_{t+1}^y, \varepsilon_{t+1}^h)$ and $\tilde{m}(m^{t+1}(a_{t+1}, \pi_{t+1}^y, \pi_{t+1}^h, \varepsilon_{t+1}^y, \varepsilon_{t+1}^h))$ with respect to their first argument.

Using our empirical finding that, after age 65, people do not adjust their out-of-pocket medical expenses when experiencing transitory income changes (that is, $\frac{dm_t}{d\varepsilon_t^y} \approx 0$),[23] there is no effect of a transitory income shock through the marginal utility channel. We obtain

$$\frac{dc_t}{d\varepsilon_t^y} = \underbrace{\left(p_t y_t - p_t^m \frac{dm_t}{d\varepsilon_t^y}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}}$$

$$\frac{dc_t}{d\varepsilon_t^h} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t - u_{ch}^t\right)\frac{1}{\vartheta_t}}_{\text{Marginal utility}} + \underbrace{\left(-p_t^m\frac{dm_t}{d\varepsilon_t^h}\right)\frac{\xi_t}{\vartheta_t}}_{\text{Resources}}$$

Moving to logs

$$\frac{dln(c_t)}{d\varepsilon_t^y} = \underbrace{\left(p_t y_t - p_t^m \frac{dm_t}{d\varepsilon_t^y}\right)\frac{\xi_t}{c_t\vartheta_t}}_{\text{Resources}}$$

$$\frac{dln(c_t)}{d\varepsilon_t^h} = \underbrace{\left(-\frac{dm_t}{d\varepsilon_t^h}\tilde{m}'(m_t)u_{c\tilde{m}}^t - u_{ch}^t\right)\frac{1}{c_t\vartheta_t}}_{\text{Marginal utility} = \text{MU}^{c,t}} + \underbrace{\left(-p_t^m\frac{dm_t}{d\varepsilon_t^h}\right)\frac{\xi_t}{c_t\vartheta_t}}_{\text{Resources} = \text{R}^{c,t}}$$

Mapping. Now, we map the expressions of the marginal utility and resources channel obtained above, which are in terms of the partial derivatives of the utility function, with the expressions of the marginal utility and resources channel obtained in the paper, which are in terms of the partial derivatives of the function $f^{c,t}$

$$\text{MU}^{c,t} = f_m^{c,t}\frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t} = \left(-\tilde{m}'(m_t)u_{c\tilde{m}}^t\frac{dm_t}{d\varepsilon_t^h} - u_{ch}^t\right)\frac{1}{c_t\vartheta_t} \tag{60}$$

$$\text{R}^{c,t} = -f_R^{c,t}p_t^m\frac{dm_t}{d\varepsilon_t^h} = -\frac{\xi_t}{c_t\vartheta_t}p_t^m\frac{dm_t}{d\varepsilon_t^h} \tag{61}$$

[23]We estimate our income pass-through coefficient for medical expenses to income, ϕ_m^y to be ≈ 0. This implies $E[\frac{dln(m_t)}{d\varepsilon_t^y}] = E[\frac{dm_t}{d\varepsilon_t^y}m_t] \approx 0$. We also find that m_t is strictly positive for most of people in our sample (only 137 out of the 5,019 are below 100$). If the sign of $\frac{dm_t}{d\varepsilon_t^y}$ is the same across all households, it must actually be zero for everyone for $E[\frac{dm_t}{d\varepsilon_t^y}\underbrace{m_t}_{>0}] = 0$. Else $E[\frac{dm_t}{d\varepsilon_t^y}m_t]$ would be strictly non-zero and of the sign of $\frac{dm_t}{d\varepsilon_t^y}$.

This means that:

$$f_m^{c,t} = \frac{\tilde{m}'(m_t)(-u_{c\tilde{m}}^t)}{c_t \vartheta_t} \tag{62}$$

$$f_h^{c,t} = \frac{(-u_{ch}^t)}{c_t \vartheta_t} \tag{63}$$

$$f_R^{c,t} = \frac{\xi_t}{c_t \vartheta_t} \tag{64}$$

Going one step further, when medical expenses do not respond to a change in income, the partial effect of assets—holding health and income constant—coincides with the partial effect of resources holding marginal utility identical, that is, with the multiplier on the resources channel $c_a^t = \frac{\xi_t}{\vartheta_t} = \frac{\xi_t}{u_{cc}^t + p_t^c \xi_t}$. Plugging this (taken at $t+1$) into the expression of ξ_t:

$$\xi_t = E_t\Bigg[\underbrace{(c_a^{t+1}}_{=\frac{\xi_{t+1}}{u_{cc}^{t+1}+p_{t+1}^c\xi_{t+1}}} u_{cc}^{t+1} + \underbrace{\tilde{m}_a^{t+1}}_{\substack{\text{Response of med.}\\ \text{exp. to a change}\\ \text{in resources}\\ =0}} u_{c\tilde{m}}^{t+1}) \frac{\tilde{s}_{t+1}R_{t+1}}{p_{t+1}}\Bigg] = E_t\left[\frac{\xi_{t+1}}{u_{cc}^{t+1} + p_{t+1}^c \xi_{t+1}} u_{cc}^{t+1} \frac{\tilde{s}_{t+1}R_{t+1}}{p_{t+1}}\right]$$

By backward induction, if $u_{cc} \leq 0$ at all periods, then $\xi \leq 0$ and $\vartheta = u_{cc}^t + p_t^c \xi_t \leq 0$ at all periods as well. As a result

$$sign(f_m^{c,t} \frac{dm_t}{d\varepsilon_t^h} + f_h^{c,t}) = sign(\tilde{m}'(m_t) u_{c\tilde{m}}^t \frac{dm_t}{d\varepsilon_t^h} + u_{ch}^t) \tag{65}$$

If we find that the marginal utility channel is positive, it means that the effect of a change in health on the marginal utility of consumption (including its effect through medical expenses) is positive.