Online Appendix
to "Does Consumption Respond to Transitory Shocks?"

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A. LITERATURE REVIEWS

A1. Estimations of MPCs from natural experiments

A number of papers exploit tax refunds and tax rebates to measure the marginal propensity to consume nondurables out of a transitory income shocks. Among them, Parker (1999) studies variations in take-home pay from predictable changes in Social Security taxes in the 1980's. He finds that the pass-through of a temporary increase in take-home pay to nondurable consumption is 0.54 over the next three months, significant at 1%. Souleles (1999) exploits tax refunds between 1979 and 1990 to measure the MPC out of transitory income. He finds that the MPC of strictly nondurable consumption out of a tax refund is 0.09 over the three months following receipt, statistically significant at 5%—with strictly nondurable consumption excluding apparel goods and services as well as some leisure goods and services so that his estimate is a lower bound for the MPC of the more general category of nondurable consumption. Souleles (2002) estimates that the MPC out of the change in take-home pay induced by the Reagan tax cuts is 0.66 over the next three months, significant at 5%. Johnson, Parker and Souleles (2006) study the 2001 Federal income tax rebate episode and find that the MPC of nondurable consumption out of the rebate is 0.37 over the three months following receipt, statistically significant at 1%. It is 0.69 over the six months following receipt, statistically significant at 1%. Agarwal, Liu and Souleles (2007) measure the response to the 2001 tax rebate in a panel dataset of credit card accounts rather than in a consumer survey dataset. They find that, although consumers initially use the rebate to pay off some of their debt, they later increase their expenses, with a large amount of heterogeneity in this increase across consumers. Misra and Surico (2011) refine the technique, using quantile regression techniques to account for heterogeneity in the response of consumption, and get a slightly lower MPC of nondurable consumption out of the 2001 tax rebates. Parker et al. (2013) study the 2008 Federal income tax rebate and estimate a MPC of nondurable consumption out of the rebate of 0.20 over the next three months, statistically significant at 1%. The MPC is 0.35 over the next six months, statistically significant at 5%. Misra and Surico (2014) rely on quantile regression techniques to account for heterogeneity in the response of consumption, and study both the 2001 and 2008 episodes of tax rebates. They obtain MPCs of nondurable consumption out of the 2001 and 2008 tax rebates of 0.68 and 0.23 over the next six months, statistically significant at 1% and 10%. Kaplan and Violante (2014) do their own trimming of the same data as Johnson, Parker and Souleles (2006), and estimate lower and more precisely measured pass-though coefficients, between 0.22 and 0.24 (second and third line of their Table 1).

Some more recent studies also rely on other types of transitory income variations. Baker and Yannelis (2017) and Gelman et al. (2018) exploit the 2013 government shutdown. They estimate the MPC of nondurable expenditures and total credit card spending over the next two weeks out of the temporary decrease in take-home pay caused by the shutdown to be 0.39 and 0.58, both statistically significant at 1%. Agarwal and Qian (2014) considers the effect of a cash payment program, the Growth Dividend Program, in Singapore, and estimate a MPC of credit card spending out of the cash payment of 0.80, statistically significant at 1%. Kan, Peng and Wang (2017) consider the effect of the 2009 Taiwan Shopping Voucher Program in Taiwan, and find that total expenses increased by 0.24% of the voucher value over the next three months, significant at 1%. Fagereng, Holm and Natvik (2018) measure the response to a lottery win. They estimate the MPC of total spending (with the growth in total spending measured as the difference between income growth and wealth growth) out of a small lottery prize (below $2,070) to be 1.35 over the next year, significant at 1%. The average MPC out of all sizes of lottery prizes is 0.52, significant at 1%.

A related but distinct literature relies on hypothetical survey responses rather than direct observations of consumption to measure how households respond to a transitory shock. Parker and Souleles (2019) review the differences between hypothetical survey measures and natural experiment measures.

A2. Semi-structural methods a la BPP

The BPP estimator has been adapted, extended, and put to use in diverse fields, and I provide a few examples for each. In household finance studies, Kaufmann and Pistaferri (2009) generalize the BPP method to account for advance information of consumers. Casado (2011) implements the BPP estimator in a database of Spanish households, in which consumption is not imputed; Blundell, Low and Preston (2013) adapt it to the use of cross-sectional data and to a more general income process. Hryshko (2014) allows for a correlation between the transitory and permanent shocks. Bayer and Juessen (2015) apply it to estimate the response of happiness to transitory and permanent income shocks. Etheridge (2015) uses the BPP estimator to disentangle rival specifications of income. Ghosh (2016) extends the BPP method to exploit both the second and third moments of log-income and log-consumption growth. Arellano, Blundell and Bonhomme (2017) let permanent income be an AR(1) with an endogenous AR coefficient. The estimator of Arellano, Blundell and Bonhomme (2017) is also more robust than the original BPP one in that it allows log-consumption growth to depend on current assets and on current permanent income, thus letting it to correlate with past shocks through the effect of those past shocks on current assets and permanent income.[1] Druedahl and Jørgensen (2020)

[1]However, as the authors focus on permanent shocks, they only present estimation results of the response to a transitory shock in simulated data (and in the Online Appendix (Figures S21-S23)). In the model, they obtain estimates that are small and not significant.

investigate a more general set-up in which households are not able to distinguish between the transitory and permanent shocks that they receive. They estimate, with a simulated method of moments, the information of households about the type of shocks that they receive, and find that consumers have almost perfect information about it. Crawley (2020) considers versions of the BPP estimator in which the permanent and transitory shocks are uniformly distributed over the period.

In labor, Ortigueira and Siassi (2013) and Heathcote, Storesletten and Violante (2014) use the BPP estimates as a benchmark against which they compare their simulation results. Blundell, Pistaferri and Saporta-Eksten (2016) allow for endogenous labor supply and estimate its elasticity to transitory and permanent wage shocks. Blundell, Pistaferri and Saporta-Eksten (2018) estimate the elasticity of hours spent with children to transitory and permanent wage shocks. The last two estimators focus on the pass-through of permanent shocks, and set to zero the wealth effect of transitory shocks on the wage rates of households (although they allow these shocks to affect labor supply).

In housing, Carlos Hatchondo, Martinez and Sanchez (2015) compare the consumption elasticities simulated from a model with mortgage default to the BPP estimates. Hedlund et al. (2017) use the BPP estimator to measure the elasticity of consumption to a change in house prices, among subgroups of households with different leverage ratios.

In development, Attanasio, Meghir and Mommaerts (2018) compare the BPP estimates of the elasticity of consumption to transitory and permanent income shocks at the village level and at the individual level, to assess the importance of within-village insurance mechanisms. Santaeulàlia-Llopis and Zheng (2018) measure the evolution of the BPP estimates of the elasticity of consumption to transitory and permanent income shocks during the period of large and sustained GDP growth in China.

B. Interpretation of the average pass-through coefficient as an average elasticity in the nonlinear case

Average elasticity In my statistical model, detrended log-consumption growth is a function of all current and past income shocks, ε and η, and of all the (independently drawn) consumption specific shocks ζ^c:

$$\Delta ln(c_{i,t}) = f_t(\varepsilon_{i,t},...,\varepsilon_{i,1},\eta_{i,t},...,\eta_{i,1},\zeta^c_{i,t},...,\zeta^c_{i,1}). \tag{B1}$$

To obtain an expression of the average elasticity of consumption to a transitory shock in the sample, I take an exact Taylor expansion of log-consumption growth around the point where the realization of the current transitory shock is zero:

$$\Delta ln(c_{i,t}) = f_t(0,\varepsilon_{i,t-1},...,\varepsilon_{i,1},\eta_{i,t},...,\eta_{i,1},\zeta^c_{i,t},...,\zeta^c_{i,1}) + \sum_{s=1}^{\infty}\frac{\varepsilon^s_{i,t}}{s!}\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon^s_{i,t}}\right)_{|0}, \tag{B2}$$

where the subscript $|_0$ indicates that the variable is considered at the point where $\varepsilon_{i,t} = 0$. The elasticity of consumption to a transitory shock of a household i at period t is:

$$\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}} = \sum_{s=1}^{\infty} \frac{\varepsilon_{i,t}^{s-1}}{(s-1)!} \left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s} \right)_{|0} . \tag{B3}$$

It writes as a polynomial of the current transitory shock. Because a transitory shock is independent of the permanent shocks η, of the other shocks ζ^c, and of its own past realizations, it is independent of $\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s} \right)_{|0}$. Thus, the average elasticity in the sample is:

$$E[\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}}] = \sum_{s=1}^{\infty} \frac{E[\varepsilon_{i,t}^{s-1}]}{(s-1)!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s} \right)_{|0} \right] . \tag{B4}$$

Case 1: Quadratic log-consumption and zero skewness When log-consumption is quadratic in the transitory shock $\varepsilon_{i,t}$, that is, such that $\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s} \right)_{|0} = 0$ for all $s \geq 3$, the average elasticity is:

(B5)

$$E[\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}}] = E\left[\left(\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}} \right)_{|0} \right] + \underbrace{E[\varepsilon_{i,t}]}_{=0} E\left[\left(\frac{\partial^2 \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^2} \right)_{|0} \right] = E\left[\left(\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}} \right)_{|0} \right] .$$

Now, when the skewness of transitory shocks is zero, $E[\varepsilon_{i,t}^3] = 0$, I show that the pass-through coefficient, which is the ratio of the covariance between log-income growth and the transitory shock over the variance of the transitory shock, takes the same value:

$$\phi^{\varepsilon} = \frac{cov(\Delta ln(c_{i,t}), \varepsilon_{i,t})}{var(\varepsilon_{i,t})} = \frac{1}{E[\varepsilon_{i,t}^2]} \sum_{s=1}^{\infty} \frac{E[\varepsilon_{i,t}^{s+1}]}{(s)!} E\left[\left(\frac{\partial^s \Delta ln(\tilde{c}_{i,t})}{\partial \varepsilon_{i,t}^s} \right)_{|0} \right] \tag{B6}$$

$$= \frac{1}{E[\varepsilon_{i,t}^2]} \left(E[\varepsilon_{i,t}^2] E\left[\left(\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}} \right)_{|0} \right] + \underbrace{\frac{E[\varepsilon_{i,t}^3]}{2!}}_{=0} E\left[\left(\frac{\partial^2 \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^2} \right)_{|0} \right] \right) \tag{B7}$$

$$= E\left[\left(\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}} \right)_{|0} \right] = E[\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}}] \tag{B8}$$

Case 2: Normal shocks I assume that each household draws its transitory shock from a normal distribution. The moment m of a variable x that is normally distributed is

$E[x^m] = \mathbb{1}_{\{m \text{ is even}\}} E[x^2]^{m/2}(m-1)!!$, so the average elasticity tends toward the following expression when the sample size tends to infinity (i.e. when the empirical distribution approaches its theoretical expression):[2]

$$\text{(B9)} \quad E[\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}}] = \sum_{s=1}^{\infty} \mathbb{1}_{\{(s-1) \text{ is even}\}} E[\varepsilon_{i,t}^2]^{(s-1)/2} \frac{(s-2)!!}{(s-1)!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s}\right)_{|0}\right]$$

$$\text{(B10)} \quad = \sum_{s=1}^{\infty} \mathbb{1}_{\{(s-1) \text{ is even}\}} \frac{E[\varepsilon_{i,t}^2]^{(s-1)/2}}{(s-1)!!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s}\right)_{|0}\right].$$

Now, the pass-through coefficient, that is, the ratio of the covariance between log-income growth and the transitory shock over the variance of the transitory shock tends toward the same value as the sample size tends to infinity:

$$\text{(B11)} \quad \hat{\phi}^{\varepsilon} = \frac{cov(\Delta ln(c_{i,t}), \varepsilon_{i,t})}{var(\varepsilon_{i,t})} = \frac{1}{E[\varepsilon_{i,t}^2]} \sum_{s=1}^{\infty} \frac{E[\varepsilon_{i,t}^{s+1}]}{(s)!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s}\right)_{|0}\right]$$

$$\text{(B12)} \quad = \sum_{s=1}^{\infty} \mathbb{1}_{\{(s+1) \text{ is even}\}} \frac{1}{E[\varepsilon_{i,t}^2]} E[\varepsilon_{i,t}^2]^{(s+1)/2} \frac{s!!}{s!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s}\right)_{|0}\right]$$

$$\text{(B13)} \quad = \sum_{s=1}^{\infty} \mathbb{1}_{\{(s+1) \text{ is even}\}} \frac{E[\varepsilon_{i,t}^2]^{(s-1)/2}}{(s-1)!!} E\left[\left(\frac{\partial^s \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}^s}\right)_{|0}\right] = E[\frac{\partial \Delta ln(c_{i,t})}{\partial \varepsilon_{i,t}}].$$

TABLE B1—MOMENTS OF THE DISTRIBUTION OF ε

	$E[\varepsilon_{i,t}^2]$	$E[\varepsilon_{i,t}^3]$	$E[\varepsilon_{i,t}^4]$	$E[\varepsilon_{i,t}^5]$
Mom.	0.0133	0.0007	0.0074	−0.0051
	(0.0025)	(0.0024)	(0.0036)	(0.0055)
Obs.	7,600	7,600	7,600	7,600

Note: Standard errors in parentheses are clustered at the household level.

Empirical moments To check whether some of these hypotheses about the distribution of the transitory shocks hold in the sample, I estimate the moments of the transitory

[2]When households are not drawing shocks all from the same normal distribution, but from J different normal distributions, with I the total number of households and I_{j_s} the number of households drawing from distribution j_s, it writes: $E[\varepsilon^m] = \frac{I_{j_1}}{I} E[\varepsilon^m | j = j_1] + .. + \frac{I_{j_J}}{I} E[\varepsilon^m | j = j_J] = \mathbb{1}_{\{m \text{ is even}\}} E[\varepsilon^2]^{m/2}(m-1)!!$. The only drawback is that I need a sufficiently large number of households drawing from each distribution $j \in J$ for the sample averages to converge towards their theoretical expressions.

shocks distribution, under the assumption that $\theta = 0.50$.[3] Table B1 shows that the odd-order moments, including the skewness, are small and not statistically significant. The even-order moments are positive, large, and statistically significant at 10%. The assumption of normality would be rejected, however, because the distribution is leptokurtic (the center and tails are fatter than a normal): $E[\varepsilon_{i,t}^4] > 3(E[\varepsilon_{i,t}^2])^2$.

C. Data

PSID 1978-1992: The main data source is the Panel Study of Income Dynamics (1978-1992), which contains longitudinal information on a representative sample of US households, surveyed every year. It started in 1968 with approximately 3,000 households, and both the original households and their splitoffs have been followed since. The period I consider is 1978-1992.[4] The files that I use are those of Blundell, Pistaferri and Preston (2008 dataset). They rely on original files from the Panel Study of Income Dynamics (1978-1992) and on original files from the Consumer Expenditure Survey (1978-1992). To deflate variables, I use Consumer Price Index (CPI) data obtained from the Bureau of Labor Statistics (1978-1992). As BPP, I select out households that are not continuously married over the period, those experiencing a dramatic change in family composition, those headed by a female, those with missing reports on race, education, and region, and those whose head is younger than 30 or older than 65. I also drop some income outliers. The dataset, the period, and the selection are the same as in BPP. The final sample is composed of 17,604 household-years observations, coming from 1,765 households. Among these, there are 7,600 for which current log-consumption growth, current log-income growth, and log-income growth two periods later are simultaneously observed, with log-income and log-consumption detrended from the current and past effects of a set of demographic characteristics.

Net income is the taxable family income reported by a household minus its financial income and minus the federal taxes paid on nonfinancial income.[5] Gross income is net income plus these taxes. Head and spouse earnings is the sum of the earnings reported by the head and the spouse.All three measures are deflated by the contemporaneous CPI, normalized at 1 over the 1982-1984 period.

Nondurable consumption is the sum of annual expenditures on food, alcohol, tobacco, nondurable services, heating fuel, public and private transport (including gasoline), personal care, and clothing, deflated by the CPI. Total consumption is the sum of nondurable

[3]The restrictions used for estimation are: $cov_t(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2}))) = \theta E[\varepsilon_{i,t}^2]$ for $E[\varepsilon_{i,t}^2]$; $cov_t(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2}))^2) = \theta^2 E[\varepsilon_{i,t}^3]$, and $cov_t((\Delta ln(y_{i,t}))^2,(-\Delta ln(y_{i,t+2}))) = \theta E[\varepsilon_{i,t}^3]$ for $E[\varepsilon_{i,t}^3]$; $cov_t(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2}))^3) = \theta^3 E[\varepsilon_{i,t}^4]$, $cov_t((\Delta ln(y_{i,t}))^2,(-\Delta ln(y_{i,t+2}))^2) = \theta^2 E[\varepsilon_{i,t}^4]$, and $cov_t((\Delta ln(y_{i,t}))^3,(-\Delta ln(y_{i,t+2}))) = \theta E[\varepsilon_{i,t}^4]$ for $E[\varepsilon_{i,t}^4]$; $cov_t(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2}))^4) = \theta^4 E[\varepsilon_{i,t}^5]$, $cov_t((\Delta ln(y_{i,t}))^2,(-\Delta ln(y_{i,t+2}))^3) = \theta^3 E[\varepsilon_{i,t}^5]$, $cov_t((\Delta ln(y_{i,t}))^3,(-\Delta ln(y_{i,t+2}))^2) = \theta^2 E[\varepsilon_{i,t}^5]$, and $cov_t((\Delta ln(y_{i,t}))^4,(-\Delta ln(y_{i,t+2}))) = \theta E[\varepsilon_{i,t}^5]$ for $E[\varepsilon_{i,t}^5]$.

[4]Following BPP, the CEX data that is used to impute consumption is difficult to use before 1978. After 1992, a number of the questions used by BPP to build their measure of income are redesigned.

[5]Total federal taxes are computed from TAXSIM. Federal taxes on nonfinancial income are assumed to be a proportion of total federal taxes; the proportionality coefficient is given by the ratio of nonfinancial income over total income.

consumption plus annual expenditures on other durable goods, including health (insurance, prescription drugs, medical services) and education, deflated by the CPI (normalized at 1 over the 1982-1984 period). Total consumption including services from vehicles and housing is the sum of total consumption plus the value of services from vehicles and housing. It is deflated by the CPI (normalized at 1 over the 1982-1984 period). As the PSID only reports expenditures on food (for a typical week), these three measures of consumption are imputed from the demographic characteristics of the households and from their food consumption, with the coefficients used for the imputation estimated with the CEX over the same period. The paper of BPP provides further details on the imputation (their section I.B.).

Heterogeneity partition Financial income from liquid wealth includes the head's income from rent, interest, and dividends, the spouse's income from rent, interest, and dividends, and the asset income of the other members of the household. Note that this definition excludes the asset part of farm income, the asset part of unincorporated business income, the asset part of farming or market gardening, the asset part of income from roomers and boarders, and the head's alimony, which correspond to income from illiquid wealth. Annual earnings is the sum of the earnings reported by the head and the spouse, deflated by the CPI. The category of employed households is made of those whose head declares to be working now or only temporarily laid-off (e.g. pregnancy leave); the category of unemployed comprises households who declare being unemployed and looking for work; the category of retired is made of households whose head declares being retired, permanently disabled, housewife, student, or other. Owners with a mortgage are households who declare owning the place in which they live and having a mortgage on this property; households without a mortgage or renters are households who declare owning and the property in which they live and not having any mortgage on it, or households who declare paying rent—the households which neither own nor pay rent on where they live are excluded. The variables on income from liquid assets, on the homeownership status, and on the mortgage status of the households are not included in the BPP dataset, so I use the original files of the Panel Study of Income Dynamics (1978-1992) and merge them with the BPP dataset. I downloaded them as packaged data, after registration, from https://simba.isr.umich.edu/Zips/ZipMain.aspx. These original files are available on the PSID repository associated with this paper, Commault (2020 dataset).

PSID 1999-2017: As a check, I run my estimator on Panel Study of Income Dynamics (1999-2017) data. This dataset is more recent and records more extensive consumption information, making it possible to avoid the use of imputed data. However, the survey is only conducted every other year. I use the original files of the Panel Study of Income Dynamics (1999-2017), downloaded as packaged data, after registration, from https://simba.isr.umich.edu/Zips/ZipMain.aspx. These original files are available on the PSID repository associated with this paper, Commault (2020 dataset). To deflate variables, I use CPI data obtained from the Bureau of Labor Statistics (1999-2017). The data selection is the same as in the main dataset. The final sample is composed of 20,925 household-year observations coming from 4,526 households. Among these, 11,089 are such that current and future log-income growth, as well as current log-consumption growth are simultaneously observed. The definitions of the variables follow BPP, except nondurable consumption, which does not include personal care and clothing (not recorded in the early waves of the post-1999 PSID), and corresponds to the sum of expenditures on food, alcohol, tobacco, nondurable services, utilities, gasoline, and transportation. The demographic characteristics that are included in the set of detrending variables are the same as well.

D. Estimating restrictions

Robust The estimating restriction on which I rely to robustly identify the pass-through coefficient ϕ^{ε} is:

$$E[\Delta ln(c_{i,t})(-\Delta ln(y_{i,t+2})) - \phi^{\varepsilon}\Delta ln(y_{i,t})(-\Delta ln(y_{i,t+2}))] = 0. \tag{D1}$$

Original BPP I follow exactly the method described in Blundell, Pistaferri and Preston (2008).

Simple non-robust The estimating restrictions on which I rely to build the counterfactual estimator that overidentifies ϕ^{ε}, with a bias when log-consumption is not a random walk, are:

$$E[\Delta ln(c_{i,t})(-\Delta ln(y_{i,t+2})) - \phi^{\varepsilon}\Delta ln(y_{i,t})(-\Delta ln(y_{i,t+2}))] = 0, \tag{D2}$$

$$E[\Delta ln(c_{i,t})(-\Delta ln(y_{i,t+1})) - \frac{1-\theta}{\theta}\phi^{\varepsilon}\Delta ln(y_{i,t})(-\Delta ln(y_{i,t+2}))] = 0, \tag{D3}$$

with θ taking the value estimated from the original BPP estimator over the same sample (it is $\theta = 0.211$ in the baseline estimation but this varies in the alternative specifications and in the numerical simulations).

Implementation I estimate the parameters with a generalized method of moments. Variances and covariances are not estimated year by year but over the whole sample (pooling all years together). Denoting $X_{i,t}$ the set of variables involved, κ the vector of parameters involved, and $g(X_{i,t},\kappa)$ the vector of restrictions that have a theoretical mean of zero in the sample, the estimates of the parameters are the values that minimize a norm of the sample analog of the moments:

$$\hat{\kappa} = \underset{\phi^{\varepsilon}}{\operatorname{argmin}} \left(\frac{1}{N}\sum_{n=1}^{N} g(X_n,\kappa)\right)^{\mathsf{T}} \hat{W} \left(\frac{1}{N}\sum_{n=1}^{N} g(X_n,\kappa)\right), \tag{D4}$$

with N the number of household-year observations (i,t) at which the variables are observed, and $\hat{W}$ a weighting matrix, chosen so the estimation of the standard error is robust to arbitrary within-household correlations (by construction, the residuals—i.e. the terms that average to zero—of the observations from the same household at different periods can be correlated because they include some of the same shocks for instance), and robust to heteroskedasticity. In practice, I use Stata and the gmm command, combined with the cluster option.

E. Dynamics

Pass-through of a transitory shock to future consumption I define the pass-though of transitory shocks to future log-consumption, denoted $\phi^{\varepsilon,+1}$, as follows:

$$\phi^{\varepsilon,+1} = \frac{cov(ln(c_{i,t+1}),\varepsilon_{i,t})}{var(\varepsilon_{i,t})}$$

It makes it possible at the same time to get a sense of the longer-run effect of the transitory shocks, and to test the random walk hypothesis that past shocks have no effect on log-consumption growth, so they should affect current and future consumption in the same way ($\phi^{\varepsilon,+1} = \phi^{\varepsilon}$).

Estimator It is possible to use the covariance between log-consumption growth at t and future log-income growth at $t+1$ to estimate this pass-though to future consumption (and therefore also the change in the pass-through of a transitory shock after one year $\phi^{\varepsilon,+1} - \phi^{\varepsilon}$)):

$$\begin{aligned} cov(\Delta ln(c_{i,t+1}),-\Delta ln(y_{i,t+2})) =& \theta(1-\theta)cov(\Delta ln(c_{i,t+1}),\varepsilon_{i,t+1}) \\ &+ \theta cov(\Delta ln(c_{i,t+1}),\varepsilon_{i,t}) \end{aligned} \tag{E1}$$

An estimator of the pass-through of a transitory shock to future consumption is:

$$\begin{aligned} \widehat{\phi^{\varepsilon,+1}} =& \frac{cov(\Delta ln(c_{i,t+1}),(-\Delta ln(y_{i,t+2})))}{cov(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2})))} \\ &+ \phi^{\varepsilon}\left(1 - \frac{1-\theta}{\theta}\frac{cov(\Delta ln(y_{i,t+1}),(-\Delta ln(y_{i,t+3})))}{cov(\Delta ln(y_{i,t}),(-\Delta ln(y_{i,t+2})))}\right), \end{aligned} \tag{E2}$$

assuming $\phi^{\varepsilon} = \frac{cov(ln(c_{i,t}),\varepsilon_{i,t})}{var(\varepsilon_{i,t})} = \frac{cov(ln(c_{i,t+1}),\varepsilon_{i,t+1})}{var(\varepsilon_{i,t+1})}$, which holds true when the number of periods in the sample is large enough so that including or not the first period in the sample does not make a difference in the value of ϕ^{ε}—or when ϕ^{ε} does not vary over time. Expression E2 requires knowing two things: the value of this pass-through ϕ^{ε}, and the persistence of the transitory shocks θ. The pass-through ϕ^{ε}, which is the main parameter of interest of the paper can be jointly estimated from (8) and (9) (the main estimating restrictions in the paper). The persistence θ can be jointly estimated from the expression of $cov(\Delta ln(y_{i,t+1}),-\Delta ln(y_{i,t+2}))$, which rewrites as a quadratic expression of

θ:

$$\begin{aligned}
&\theta^2 cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2})) \\
\text{(E3)} \quad & \\
&-\theta\Big(cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2})) + cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+3})) \\
&+ cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+2}))\Big) + cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+3})) + \theta var(\zeta^y_{i,t+1}) = 0
\end{aligned}$$

This requires making assumptions about the magnitude of the variance of measurement error $var(\zeta_{i,t+1})$. I express in proportion to the variance of the transitory shocks, $var(\varepsilon_{i,t+1})$, and test different assumptions about this proportion.[6] In practice, in my baseline specification, there are two real roots to this equation and both are positive, with one below one and one above four. I put a small initial value to θ, so my estimate is the root below one, following Meghir and Pistaferri (2004) who find that θ should be smaller than one in the 1967-1992 PSID (see their p.11). These restrictions require a longer panel, so they reduce the size of the sample on which these parameters are estimated.

Estimator with continuous shocks When transitory and permanent income shocks are drawn uniformly over the period rather than once at the beginning of each period, as suggested by Crawley (2020), it does not affect the robust estimation of the pass-through of transitory shocks to contemporaneous consumption,[7] but it does affect the estimation of the dynamics: the moments above, (E2) and (E4) are not the same. Under the assumption of uniformly distributed shocks, from Crawley (2020), these two moments above rewrite as:

$$\begin{aligned}
&\widehat{\phi^{\varepsilon,+1}} = \frac{cov(\Delta ln(c_{i,t+1}), (-\Delta ln(y_{i,t+2})))}{cov(\Delta ln(y_{i,t}), (-\Delta ln(y_{i,t+2})))} + \phi^{\varepsilon}\left(1 - \frac{1-\theta}{\theta}\frac{cov(\Delta ln(y_{i,t+1}), (-\Delta ln(y_{i,t+3})))}{cov(\Delta ln(y_{i,t}), (-\Delta ln(y_{i,t+2})))}\right) \\
\text{(E4)} \quad & \\
&\qquad + share\frac{1}{2}\phi^{\eta}\frac{cov(\Delta ln(y_{i,t+1}), ln(y_{i,t+2}) - ln(y_{i,t-3})))}{cov(\Delta ln(y_{i,t}), (-\Delta ln(y_{i,t+2})))},
\end{aligned}$$

[6]Formally, I substitute $\theta var(\zeta_{i,t+1})$ with $\theta var(\zeta_{i,t+1}) = k\theta var(\varepsilon_{i,t+1}) = kcov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+3}))$, and make different assumptions about k.

[7]It does not affect it provided that the persistence of the transitory shock is not continuous, but is modeled as receiving over the next year a one-off shock that is a proportion θ of the value of the transitory shock.

and as:

$$
\begin{aligned}
&\theta^2 cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2})) - \theta \bigg(cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2})) \\
&+ cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+3})) + cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+2})) \bigg) \\
&+ cov(\Delta ln(y_{i,t+1}), -\Delta ln(y_{i,t+3})) + \theta var(\zeta^y_{i,t+1}) \\
&- share \frac{1}{6} cov(\Delta ln(y_{i,t+1}), ln(y_{i,t+2}) - ln(y_{i,t-3}))) = 0,
\end{aligned}
\tag{E5}
$$

where $cov(\Delta ln(y_{i,t+1}), ln(y_{i,t+2}) - ln(y_{i,t-3}))) = var(\eta_{i,t+1})$ when income is a transitory-permanent process. The parameter *share* makes it possible to embed the discrete case in a more general framework: the parameter determines the share of the variance of the permanent shocks that comes from uniformly distributed shocks.[8] Thus, in the case considered by Crawley, $share = 1$, and in the purely discrete case, $share = 0$. I also need to make assumptions about the value of the pass-through of permanent shocks to consumption, ϕ^η. I set it at $\phi^\eta = 0.34$, from Crawley's results. These restrictions (E4) and (F1) require an even longer panel, so they further reduce the size of the sample on which these parameters are estimated.

Estimates Table E1 reports the results of these joint estimations under different set of assumptions: I consider that the variance of measurement error can be either 1.5, 2, or 0.5 time the variance of the transitory shocks, and that the share of the variance of permanent shocks that is driven by uniformly distributed shocks is either 0, 0.5, or 1. In all these scenarios, the pass-through of consumption to future consumption $\phi^{\varepsilon,+1}$ remains imprecisely measured. However, Table E1 shows that its point estimate is much smaller than the pass-through to contemporaneous consumption. In some cases it is even negative. This suggests that the effect of a transitory shock is short-lived, and that households might even either overshoot in the response of their contemporaneous consumption or consume more durable goods whose utility persists, leading them to possibly reduce their spending one period later. Over these smaller samples, the pass-through of contemporaneous shocks ϕ^ε remains large, at 0.648 and 0.688, statistically significant at 5%. The difference between the two pass-through coefficients is statistically significant at 5.3% in the third specification, in which the variance of measurement error is small. It is another way to reject the random walk assumption, which implies that the two coefficient should be the same. Finally, the persistence of the transitory shocks θ is precisely measured in all these specifications. The point estimates range from 0.385 to 0.857, substantially above the value $\theta = 0.211$ obtained with the original BPP estimator (on the same data, additionally detrended from the effect of past demographic characteristics). As a check, I set the variance of measurement error in income to zero and assume discrete shocks,

[8] One could for instance have two permanent shocks per household and per period, one being uniformly distributed, and the other discretely distributed. The term *share* would coincide with the ratio of the variance of the continuous permanent shock over the variance of the discrete permanent shock.

TABLE E1—CHANGE THE PASS-THROUGH OF TRANSITORY SHOCKS AFTER ONE YEAR $\phi^{\varepsilon,+1} - \phi^{\varepsilon}$

	Robust	Robust	Robust	Robust	Robust
$var(\zeta^y_{i,t})/var(\varepsilon_{i,t})$	1.5	2	0.5	1.5	1.5
share	0	0	0	0.5	1
$\phi^{\varepsilon,+1}$	−0.030	0.194	−0.911	0.101	0.239
	(0.327)	(0.314)	(0.585)	(0.308)	(0.297)
ϕ^{ε}	0.648	0.648	0.648	0.688	0.688
	(0.270)	(0.270)	(0.270)	(0.308)	(0.308)
$\phi^{\varepsilon} - \phi^{\varepsilon,+1}$	0.678	0.454	1.559	0.587	0.449
	(0.455)	(0.383)	(0.805)	(0.459)	(0.466)
θ	0.686	0.857	0.385	0.653	0.618
	(0.120)	(0.162)	(0.060)	(0.124)	(0.117)
Obs.	6,337	6,337	6,337	5,158	5,158
Est. moments	(8), (9) at k=1	(8), (9) at k=1	(8), (9) at k=1	(8), (9) at k=1	(8), (9) at k=1
	$(E.2), (E.3)$	$(E.2), (E.3)$	$(E.2), (E.3)$	$(E.4), (E.5)$	$(E.4), (E.5)$

Note: Consumption is nondurable consumption. Income is net income including transfers. Standard errors in parentheses are clustered at the household level.

as in the original BPP method, and I do obtain an estimate of $\theta = 0.249$, close to the original BPP estimate, so it is indeed the neglecting measurement error and assuming discrete shocks that drives their low estimate of θ.

F. ALTERNATIVE SPECIFICATIONS

TABLE F1—ESTIMATES UNDER ALTERNATIVE SPECIFICATIONS

	Baseline	AR(1) permanent income	Anticipations	Serially correlated measurement error
ϕ^{ε}	0.596	0.633	0.710	0.768
	(0.273)	(0.306)	(0.310)	(0.364)
$\underline{MPC^{\varepsilon}}$	0.320	0.340	0.379	0.413
	(0.147)	(0.165)	(0.166)	(0.196)
Obs.	7,600	7,600	5,158	7,600

Note: Standard errors in parentheses are clustered at the household level.

AR(1) permanent income In this alternative specification, I consider a more general income process in which permanent income is not necessarily a random walk, but simply an AR(1) with coefficient ρ:

$$p_t = \rho p_{t-1} + \eta_t.$$

With such a model, if $\rho \neq 1$, the estimator that I use is biased, because future log-income growth does not capture only the mean reversion of transitory income, but also the decline in the effect of the permanent shock.[9] The direction of the bias is undetermined, as it depends on the effect of past and contemporaneous permanent shocks on current log-consumption growth, which can go both ways.[10] Yet, conditionally on knowing the AR(1) coefficient ρ, Kaplan and Violante (2010) show that a consistent estimator can be obtained, substituting log-income growth with its quasi-difference. Denoting $\Delta^{\rho} ln(y_{i,t}) = ln(y_{i,t}) - \rho ln(y_{i,t-1})$, the consistent estimator is:

$$\hat{\phi}^{\varepsilon}_{AR1-\rho} = \frac{cov(\Delta ln(c_{i,t}), -\Delta^{\rho} ln(y_{i,t+2}))}{cov(\Delta^{\rho} ln(y_{i,t}), -\Delta^{\rho} ln(y_{i,t+2}))}. \tag{F1}$$

I implement such an estimator under the assumption that $\rho = 0.95$. The second column in Table F1 shows that the pass-through coefficient remains statistically significant at 5%. The point estimate is even larger than under the baseline random walk assumption, at 0.633, and the lower bound on the MPC is 0.340. Models in which the AR(1) coefficients are even lower than $\rho = 0.95$ yield even larger point estimates.

Anticipations In this alternative specification, I modify the statistical model by allowing part of the realizations of the permanent and transitory shocks at t to be anticipated at previous periods $t-s$ and $t-l$:

$$\eta_{i,t} = \eta_{i,t}^{surp} + \eta_{i,t}^{ant,t-s},$$
$$\varepsilon_{i,t} = \varepsilon_{i,t}^{surp} + \varepsilon_{i,t}^{ant,t-l}.$$

Each shock writes as the sum of a surprise component and of an anticipated component whose value realizes at t but is known at $t-s$ or $t-l$. The anticipated and surprise components of each shock are uncorrelated with each other. In the moments presented in Table 1 of the main paper, log-consumption growth at t no longer covaries with future log-income growth at $t+3$ or later, which is informative about how early each type of shock can be anticipated. Indeed, in the presence of anticipation, the covariance between

[9] The log-income growth of a household at $t+2$ then depends on all the permanent shocks it has received prior to $t+2$, instead of depending only on the permanent shock at $t+2$ and transitory shocks at $t+2$, $t+1$ and t: $\Delta ln(y_{t+2}) = \eta_{t+2} - (1-\rho)\eta_{t+1} - (1-\rho)\rho\eta_t - ... - (1-\rho)\rho^t\eta_1 - (1-\rho)\rho^{t+1}p_0 + \varepsilon_{t+2} - (1-\theta)\varepsilon_{t+1} - \theta\varepsilon_t$.

[10] In a standard life-cycle model with uncertainty, having received a positive permanent shock in the past increases current assets, relaxing the precautionary motive, but also increases the variance of future income, strengthening the precautionary motive.

log-consumption growth and future log-income growth at $t+3$ is:

$$\begin{aligned}0 &= cov(\Delta ln(c_{i,t}), \Delta ln(y_{i,t+3})) \\ &= \underbrace{cov(\Delta ln(c_{i,t}), \eta^{ant,t+3}_{i,t+3-s})}_{\neq 0 \text{ if } s>2} + \underbrace{cov(\Delta ln(c_{i,t}), \varepsilon^{ant,t+3}_{i,t+3-k})}_{\neq 0 \text{ if } l>2} - (1-\theta)\underbrace{cov(\Delta ln(c_{i,t}), \varepsilon^{ant,t+2}_{i,t+2-k})}_{\neq 0 \text{ if } l>1} \\ &\quad - \theta \underbrace{cov(\Delta ln(c_{i,t}), \varepsilon^{ant,t+1}_{i,t+1-l})}_{\neq 0 \text{ if } l>0}.\end{aligned} \tag{F2}$$

It implies that transitory shocks cannot anticipated (or that, if anticipated, households do not respond to these anticipations, e.g. because they are myopic or constrained, which has the same effect as a situation of no anticipation on the estimator), $l=0$. Indeed, otherwise $cov(\Delta ln(c_{i,t}), \varepsilon^{ant,t+1}_{i,t+1-k}) \neq 0$ and $cov(\Delta ln(c_{i,t}), \Delta ln(y_{i,t+3})) \neq 0$ (assuming away the knife-edge case in which the other terms that compose $cov(\Delta ln(c_{i,t}), \Delta ln(y_{i,t+3}))$ are exactly equal to the opposite of $cov(\Delta ln(c_{i,t}), \varepsilon^{ant,t+1}_{i,t+1-k})$). Regarding permanent shocks, they cannot be anticipated more than two periods in advance without some terms being non-zero in restriction (F2). Assuming away a knife-edge case in which the terms would be non-zero but perfectly compensate each other, it implies that $s \leq 2$. Now, when a permanent shock is anticipated one period in advance ($s=1$), the robust estimator remains unbiased. When a permanent shock is anticipated two periods in advance ($s=2$), however, and when the anticipation of a permanent shock affects log-consumption positively, then the robust estimator is downward biased. Indeed, in that case, the instrument is endogenous: future log-income growth at $t+2$ is negatively correlated with log-consumption growth at t through the current transitory shock but positively correlated with it through the anticipated component of the future permanent shock. The covariance between log-consumption growth and the instrument is smaller, in absolute value, because of the anticipation: not disentangling the two leads to underestimating the response of log-consumption to a contemporaneous transitory shock. A consistent estimator is:

$$\hat{\phi}^{\varepsilon}_{ant,s=2} = \frac{cov(\Delta ln(c_{i,t}), -\Delta ln(y_{i,t+2})) + \phi^{\eta,ant} var(\eta^{ant,t-2}_{i,t+2})}{cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2}))}. \tag{F3}$$

I implement this alternative estimator in my baseline dataset, under the assumption that $l=0$ and $s=2$, that the pass-through of the anticipated component of a permanent shock two years in the future is $\phi^{\eta,ant}=0.10$, and that 10% of the variance of a permanent shock is explained by the variance of the anticipated component, $\frac{var(\eta^{ant,t-2}_{i,t})}{var(\eta^{ant,t-2}_{i,t})+var(\eta^{surp}_{i,t})} = 0.10$.[11] The third column in Table F1 shows that the pass-through remains significant at

[11]The variance of the sum is estimated with $var(\eta^{ant,t-2}_{i,t}) + var(\eta^{surp}_{i,t}) = cov(\Delta ln(\tilde{y}_{i,t}), \Delta ln(\tilde{y}_{i,t-2}) + \Delta ln(\tilde{y}_{i,t-1}\Delta ln(\tilde{y}_{i,t}) + \Delta ln(\tilde{y}_{i,t+1}\Delta ln(\tilde{y}_{i,t+2}))$.

5%, and the point estimate increases to 0.710 when correcting for this downward bias. The lower bound on the MPC is 0.379.

Serial correlation in measurement error In this alternative specification, I consider a set-up in which measurement error ζ^y can be correlated over time. It is no longer orthogonal to its past values but such that: $\zeta^y_{i,t} = \dot{\zeta}^y_{i,t} + \nu\dot{\zeta}^y_{i,t-1}$, with ν a parameter measuring the strength of the serial correlation. Thus, log-income growth depends on past measurement error $\dot{\zeta}^y$ up to two periods ago:

$$\Delta ln(y_{i,t}) = \eta_{i,t} + \varepsilon_{i,t} - (1-\theta)\varepsilon_{i,t-1} - \theta\varepsilon_{i,t-2} + \dot{\zeta}^y_{i,t} - (1-\nu)\dot{\zeta}^y_{i,t-1} - \nu\dot{\zeta}^y_{i,t-2}$$

The presence of serial correlation in measurement error leads to an overestimation of the variance of the transitory shocks: the denominator measures $\theta var(\varepsilon_{i,t}) + \nu var(\dot{\zeta}_{i,t})$ instead of $\theta var(\varepsilon_{i,t})$, so part of what is measured as the variance of the transitory shocks is in fact the variance of measurement error. The estimation of the covariance between log-consumption growth and a current transitory shock, however, is unaffected because consumption does not respond to a change that is caused by measurement error. Thus, in the presence of serial correlation, the exactly identified estimator underestimates the elasticity of consumption to a transitory shock.[12] A consistent estimator is:

$$\text{(F4)} \qquad \hat{\phi}^{\varepsilon}_{sc\ in\ \zeta^y} = \frac{cov(\Delta ln(c_{i,t}), -\Delta ln(y_{i,t+2}))}{cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+2})) - (\nu/\theta)var(\dot{\zeta}_{i,t})}.$$

I implement this alternative estimator under the assumption that the MA(1) coefficient of the measurement error process is $\nu = 0.1$, and that the share of the variance of income measurement error is as large as the variance of the transitory shocks, $var(\dot{\zeta}_{i,t}) = var(\varepsilon_{i,t})$—and the point estimate increases when I assume that the variance of measurement error is larger than the variance of transitory shocks. The parameter θ is estimated from the covariance between current and future log-income growth, modified to incorporate serially correlated measurement error: $cov(\Delta ln(y_{i,t}), -\Delta ln(y_{i,t+1})) = (1-\theta)var(\varepsilon_{i,t}) - \theta(1-\theta)var(\varepsilon_{i,t}) + (1-\nu)var(\dot{\zeta}^y_{i,t}) - \nu(1-\nu)var(\dot{\zeta}^y_{i,t-1})$.[13] The fourth column in Table F1 shows that the point estimate of the pass-through coefficient increases

[12] If I additionally allow measurement error in consumption to correlate with measurement error in income, the generalized, robust estimator would overestimate both the covariance between log-consumption growth and a transitory shock and the variance of the transitory shocks. It still underestimates the elasticity to a transitory shock as long as the pass-through of measurement error in income to consumption (caused by the correlation between measurement error in consumption and in income) is smaller than its pass-through of transitory shocks to consumption, and that ν and θ are small: in that case, the robust estimator measures $\hat{\phi}^{\varepsilon} = \frac{\theta cov(\Delta ln(c_{i,t}),\varepsilon_{i,t}) + \nu cov(\Delta ln(c_{i,t}),\dot{\zeta}^y_{i,t})}{\theta var(\varepsilon_{i,t}) + \nu var(\dot{\zeta}^y_{i,t})} < \frac{cov(\Delta ln(c_{i,t}),\varepsilon_{i,t})}{var(\varepsilon_{i,t})} = \phi^{\varepsilon}$ if $\frac{cov(\Delta ln(c_{i,t}),\dot{\zeta}^y_{i,t})}{var(\dot{\zeta}^y_{i,t})} < \frac{1-\theta}{\nu}\frac{cov(\Delta ln(c_{i,t}),\varepsilon_{i,t})}{var(\varepsilon_{i,t})}$.

[13] In this expression I assume that $var(\varepsilon_{i,t}) \approx var(\varepsilon_{i,t-1})$, to keep more observations. When I let the two differ, I obtain obtain $\phi^{\varepsilon} = 0.807$, significant at 5%, estimated over 6,337 observations.

to 0.768, statistically significant at 5%, and the lower bound on the MPC increases to 0.413.

G. Variations in the set demographic characteristics, interactions, clusters, and measures of consumption and income

I check the sensitivity of the results to (i) variations in the set of demographic characteristics z_t; (ii) variations in the variables by which the effect of demographic characteristics are interacted; (iii) variations in the measures of consumption considered; (iv) variations in the measures of income considered.

Table G1—Estimates with alternative sets of detrending variables

	Baseline	$+t-2$	- Fixed	- Employment	- Geographic	Only year
ϕ^{ε}	0.596	0.576	0.639	0.513	0.557	0.385
	(0.273)	(0.353)	(0.226)	(0.290)	(0.277)	(0.320)
$\underline{MPC}^{\varepsilon}$	0.320	0.310	0.343	0.275	0.299	0.207
	(0.147)	(0.190)	(0.122)	(0.156)	(0.149)	(0.172)
Obs.	7,600	6,349	7,600	7,600	7,600	7,600

Note: Standard errors in parentheses are clustered at the household level.

Variations in the sets of detrending variables I examine the impact of varying the set of demographic characteristics that I use to detrend log-income and log-consumption. The baseline set of detrending variables is made of dummies for year, year-of-birth, family size, number of children, existence of outside dependent children, education, race, employment status, presence of an additional income recipient that is not the head or spouse, region, residence in a large city, at the current and immediately past period, plus the interactions of a subset of these dummies with year dummies, to allow their effect to vary over time. The second column of Table G1 presents the results that I obtain when I also add the value of these demographic characteristics two periods ago. The precision of the estimation drops a little, and the pass-through is only significant at the 10% level, but the point estimate is almost unchanged by this addition, at 0.576. For the specification reported in the third column, I remove from the baseline set of detrending variables the dummies for year-of-birth, education, and race—both at the current and past period—, which are characteristics that are unlikely to change over time, so detrending from their effect or not should not affect much the estimation. I obtain that, indeed, the point estimate does not shift much, and remains at 0.639, significant at the 1% level. In the fourth column, I remove dummies for employment status and for the presence of an extra income recipient—both at the current and past period—, which changes are likely to be correlated over time. I do find that such a change has a more substantial impact on the point estimate, which drops to 0.513, and is only significant at the 10% level. In the fifth column, I remove dummies for region and residence in a big city—both at the current and past period—, which changes are also likely to be correlated over time. The point estimate drops a little, to 0.557, statistically significant at the 5% level. Finally, in the sixth column, I only include year dummies as detrending variables. The pass-through is no longer precisely measured, but the point estimate remains large, at 0.385.

TABLE G2—ESTIMATES WITH ALTERNATIVE DEMOGRAPHIC INTERACTIONS

	Year	Year + edu.	Edu.	Year + edu. + coh.	Coh.
ϕ^{ε}	0.596	0.570	0.558	0.538	0.539
	(0.273)	(0.269)	(0.291)	(0.238)	(0.248)
$\underline{MPC}^{\varepsilon}$	0.320	0.306	0.300	0.289	0.290
	(0.147)	(0.145)	(0.156)	(0.128)	(0.133)
Obs.	7,600	7,600	7,600	7,600	7,600

Note: Standard errors in parentheses are clustered at the household level.

Variations in the demographic interactions I examine the impact of the choice of interactions allowed when detrending the effect of demographic characteristics on log-income and log-consumption. The baseline detrending model includes interactions between a subset of demographic characteristics and year dummies.[14] In the second column of Table G2 I additionally allow for interactions between the same subset of characteristics and education dummies. It does not greatly affect the point estimate of the pass-through coefficient, which only shifts to 0.570 and remains significant at the 5% level. In the third column, I only allow for interactions with educations dummies. The point estimate remains at 0.558. In the fourth column, I allow for three types of interactions, with year, education, and cohort dummies. The point estimate drops a little more, to 0.538, significant at the 5% level. Finally, in the fifth column, I consider a detrending model that includes only interactions with cohort dummies. The point estimate is 0.539, significant at the 10% level.

Variations in the measures of consumption Table G3 presents the pass-through of transitory shocks to three alternative measures of consumption: food, total consumption, and total consumption plus services from vehicles and housing. The exact content of each measure of consumption is described in Section C of this Online Appendix. The pass-through to food expenditures is 0.377, statistically significant at 10%. This smaller estimate suggests that food is less elastic than other nondurable consumption, although the difference is not statistically significant. The associate lower bound on the MPC is 0.066. This small value is partly a mechanical consequence of considering a smaller category

[14]The subset of characteristics that are interacted is made of education dummies, race dummies, employment status dummies, region dummies, and a dummy for residence in a large city.

TABLE G3—ESTIMATES WITH ALTERNATIVE MEASURES OF CONSUMPTION

	Nondur.	Food	Total	Total + services from veh. and housing
ϕ^{ε}	0.596	0.377	0.676	0.654
	(0.273)	(0.227)	(0.337)	(0.330)
$\underline{MPC}^{\varepsilon}$	0.320	0.066	0.559	0.744
	(0.147)	(0.040)	(0.279)	(0.376)
Obs.	7,600	7,613	7,600	7,600
Elasticity of the share of food in nondur. : -21.9%				
Elasticity of the share of nondur. in total : -8%				

Note: Standard errors in parentheses are clustered at the household level.

of expenditures: as food represents a small share of total expenditures, the share of a gain in income that is spent on food would be limited even if the household had multiplied its food expenditures by as much as other nondurable expenditures. Because food consumption is not imputed but directly reported in the PSID, the estimation of the food elasticity does not require making the assumptions implied by the imputation procedure. Still, the pattern is not too different from the one I obtain with imputed consumption: even the pass-through to food, which is likely to be particularly inelastic, is much above the original BPP estimate. The pass-through to total consumption is 0.676, significant at 5%. The lower bound on the MPC is 0.559, which means that more than half of a transitory income gain is spent on total consumption within the year. The pass-through to total consumption plus services from vehicles and housing is very similar to that of total consumption, at 0.654, statistically significant at 5%, which suggests that expenditures on services from vehicle and housing react in the same way as total expenditures, so that adding them does not modify the elasticity. The MPC is larger, however, at 0.744, because the size of the expenditures to which the elasticity applies is larger when these service expenditures are included.

Response of the composition of the consumption basket In a model of consumption decision such that the pass-through coefficients to these three measures of consumption can simultaneously be interpreted as average elasticities—so that I am not changing specification when changing the category of consumption considered—, the comparison between the pass-through coefficients provides information about the elasticity of the composition of the consumption basket to a transitory shock:[15]

$$E\left[\frac{d(c_{i,t}^{\text{Food}}/c_{i,t}^{\text{Nondur.}})}{d\varepsilon_{i,t}}\frac{1}{(c_{i,t}^{\text{Food}}/c_{i,t}^{\text{Nondur.}})}\right]=E\left[\phi_{i,t}^{\varepsilon\ \text{Food}}-\phi_{i,t}^{\varepsilon\ \text{Nondur.}}\right]=-0.219$$
$$E\left[\frac{d(c_{i,t}^{\text{Nondur.}}/c_{i,t}^{\text{Tot.}})}{d\varepsilon_{i,t}}\frac{1}{(c_{i,t}^{\text{Nondur.}}/c_{i,t}^{\text{Tot.}})}\right]=E\left[\phi_{i,t}^{\varepsilon\ \text{Nondur.}}-\phi_{i,t}^{\varepsilon\ \text{Tot.}}\right]=-0.080$$

It implies that the average elasticity of the share of food in nondurable consumption to a transitory shock is -0.219: a transitory shock that raises current income by 10% and next period income by $\theta\times 10\%$ shifts down the share of food in nondurable consumption by 2.19%. Similarly, the difference between the average elasticities of nondurable and total consumption is -0.080, so a transitory shock that raises current income by 10% and next period income by $\theta\times 10\%$ shifts down the ratio of nondurable consumption in total consumption by 0.8%.

Comparison with the literature on natural experiments Such findings are broadly similar to the literature on natural experiments as well. Regarding food expenditures, Souleles (1999) finds that the MPC of food out of a change in take-home pay is 0.06 over the next three month, significant at 5%.[16] Regarding total expenditures, Parker (1999) finds an elasticity of total expenditures out of a change in take-home pay of 0.56 over the next three months, statistically significant at 5%; Souleles (1999) obtains a MPC of total expenditures out of a change in take-home pay of 0.64 over the next three months, statistically significant at 5%; Parker et al. (2013) find a MPC of total expenditures out of the 2008 tax rebate of 0.52 over the next three months, statistically significant at 5%; as mentioned when discussing the response of nondurable expenditures, Fagereng, Holm and Natvik (2018) find that the MPC of total spending (with the growth in total spending measured as the difference between income growth and wealth growth) over the next year is 0.523, significant at 1%.

Variations in the measures of income Table G4 presents the estimates obtained when considering measures of income other than net income. The way these alternative measures are built is described in Section C of this Online Appendix. The pass-through of transitory shocks on gross income to nondurable consumption is 0.512, statistically sig-

[15]Formally, the difference between the elasticity of two different measures of consumption corresponds to the elasticity of their ratio because: $\frac{d(c_{i,t}^{\text{Food}}/c_{i,t}^{\text{Nondur.}})}{d\varepsilon_{i,t}}\frac{c_{i,t}^{\text{Nondur.}}}{c_{i,t}^{\text{Food}}}=\left(\frac{dc_{i,t}^{\text{Food}}}{d\varepsilon_{i,t}}\frac{1}{c_{i,t}^{\text{Nondur.}}}-\frac{dc_{i,t}^{\text{Nondur.}}}{d\varepsilon_{i,t}}\frac{c_{i,t}^{\text{Food}}}{(c_{i,t}^{\text{Nondur}})^2}\right)\frac{c_{i,t}^{\text{Nondur.}}}{c_{i,t}^{\text{Food}}}=\left(\frac{dc_{i,t}^{\text{Food}}}{d\varepsilon_{i,t}}\frac{1}{c_{i,t}^{\text{Food}}}-\frac{dc_{i,t}^{\text{Nondur.}}}{d\varepsilon_{i,t}}\frac{1}{c_{i,t}^{\text{Nondur}}}\right)=\phi_{i,t}^{\varepsilon\ \text{Food}}-\phi_{i,t}^{\varepsilon\ \text{Nondur.}}$. A similar relation holds between nondurable consumption and total consumption.

[16]Other estimates exist but are not precise. Parker (1999) obtains an elasticity of food expenditures out of a change in take-home pay of 0.13 over the next three months, but it is not statistically significant. Johnson, Parker and Souleles (2006) estimate a MPC of food expenditures out of the 2001 tax rebate of 0.17 over the next sixth months, not statistically significant; Parker et al. (2013) estimate the corresponding MPC out of the 2008 tax rebate to be 0.02 over three months and not statistically significant.

TABLE G4—ESTIMATES WITH ALTERNATIVE MEASURES OF INCOME

	Net income (earn.+trans.-tax.)	Gross income (earn.+trans.)	Head and spouse earnings
ϕ^{ε}	0.596	0.512	0.275
	(0.273)	(0.236)	(0.155)
$\underline{MPC}^{\varepsilon}$	0.320	0.246	0.159
	(0.147)	(0.113)	(0.089)
Obs.	7,600	7,600	7,273

Note: Standard errors in parentheses are clustered at the household level.

nificant at 5%, and the pass-through of the total labor income of the head and spouse (before taxes and transfers) is 0.275, statistically significant at 10%. Although the pass-through coefficients are not statistically different from one another, the decreasing pattern suggests that adjustments in taxes and transfers are mitigating the impact of the income shocks (with taxes increasing and transfers decreasing in response to a positive shock and vice-versa). Thus, households do not respond as much to a shock that will be partly compensated by variations in taxes and transfers than they do to a shock on their final, net income.

H. HETEROGENEITY

Table H1 presents the estimates obtained when partitioning the sample and running the robust estimator separately on different subgroups. In none of the partitions that I consider are the results statistically different across subgroups (the pass-through are different at the 15% level between households with young vs old heads and between households with low vs high female earnings). However, since the point estimates are quite different, the absence of statistical difference could be due only to a lack of power of the test. The point estimates suggest that the lower bound on the MPC is larger among households with an older head, a higher paid female spouse, a lower paid male head, a higher level of education, and a head born in an older cohort. Why is it that the effect of female earnings seem to be going in the opposite direction as that of male earnings? One possible explanation is that in a number of affluent households, which face little uncertainty or financial constraints and thus have a low pass-through of transitory shocks to consumption, the female spouse stays at home and does not work for a paid wage, pushing down the average female earnings in these households. The fact that having some college education raises the point estimate of the pass-though could confound the effect of age, with households whose head has received at least some college education also having a younger head.

TABLE H1—ESTIMATES ACROSS DIFFERENT SUBGROUPS

	Age ($\leq/>$ age 44)		Female earnings ($\leq/>$ \$5,000)		Male earnings ($\leq/>$ \$25,000)	
	Low	High	Low	High	Low	High
ϕ^{ε}	0.995	0.226	0.238	0.976	0.570	0.695
	(0.411)	(0.343)	(0.378)	(0.364)	(0.298)	(0.637)
p-values of equality test	Low-High: 15%		Low-High: 15%		Low-High: 86%	
$\underline{MPC^{\varepsilon}}$	0.538	0.121	0.147	0.450	0.363	0.307
	(0.222)	(0.183)	(0.233)	(0.168)	(0.190)	(0.281)
Obs.	4,086	3,514	3,752	3,848	3,732	3,868

	Education level Less than college vs Some college		Year of birth 1940-1949 vs 1930-1939	
ϕ^{ε}	0.432	0.925	0.678	0.597
	(0.323)	(0.526)	(0.353)	(0.474)
p-values of equality test	Low-High: 42%		40's-30's: 89%	
$\underline{MPC^{\varepsilon}}$	0.247	0.467	0.368	0.314
	(0.185)	(0.265)	(0.192)	(0.249)
Obs.	3,682	3,918	2,935	1,856

Note: Standard errors in parentheses are clustered at the household level. An observation of a given household at a given period is defined as a triplet of its log-income growth at this period, its log-consumption growth at this period, and its log-income growth two periods later. The assignation of an observation to a subgroup is based on the characteristics of the household at the observation period. Dollars are of the year of observation. The wage rate and age refer to that of the head.

I. THEORETICAL DIFFERENCES BETWEEN YEARLY AND BIENNIAL PASS-THROUGH COEFFICIENTS

When the income shocks are yearly, using a semi-structural estimator with a period of one year or of two years makes a difference. I denote Δ_2 the growth of a variable over two years. Log-income growth over two years is:

(I1)
$$\Delta_2 ln(y_{i,t}) = \underbrace{\eta_{i,t}+\eta_{i,t-1}}_{\eta_{2i,t}} + \underbrace{\varepsilon_{i,t}+\theta\varepsilon_{i,t-1}}_{\varepsilon_{2i,t}} - \underbrace{(\varepsilon_{i,t-2}+\theta\varepsilon_{i,t-3})}_{\varepsilon_{2i,t-2}} + \underbrace{\zeta^y_{i,t}+\zeta^y_{i,t-1}-(\zeta^y_{i,t}+\zeta^y_{i,t-1})}_{\zeta_{2i,t}-\zeta_{2i,t-2}},$$

where $\eta_{2i,t}$ is the permanent component of log-income growth when a period is two years, $\varepsilon_{2i,t}$ its transitory component, and $\zeta_{2i,t}$ the measurement error over two years. By definition, the biennial pass-through coefficient ϕ_2^ε is:

$$\begin{aligned}
\phi_2^\varepsilon &= \frac{cov(\Delta_2 ln(c_{i,t}), \varepsilon_{2i,t})}{var(\varepsilon_{2i,t})} = \frac{cov(\Delta ln(c_{i,t}) + \Delta ln(c_{i,t-1}), \varepsilon_{i,t} + \theta\varepsilon_{i,t-1})}{var(\varepsilon_{i,t} + \theta\varepsilon_{i,t-1})} \\
&= \frac{cov(\Delta ln(c_{i,t}), \varepsilon_{i,t}) + \theta cov(\Delta ln(c_{i,t-1}), \varepsilon_{i,t-1})}{var(\varepsilon_{i,t}) + \theta^2 var(\varepsilon_{i,t-1})} + \frac{\theta cov(\Delta ln(c_{i,t}), \varepsilon_{i,t-1})}{var(\varepsilon_{i,t} + \theta\varepsilon_{i,t-1})} \\
&\approx \underbrace{\frac{(1+\theta) cov(\Delta ln(c_{i,t}), \varepsilon_{i,t})}{(1+\theta^2) var(\varepsilon_{i,t})}}_{\phi^\varepsilon} + \frac{\theta}{1+\theta} \underbrace{\frac{cov(\Delta ln(c_{i,t}), \varepsilon_{i,t-1})}{var(\varepsilon_{i,t})}}_{\neq 0 \text{ when no random walk}}. \qquad \text{(I2)}
\end{aligned}$$

Assuming that the sample is long enough, so the period at the beginning does not matter and that $\varepsilon_{i,t-1} \approx \varepsilon_{i,t}$ and $cov(\Delta ln(c_{i,t-1}), \varepsilon_{i,t-1}) \approx cov(\Delta ln(c_{i,t}), \varepsilon_{i,t})$, then what drives the difference between the biennial and yearly pass-through coefficients are the fact that the biennial coefficient is multiplied by $\frac{1+\theta}{1+\theta^2}$ and the fact that it incorporates the covariance between log-consumption growth at t and the transitory shock that occur in the middle of the two year period, $\varepsilon_{i,t+1}$. When log-consumption is a random walk, this covariance is zero, and the two coefficients should be proportional by a factor $\frac{1+\theta}{1+\theta^2}$. When log-consumption departs from a random walk, the covariance drives a wedge between the two coefficients. As this covariance is likely to be negative, the biennial pass-through can be smaller than the yearly pass-through.

J. Sensitivity analysis of simulations

Tables J1 and J2 present the sensitivity of the simulation results to the calibration of the model.

K. Random walk model simulations

Random walk model and calibration In addition to the standard model and calibration, I consider a model in which log-consumption evolves as a random walk: instead of choosing their current consumption so that it satisfies the Euler equation, households choose their current consumption so that it equals their expected future consumption.[17] In addition, in this model, households face no borrowing limit and they start their working-age life with \$150,000 in wealth. Indeed, because for comparison purposes households still have a log-utility, they still face the constraint that arises from their consumption having to be positive (combined with their budget constraints). Thus, to make sure that this constraint is not binding, thus not shifting consumption away from a random walk, I have households start their life with a large amount of wealth. There are no intertemporal substitution motives nor demographic shifters ($\beta(1+r)e^{\Delta\delta_k z_k} = 1$ for all k), so log-consumption is not even a random walk with trend. Since the original BPP

[17] I simulate a random walk in the level of consumption, which is what would be obtained with quadratic preferences. However, results are very similar when simulating a random walk in log-consumption.

TABLE J1—PASS-THROUGH OF TRANSITORY SHOCKS TO CONSUMPTION ϕ^{ε}

	True values	Estimators		
		Robust	BPP	Simple non-robust
Baseline Model	0.547	0.532	0.085	0.148
		(0.041)	(0.009)	(0.009)
Persistence of transitory inc.				
$\theta = 0$	0.465	0.453	0.103	−0.271
		(0.393)	(0.010)	(0.126)
$\theta = 0.60$	0.559	0.548	0.084	0.145
		(0.035)	(0.009)	(0.009)
Variance transitory shocks				
$\sigma_{\varepsilon} = 0.005$	0.576	0.562	0.074	0.119
		(0.054)	(0.010)	(0.010)
$\sigma_{\varepsilon} = 0.05$	0.388	0.376	0.116	0.288
		(0.010)	(0.006)	(0.006)
Variance permanent shocks				
$\sigma_{\eta} = 0.005$	0.567	0.570	0.092	0.151
		(0.040)	(0.008)	(0.009)
$\sigma_{\eta} = 0.05$	0.332	0.343	0.055	0.112
		(0.050)	(0.017)	(0.014)
Discount factor				
$\beta = 0.96$	0.652	0.627	0.110	0.174
		(0.042)	(0.010)	(0.010)
$\beta = 0.98$	0.397	0.392	0.058	.111
		(0.040)	(0.009)	(0.008)
Interest rate				
$r = 0.01$	0.648	0.622	0.111	0.172
		(0.042)	(0.010)	(0.010)
$r = 0.03$	0.406	0.401	0.058	0.114
		(0.040)	(0.009)	(0.009)
Borrowing limit				
$L = -\$50,000$	0.404	0.398	0.059	0.113
		(0.040)	(0.009)	(0.009)
$L = 0$	0.597	0.577	0.098	0.155
		(0.042)	(0.009)	(0.010)
Initial variance of permanent inc.				
$\sigma_{\eta_0} = 0.05$	0.551	0.540	0.090	0.151
		(0.040)	(0.009)	(0.009)
$\sigma_{\eta_0} = 0.25$	0.551	0.539	0.083	0.146
		(0.041)	(0.009)	(0.009)
Initial wealth				
$a_0 = 0$	0.531	0.579	0.084	0.148
		(0.041)	(0.010)	(0.009)
Implies $\sigma_{a_0} = 39,821$	0.537	0.524	0.084	0.144
		(0.041)	(0.009)	(0.009)
Obs.	68,000	68,000	68,000	68,000

TABLE J2—PASS-THROUGH OF TRANSITORY SHOCKS TO CONSUMPTION ϕ^{ε}

	True values	Estimators		
		Robust	BPP	Simple non-robust
Baseline Model	0.547	0.532	0.085	0.148
		(0.041)	(0.009)	(0.009)
Years of retirement T				
$T = 5$	0.528	0.605	0.071	0.154
		(0.045)	(0.010)	(0.010)
$T = 25$	0.527	0.561	0.080	0.164
		(0.039)	(0.009)	(0.009)
Demographic trend				
$k = 1$	0.347	0.339	0.051	0.097
		(0.039)	(0.008)	(0.008)
$k = 0.95$	0.619	0.600	0.101	0.165
		(0.042)	(0.010)	(0.010)
Obs.	68,000	68,000	68,000	68,000

estimator is not robust to measurement error, I do not add measurement error noise to this random walk calibration.

TABLE K1—GOODNESS OF FIT STATISTICS

	Mean cons.	Std. d. cons.	Mean inc.	Std. d. inc.	Corr(cons.,inc.)
PSID data	14,430	8,104	32,661	22,534	0.365
Sim. (Bas.)	13,891	8,575	36,534	24,672	0.940
Sim. (RW)	15,108	7,387	36,318	24,445	0.939

Note: The values from the PSID data are in 1982-1984 \$. There is no inflation in the numerical simulations.

Simulation and model fit This random walk model is simulated in the same way as the baseline model. Table K1 shows that the fit of the random walk model is similar to the fit of the standard model.

Performance of the different estimators Table K2 presents the features of the simulations as well as the performance of the different estimators in this random walk model. First, note that the simulations do generate a random walk, as the value of $cov(\Delta ln(c_{i,t}), \varepsilon_{i,t-1})$ is negligible, at 0.002. This random walk model implies a lower

TABLE K2—PASS-THROUGH OF TRANSITORY SHOCKS ϕ^{ε} IN A RANDOM WALK MODEL

	True values	Estimators		
		Robust	BPP	Simple non-robust
$cov(\Delta ln(c_{i,t}), \varepsilon_{i,t-1})$	$cov = 0.002$			
Value of θ	$\theta = 0.500$	Not required	Estimated	Imposed
			$\hat{\theta} = 0.517$	$\theta = 0.517$
ϕ^{ε}	0.086	0.111	0.053	0.105
		(0.010)	(0.007)	(0.007)
Obs.	68,000	68,000	68,000	68,000

true pass-through coefficient of $\phi^{\varepsilon} = 0.086$.[18] Regarding the performance, the three estimators get close to the true value. The robust estimator yields a point estimate of 0.111, the original BPP estimator a point estimate of 0.053—a little bit further away from true value, maybe because of the joint estimation with other parameters—, and the counterfactual estimator a point estimate of 0.105. This confirms that, when log-consumption does evolve as a random walk, all estimators are able to estimate the pass-through coefficient without large biases. The BPP estimator does also much better at estimating the persistence of the transitory shock, with a point estimate of $\theta = 0.517$ when the true value is 0.5.

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[18]Note that this result is consistent with what was expected from theory: if households were infinitely lived, their MPC of total consumption out of transitory income would be $r/(1+r) \approx 0.02$. Households who expect to live between (at most) 50 periods and (at most) 15 periods should have a larger MPC and an even larger pass-through coefficient.

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