Disentangling Insurance and Information in Intertemporal Consumption Choices

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The textbook version of the life-cycle permanent income hypothesis with no liquidity constraints predicts that consumption should react very little to transitory shocks to income and very strongly to permanent shocks. This prediction has important policy implications, i.e., to understand the response of consumers to tax rebates or increases that are made for stabilization purposes. In recent years there has been a resurgence of interest in estimating these important parameters, either using quasi-experimental data (such as randomization of the timing when tax rebate checks are received by households, see Christian Broda and Jonathan Parker, 2008; David Johnson, Parker, and Nicholas Souleles, 2008), or imposing structural restrictions on the stochastic income process faced by consumers (Orazio Attanasio and Nicola Pavoni, 2008; Richard Blundell, Luigi Pistaferri and Ian Preston, 2008; Jonathan Heathcote, Kjetil Storesletten and Gianluca Violante, 2006; Giorgio Primiceri and Thijs van Rens, 2008).

The main objection of quasi-experimental studies is that the results may be context-specific. The main problem with the second strand of the literature is that estimates of the response of consumption to income shocks may confound two issues, insurance and information. On the one hand, the estimate reflects the ability (or lack thereof) of the

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household to smooth consumption through a variety of channels, such as self-insurance, government-provided insurance, credit markets, or other informal mechanisms. On the other hand, the identification strategy requires the ability to statistically separate what is a shock (when seen from the point of view of the individual) from what is an anticipated event (*ditto*). In reality, the individual may have more information than the econometrician about the evolution of future income. Thus, consumption may react very little to changes that are labeled as innovations by the econometrician simply because they are anticipated by the agent, and hence already incorporated in the optimal plan. In general, it is hard to separate *superior information* from *partial insurance*.

In this paper, we propose combining data on realizations and expectations to solve this identification problem. We use a data set that includes longitudinal information on household income, consumption, and quantitative subjective expectations of future income for a representative sample of the Italian population.

1 Identification

1.1 The Case Without Subjective Expectations Data

We assume that the log income process can be written as the sum of the effect of observable characteristics, an i.i.d. transitory component, and a random walk permanent component:

$$y_{it} = X_{it}'\beta + \varepsilon_{it} + P_{it} \tag{1}$$

with

$$P_{it} = P_{it-1} + \zeta_{it} \tag{2}$$

This is a popular characterization in the consumption literature (Christopher Carroll, 1995; Angus Deaton, 1992). We next assume that ε_{it} and ζ_{it} can be decomposed into anticipated and unanticipated components (from the individual's point of view), i.e.

$$\varepsilon_{it} = \varepsilon_{it}^{U} + \varepsilon_{it}^{A} \tag{3}$$

$$\zeta_{it} = \zeta_{it}^{U} + \zeta_{it}^{A} \tag{4}$$

Hence, we assume that $E\left(\varepsilon_{it}|\Omega_{t-1}^{i}\right) = \varepsilon_{it}^{A}$ and $E\left(\zeta_{it}|\Omega_{t-1}^{i}\right) = \zeta_{it}^{A}$, where Ω_{t-1}^{i} is the information set of the individual at time $t-1$. For example, the individual may know that in future periods his income is going to increase permanently due to a promotion. Or, she may be planning to temporarily take some time off work, which may result in a transitory change of her income that is completely anticipated. The econometrician does not have this information, so will assume that $E\left(\varepsilon_{it}|\Omega_{t-1}^{e}\right) = E\left(\zeta_{it}|\Omega_{t-1}^{e}\right) = 0$, where Ω_{t-1}^{e} is her information set.

The typical strategy for identifying the variance of transitory and permanent innovations in the literature is to first take out variations in income that can be predicted on the basis of observable characteristics (age, tenure, etc.). This defines a residual term

$$v_{it} = \Delta\left(y_{it} - X_{it}'\beta\right) = \Delta\varepsilon_{it}^{U} + \Delta\varepsilon_{it}^{A} + \zeta_{it}^{A} + \zeta_{it}^{U} \tag{5}$$

Next, one imposes covariance restrictions on this residual (see Blundell, Pistaferri, and Preston, 2008, for example). The model is however clearly underidentified with income moments alone (zero- and first-order autocovariances). Other moments (such as autocovariances at longer lags) do not help. It is easy to show that all one can hope to identify are the *sum* of the variance of transitory variations in income (both anticipated and unanticipated) and the sum of the variance of permanent variations in income (both anticipated and unanticipated). However, there is no way of telling apart anticipated from unanticipated changes in income (either transitory or permanent) using just income data. In other words, we are two moments short.

It may seem that adding consumption data, and imposing some further structure regarding the relationship between consumption and income innovation, one can improve on this identification problem. However, this is not the case, unless some strong assumptions are imposed. To see why, consider a simplified version of the expression for consumption growth derived by Blundell, Pistaferri and Preston (2008):

$$\Delta c_{it} = \Delta X_{it}' \gamma + \phi \zeta_{it}^U + \psi \varepsilon_{it}^U$$

where ϕ and ψ are partial insurance coefficients with respect to permanent and transitory shocks (*unanticipated* income changes), respectively. Define changes of consumption net of the effect played by observable characteristics, i.e.

$$u_{it} = \Delta \left(c_{it} - X_{it}' \gamma \right) = \phi \zeta_{it}^U + \psi \varepsilon_{it}^U$$

The data on consumption add two extra parameters, but only three extra moments, hence we remain one moment short.[1] In particular, we have

$$\begin{aligned} E\left(u_{it}^2\right) &= \phi^2 \sigma_{\zeta^U}^2 + \psi^2 \sigma_{\varepsilon^U}^2 &(6)\\ E\left(u_{it} v_{it}\right) &= \phi \sigma_{\zeta^U}^2 + \psi \sigma_{\varepsilon^U}^2 &(7)\\ E\left(u_{it} v_{it+1}\right) &= -\psi \sigma_{\varepsilon^U}^2 &(8) \end{aligned}$$

To see the bias involved with ignoring that some of the income variation is not an innovation, consider the identification strategy pursued in Blundell, Pistaferri and Preston (2008).

[1] Things get worse if we complicate the model by adding a consumption taste shock, or measurement error in income. In contrast, adding measurement error in consumption does not worsen the identification problem because one extra moment comes to play ($E\left(u_{it} u_{it+1}\right)$).

They (and all the literature using data only on consumption and income realizations) implicitly assume that $\sigma^2_{\varepsilon^A} = \sigma^2_{\zeta^A} = 0$ and therefore identify the "insurance" parameters using the following expressions:

$$\begin{aligned}\psi &= \frac{E\left(u_{it}v_{it+1}\right)}{E\left(v_{it}v_{it+1}\right)} \\ \phi &= \frac{E\left(u_{it}v_{it}\right) + E\left(u_{it}v_{it+1}\right)}{E\left(v^2_{it}\right) + 2E\left(v_{it}v_{it+1}\right)}\end{aligned}$$

with one overidentifying restriction. However, if $\sigma^2_{\varepsilon^A} \neq 0$ and $\sigma^2_{\zeta^A} \neq 0$, the moment condition that identifies ϕ produces

$$p\lim \widehat{\phi} = \phi \frac{\sigma^2_{\zeta^U}}{\sigma^2_{\zeta^A} + \sigma^2_{\zeta^U}}$$

so the estimate of ϕ is downward biased. The extent of bias depends on how much of the variance of the permanent variation in income is accounted for by the unanticipated component. It is easy to show that there is a similar attenuation bias in the estimate of $\widehat{\psi}$.

1.2 The Case With Subjective Expectations Data

Suppose now that the econometrician has access to quantitative subjective expectations of future income, i.e., data that allows to construct $E\left(\Delta y_{it}|\Omega^i_{t-1}\right)$. We will show that this kind of information solves the problem of separately identifying the anticipated from the unanticipated variation in income. Next, we show that if we use consumption data in addition to income data (both realized and expected) we get full identification of the model, i.e., we are able to separate insurance from information. Use equations (1)-(4) and consider the individual's expectation of income growth:

$$E\left(\Delta y_{it}|\Omega^i_{t-1}\right) = \Delta X'_{it}\beta - \varepsilon^U_{it-1} + \Delta\varepsilon^A_{it} + \zeta^A_{it}$$

As above, it is useful to net out the effect of the observables and define the error term

$$\omega_{it} = E\left(\Delta y_{it}|\Omega^{i}_{t-1}\right) - \Delta X'_{it}\beta = -\varepsilon^{U}_{it-1} + \Delta\varepsilon^{A}_{it} + \zeta^{A}_{it}$$

We have now access to two types of "innovations", the individual's (ω_{it}) and the econometrician's (υ_{it}, defined above in (5)). This defines the following moments

$$\begin{aligned}
E\left(\omega^2_{it}\right) &= \sigma^2_{\varepsilon^U} + 2\sigma^2_{\varepsilon^A} + \sigma^2_{\zeta^A} \\
E\left(\omega_{it}\omega_{it+1}\right) &= -\sigma^2_{\varepsilon^A} \\
E\left(\upsilon^2_{it}\right) &= 2\sigma^2_{\varepsilon^U} + 2\sigma^2_{\varepsilon^A} + \sigma^2_{\zeta^U} + \sigma^2_{\zeta^A} \\
E\left(\upsilon_{it}\upsilon_{it+1}\right) &= -\sigma^2_{\varepsilon^U} - \sigma^2_{\varepsilon^A} \\
E\left(\omega_{it}\upsilon_{it}\right) &= \sigma^2_{\varepsilon^U} + 2\sigma^2_{\varepsilon^A} + \sigma^2_{\zeta^A}
\end{aligned}$$

which shows that one could potentially identify all the income parameters using just income moments (realizations *and* expectations). In fact, the model is overidentified. The key to identification is the fact that the individual's "innovation" incorporates less variation that the econometrician's.

The consumption moments (6)-(8) are now complemented by the extra moment $E\left(u_{it}\omega_{it+1}\right) = -\psi\sigma^2_{\varepsilon^U}$. It is easy to show that the parameters of interest $(\sigma^2_{\varepsilon^A},\ \sigma^2_{\varepsilon^U}, \sigma^2_{\zeta^A}, \sigma^2_{\zeta^U}, \psi, \phi)$ are all identified. In fact, the model with consumption, income realizations and income expectations is also overidentified. In particular, the estimates of $\sigma^2_{\zeta^A}$ and ϕ allow us to separate information from insurance.

2 Data

The Survey of Household Income and Wealth (SHIW) is a representative survey of the Italian population. The 1995, 1998, and 2000 SHIW have data on income, consumption, financial wealth, real estate wealth, and several demographic variables. Some of the households are reinterviewed in subsequent years. For example, of the 8,135 (7,147) households interviewed in 1995 (1998), 2,669 (3,873) were reinterviewed in 1998 (2000). A special section of the 1995 and 1998 surveys was designed to characterize the distribution of future income and the probability of unemployment. These questions are similar to those asked in the US Survey of Economic Expectations (SEE), which has been used by Jeffrey Dominitz and Charles Manski (1997a) and others.

The survey questions focus on earnings rather than disposable income and on individuals rather than households. Focus on earnings avoids mixing labor income and capital income uncertainty. Focus on individuals avoids relying on one person to evaluate the income prospects of other household members. The SHIW households report the distribution of after-tax income, rather than gross income. One advantage of using after-tax income is that most household choices ultimately depend on disposable income, not income before taxes. Furthermore, since in Italy income taxes and social security contributions are withheld at source, employees are better informed about their after-tax earnings.

Questions on income expectations were asked to half of the overall sample after excluding the currently retired and people not in the labor force. Both the employed, the unemployed and the job seekers are asked to state, on a scale from 0 to 100, their chances of having a job in the 12 months following the interview. Each individual assigning a positive probability to being employed is then asked to report the minimum (m) and the maximum (M) incomes he or she expects to earn if employed, and the probability of earning less than the midpoint of the support of the distribution, $\Pr(y \leq 0.5\,(m+M))$. See Luigi Guiso, Tullio Jappelli and Pistaferri (2001) for the exact wording of these questions. To compute moments of the distribution of future income, one needs to make assumptions about the density of the underlying distribution $f(y)$. Two simple assumptions are that $f(y)$ is uniform or triangular, as assumed in Guiso, Jappelli and Pistaferri (2001). In this paper, we assume that $f(y)$ is triangular.

Our sample selection is as follows. We use the subjective expectations reported by heads aged 18 to 65. We drop individuals who have clear misunderstanding of the subjective expectation questions (i.e., people who report $\Pr(y \leq 0.5(m+M)) = \{0,1\}$ and $m \neq M$). We use non-missing household panel data on family non-financial income and non-missing panel data on family consumption to estimate moments of v_{it} and u_{it}, respectively. Finally, we define $E(\Delta y_{it+1}|\Omega_t^i)$ as the difference between the head's subjective expectation of log earnings at time $t+1$ as reported at time t ($t = \{1995, 1998\}$) and actual family log non-financial income reported at time t.[2] Non-missing panel data on this variable allows us to estimate moments of ω_{it}. We assume that X_{it} includes year dummies, a cubic in age, and fixed characteristics that are removed when we take first differences.

One aspect to be aware of is that the identification strategy illustrated in the previous section is for a data set with annual frequency, so that all growth terms are annual. In practice, there are a number of complications once we bring the model to our data. First, with SHIW one can construct two- and three-year income growth rates, not annual growth rates. Moreover, the timing of the subjective data is not synchronized with the data on the realizations, because people report 1-year ahead expectations. To be more precise, we observe $y_{i,s}$ ($s = 1995, 1998, 2000$) and $E(y_{i,\tau+1}|\Omega_\tau^i)$ ($\tau = 1995, 1998$). In an Appendix available on request from the authors, we show that the moment conditions derived above can be appropriately rewritten so that the identification strategy is preserved in the spirit if not in the letter.

[2] In principle, one should use the expectation of log family non-financial income, which unfortunately is not available. We use the heads's expectation of log earnings as a proxy.

3 Results

How reliable are the subjective expectations? We start by comparing, for our sample of heads, the realized log earnings in period $t+s$ ($s = \{2,3\}$) with the period t's expectation of log earnings in period $t+1$. The correlation coefficient is 0.54. In regressions available on request, we find that expected log earnings are a concave function of age (consistent with the shape of life-cycle income profiles), increase with education, and are higher for males and those living in the North. The correlation between the realized growth rate of earnings in period $t+s$ ($s = \{2,3\}$) and the period t's expected one-year growth rate of earnings is 0.44, which is particularly remarkable because growth rates are notoriously hard to predict. In a regression that controls for a quadratic in age, gender, education, year dummies, region of residence, the expected growth rate has a coefficient of 0.74 with a standard error of 0.04.[3]

Table 1: EWMD Results

Parameter	(1)	(2)	(3)
$\sigma^2_{\varepsilon^U}$	0.1056 (0.0191)	0.1172 (0.0175)	0.0197 (0.0208)
$\sigma^2_{\varepsilon^A}$	0	0	0.0541 (0.0163)
σ^2_y	0	0	0.0342 (0.0215)
$\sigma^2_{\zeta^U}$	0.0301 (0.0131)	0.0253 (0.0113)	0.0208 (0.0133)
$\sigma^2_{\zeta^A}$	0	0	0.0127 (0.0251)
σ^2_c		0.0537 (0.0062)	0.0474 (0.0097)
σ^2_e			0.1699 (0.0225)
ψ		0.1442 (0.0535)	0.3120 (0.4274)
ϕ		0.6890 (0.2699)	0.9341 (0.5103)
χ^2 (df; p-value)	3.2440 (1; 7%)	16.4171 (5; 0.6%)	36.4001 (12; 0.03%)

[3] For the measure of income we use in the minimum distance procedure below (see the discussion in the Data section), the same regression gives a coefficient of 0.34 with a standard error of 0.03.

We regress consumption growth, income growth, and expected income growth on a quadratic in age and year dummies. The residuals represent our estimates of $u_{i,t}$, $v_{i,t}$, and $\omega_{i,t}$, respectively. Inspection of the autocovariance matrix led us to make three additions to the statistical model presented above. First, there is a measurement error in income that has no economic, but statistical content. We assume this error has variance σ_y^2. Second, there is a measurement error in consumption, with variance σ_c^2. Finally, there is a strong persistent component in subjective expectation reports, which we model as a fixed effect with variance σ_e^2 (this effect may itself be interpreted as a persistent measurement error, or persistent optimism/pessimism in subjective reports of future earnings across waves).

Table 1 reports the main results obtained using Equally Weighted Minimum Distance (EWMD), following the recommendations of Joseph Altonji and Lewis Segal (1996). In column (1) we use only income data; in column (2) we use income and consumption data. The parameters $\sigma^2_{\varepsilon^A}$, $\sigma^2_{\zeta^A}$, and σ_y^2 are not identified and so are set to 0. That is, the assumption is that all variation in income is unanticipated and that there is no measurement error in income (transitory variation in income is economically relevant). Finally, in column (3) we use data on income, consumption, and income expectations. At face value, the results confirm the scheme presented in Section 1. Assuming that all variation in income is unanticipated provides evidence of insurance with respect to permanent and transitory shocks. Note that unlike what predicted by the traditional version of the PIH, the transitory shock is not fully insured, perhaps because of binding borrowing constraints (see Jappelli and Pistaferri, 2006). The results in column (3) show a number of interesting facts. First, the transitory variation in income is split between anticipated component (about 50%), the unanticipated component (20%) and measurement error (30%). This lowers the estimated degree of insurance with respect to transitory shocks. Similarly, a good fraction of the permanent variation (about 1/3) appears anticipated, and this now pushes the estimated insurance coefficient towards 1 - i.e., these results show evidence that there is no insurance whatsoever with respect to permanent shocks.

There are a few notes of caution to add to the comment of these results. First, the overidentifying restrictions are rejected. Second, while the economic significance of the results is in accordance with the model of Section 1, the standard errors are high, preventing reliable inference. We plan to examine these important issues in future work.

4 Conclusions

We combine panel data on income realizations and quantitative subjective expectations of future income to identify anticipated and unanticipated components of income changes. We show that in more general settings, data on income and consumption are not sufficient to separately identify advance information that consumers may have about their income from the extent of consumption insurance against income innovations. The addition of subjective income expectations solves the identification problem. We show that the degree of insurance of income shocks is exaggerated. Hence, differences in information sets between the individual and the econometrician is potentially able to explain the empirical puzzle of excess consumption smoothness. We find that a large part of the transitory variation in income is either anticipated or the result of measurement error, while about two-third of the permanent variation in income can be labeled as a true innovation.

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