# The Consumption Response to Income Changes

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## Key Words

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## Abstract

We review different empirical approaches that researchers have taken to estimate how consumption responds to income changes. We critically evaluate the empirical evidence on the sensitivity of consumption to predicted income changes, distinguishing between the traditional excess sensitivity tests and the effect of predicted income increases and income declines. We also review studies that attempt to estimate the marginal propensity to consume out of income shocks, distinguishing between three different approaches: identifying episodes in which income changes unexpectedly, relying on the covariance restrictions that the theory imposes on the joint behavior of consumption and income growth, and combining realizations and expectations of income or consumption in surveys in which data on subjective expectations are available.

## 1. INTRODUCTION

How does household consumption respond to changes in economic resources? Does the response depend on the nature and duration of the changes? Do anticipated income changes have a different consumption impact than unanticipated shocks? And do transitory income shocks have a lower impact than permanent ones? These questions are crucial to understand consumers' behavior and to evaluate policy changes that impact households' resources. Indeed, in virtually all countries, consumption represents more then two-thirds of GDP, and knowledge of how consumers respond to income shocks is crucial for evaluating the macroeconomic impact of tax and labor market reforms as well as for designing stabilization and income-maintenance policies.[1] Indeed, labor economists, macroeconomists, and experts in public finance are active contributors to this literature.

In this survey we review different empirical approaches that researchers have taken to estimate these important policy parameters. Our emphasis is on methods and on the discussion of the most relevant approaches and empirical results, especially the most recent ones. Our objective is to critically evaluate evidence on two issues: excess sensitivity tests to predicted income changes and estimates of the marginal propensity to consume out of income shocks.

To put matters in perspective, **Figure 1** (see color insert) provides a roadmap to the main links between consumption and income changes, underscoring the different questions that are examined. The main distinction that we draw is between the effect of anticipated and unanticipated income changes. The Modigliani & Brumberg (1954) and Friedman (1957) celebrated life-cycle and permanent income models posit that people use savings to smooth income fluctuations and that they should respond little if at all to changes in income that are anticipated. When this important theoretical prediction is violated, researchers conclude that consumption is excessively sensitive to anticipated income changes. Although this is a clear implication of the theory, one encounters two types of problems when trying to provide a clean test of the theory: one empirical and one theoretical. On the empirical side, it is difficult to identify situations in which income changes in a predictable way. But even if the empirical problems can be surmounted, there are many plausible explanations why the implications of the theoretical models may be rejected, ranging from binding liquidity constraints to nonseparabilities between consumption and leisure, home-production considerations, habit persistence, aggregation bias, and durability of goods.

More recently, the literature has sought to gain further insights by distinguishing between situations in which consumers expect an income decline and those in which they expect an income increase. Although credit constraints may be responsible for a correlation between consumption and expected income increases, they cannot explain why consumption reacts to expected income declines (e.g., after retirement). A further distinction that has proven to be useful is between large and small expected income changes, as consumers might react mostly to the former and neglect the impact of the latter.

The branch on the right-hand side of **Figure 1** focuses instead on the impact of unanticipated income shocks. Here the main distinction is between transitory shocks, which according to the theory should have a small impact on consumption, and permanent shocks, which should lead to major revisions in consumption. As with anticipated changes, the literature has sought to pin down the empirical estimates identifying positive and

[1]A related literature looks at the effect of wealth shocks on consumption (Maki & Palumbo 2001).

negative shocks. As here the econometrician can study how consumption responds to income innovations, the interest is in estimating structural parameters (in particular, the marginal propensity to consume) as well as on testing.

The survey proceeds as follows. Section 2 summarizes the theoretical literature and provides an organizing framework to study the effect of income changes on consumption. Section 3 focuses on expected income changes, distinguishing between the traditional excess sensitivity tests and the effect of income increases and of income declines. Section 4 reviews three approaches to estimate the effect of unexpected income changes on consumption: attempts at identifying episodes in which income changes unexpectedly, estimates of the marginal propensity to consume that rely on the covariance restrictions that the theory imposes on the joint behavior of consumption and income growth, and estimates that combine realizations and expectations of income or consumption in surveys in which data on subjective expectations are available. Section 5 concludes.

## 2. THEORETICAL PREDICTIONS

To organize the discussion, we consider the standard problem of an agent who maximizes the expected utility of consumption over a certain time horizon subject to an intertemporal budget constraint and a terminal condition on wealth. If consumers can borrow and lend at the same interest rate and if the utility function is state and time separable, one obtains the well-known Euler equation for consumption:

$$u'(c_{it-1}) = (1+\delta)^{-1} E_{t-1}[(1+r_t)u'(c_{it})], \tag{1}$$

where $c$ is consumption, $r$ is the real interest rate, $\delta$ is the intertemporal discount rate, and $E_{t-1}$ is the expectation operator based on information available at time $t-1$. Equation 1 states that in equilibrium there are no intertemporal consumption reallocations that can increase consumers' utility at the margin. If the interest rate is constant and equal to the intertemporal discount rate, one obtains the result that the marginal utility is a martingale:

$$E_{t-1}u'(c_{it}) = u'(c_{it-1}). \tag{2}$$

Ex ante current marginal utility is the best predictor of the next period's marginal utility; ex post, marginal utility changes only if expectations are not realized, a property of the solution first noted by Hall (1978). Hence, changes in marginal utility are unpredictable on the basis of past information. For instance, an anticipated income decline (due to retirement or unemployment) should not affect the marginal utility of consumption at the time it occurs because consumers would have already incorporated the expectation of the income decline in their optimal consumption plan when the information first became known. However, as shown below, unexpected income changes do affect the marginal utility of consumption to an extent that depends on the nature and duration of shocks and the structure of credit and insurance markets.

### 2.1. The Response of Consumption to Predictable Income Changes

Earlier attempts at testing the implication of the theory that the marginal utility is a martingale relied on the special case of quadratic preferences. This case is known in the literature as the permanent income model with certainty equivalence (Flavin 1981, Campbell 1987). Under this assumption, Equation 2 is rewritten as

$$c_{it} = c_{it-1} + \varepsilon_{it}, \tag{3}$$

where $\varepsilon_{it} = c_{it} - E_{t-1}c_{it}$ is a consumption innovation, i.e., the effect on consumption of all new information about the sources of uncertainty faced by the consumer. The sources of uncertainty may be idiosyncratic or aggregate and include shocks to income, interest rates, health, or demographic variables. Hence, it is consumption itself, not marginal utility as in the general case of Equation 2, that behaves as a martingale. Ex ante current consumption is the best predictor of the next period's consumption; ex post, consumption changes only if expectations are not fulfilled.

Under the null hypothesis that consumption is a martingale, Equation 3 gives an orthogonality condition that can be tested empirically: No variables known in period $t-1$ (and earlier) should be correlated with changes in consumption between $t-1$ and $t$. Hence, in the following regression,

$$\Delta c_{it} = \sum_{j=0}^{J} x'_{it-1-j'}\beta_j + \varepsilon_{it}, \tag{4}$$

the permanent income model predicts that $\beta_j = 0$ for all $j$. The orthogonality condition test does not require specific assumptions about the sources of uncertainty faced by consumers, but in this survey we are particularly interested in the case in which the $x$ variable coincides with expected income changes. Note that rejection of the null hypothesis ($\beta_j \neq 0$) does not point to specific reasons why consumption does not follow a martingale, and hence it is intrinsically a weak test of the theory.

## 2.2. The Response of Consumption to Unpredictable Income Shocks

Another important testable implication of the model is that consumption should respond to unpredictable changes in the variables about which the consumer is uncertain. For working-age individuals, the most important source of uncertainty is labor income. If labor income is the only source of uncertainty, Equation 3 can be rewritten as

$$\Delta c_{it} = \underbrace{\frac{r}{1+r}\left(1 - \frac{1}{(1+r)^{T-t+1}}\right)^{-1}}_{\text{annuitization factor}} \sum_{\tau=0}^{T-t}(1+r)^{-\tau}(E_t - E_{t-1})y_{it+\tau}. \tag{5}$$

Equation 5 offers a structural interpretation for the consumption innovation $\varepsilon_t$ of Equation 3. The change in consumption between $t-1$ and $t$ depends only on revisions in the expectations of future income between the two periods. If no new information about future income arrives, consumption is constant. In contrast, new information about future income available in period $t$ induces the consumer to update the optimal consumption plan. The impact of the income revisions is proportional to an annuitization factor (which depends on the interest rate and the consumers' horizon). When the horizon is infinite, this factor collapses to $r/(1+r)$.

Equation 5 is useful because it suggests that different assumptions about the income process imply very different consumption responses to income shocks. To exemplify, we assume that the planning horizon is infinite and consider different income processes. In the first case we examine, which is often used to characterize macroeconomic series, income follows an ARMA(1,1) process:

$$y_{it} = \rho y_{it-1} + v_{it} + \theta v_{it-1},$$

with $\rho$ possibly equal to 1, so that Equation 5 is rewritten as

$$\Delta c_{it} = \frac{r}{1+r}\frac{1+r+\theta}{1+r-\rho}v_{it}. \tag{6}$$

In Equation 6 consumption changes depend on the degree of persistence of the income process. The more persistent the process is, the more volatile is consumption from one year to the next. To simplify the discussion, consider the AR(1) case and how the AR coefficient affects the sensitivity of consumption with respect to income shocks. If $\rho = 0$ (the income process is not serially correlated), the marginal propensity to consume with respect to income shocks is $r/(1 + r)$. This happens because, when $\rho = 0$, all variations in income are transitory, and individuals consume only the annuity value of the income revision. Hence in this case consumption is much less volatile than income. If instead $\rho = 1$ (income follows a martingale process), all changes in income are permanent, and the marginal propensity to consume with respect to income shocks equals 1.

**Figure 2** (see color insert) plots consumption against time for income processes with different degrees of persistence, starting from a normalized initial consumption value of 1 and assuming $\sigma_v = 0.1$. The figure shows that consumption is much more variable when the process that generates income is more persistent. Quite clearly, the volatility of consumption depends heavily on the size of the autoregressive coefficient.

The limitation of the ARMA characterization of the income process is that it restricts shocks to be only of one type. However, since the work of Friedman (1957), economists have recognized that some of the income shocks are transitory (mean reverting), and their effect does not last long, whereas others are highly persistent (non–mean reverting), and their effect cumulates over time. Examples of transitory shocks are fluctuations in overtime labor supply, bonuses, lottery prizes, and bequests. Examples of permanent innovations are generally associated with job mobility, promotions, layoffs, and severe health shocks. A widely adopted characterization of the income process that allows simultaneously for both types of shocks is

$$y_{it} = P_{it} + v_{it}, \tag{7}$$

where $P_{it}$ is the permanent component following a martingale process,

$$P_{it} = P_{it-1} + u_{it}, \tag{8}$$

and $v_{it}$ is an independently and identically distributed (i.i.d.) transitory component. The consumption equation (Equation 5) in this case depends on both types of shocks,

$$\Delta c_{it} = \frac{r}{1+r}v_{it} + u_{it}, \tag{9}$$

which implies that consumption responds one to one to permanent income shocks but is nearly insensitive to transitory shocks.

To encompass the effect on consumption of various specifications of the income-generating processes, one can write a general expression for consumption changes:

$$\Delta c_{it} = \sum_{k=1}^{K} \varphi^k \pi_{it}^k,$$

where the income process has $K$ different components, and each differs in its degree of persistence. The coefficient $\varphi^k$ measures the effect of the innovation of the $k$-th income component on consumption changes. Its size depends on the persistence of the income component itself and (except for the infinite-horizon case) on the consumer's horizon. To exemplify, in the case of the ARMA(1, 1) process of Equation 6, $K = 1$, $\pi^1 = v$, and $\phi^1 = \frac{r}{1+r}\frac{1+r+\theta}{1+r-\rho}$. In the case of the process described by Equations 7 and 8, $K = 2$, $\pi^1 = v, \pi^2 = u, \phi^1 = (r/1 + r)$, and $\phi^2 = 1$. In the finite-horizon case, the consumption sensitivity to income shocks is adjusted by an annuitization factor that grows as the consumer approaches the end of the planning horizon. Other cases can be obtained in a similar fashion, allowing for aggregate as well as idiosyncratic income components, or more complex income processes (such as those including random trends and unevenly distributed aggregate shocks).

As shown by Campbell (1987), under the same set of assumptions considered above (in particular, quadratic preferences, intertemporal separability, infinite horizon, and perfect credit markets), one can derive the following saving function:

$$s_{it} = -\sum_{j=1}^{\infty} \frac{E_t \Delta y_{it+j}}{(1+r)^j}. \tag{10}$$

This equation states that people save when they expect their income to decline and borrow when they expect income to increase, an implication of the model that is known as saving for a rainy day and that is the mirror image of Equation 5. When income follows the process described by Equations 7 and 8, the Campbell equation becomes

$$s_{it} = \frac{1}{1+r} v_{it}.$$

As income changes that are not consumed are by definition saved, saving responds (almost) one for one to transitory income shocks and is completely insensitive to permanent shocks. The effect of income shocks can be studied referring to the consumption equation (Equation 5) or to the saving equation (Equation 10); the particular specification and test adopted depend mainly on data quality and availability.

### 2.3. Precautionary Saving

In the quadratic utility model, people save only if they expect income to decline, and they do not change their saving behavior if their income becomes more uncertain. To allow for precautionary saving, we now assume that preferences are isoelastic, the interest rate is constant and equal to the intertemporal discount rate, and consumption is log-normally distributed. The first-order condition for utility maximization becomes

$$\Delta \ln c_{it} = \frac{\gamma}{2} \mathrm{var}_{t-1}(\Delta \ln c_{it}) + \varepsilon_{it}, \tag{11}$$

where $\gamma$ is the coefficient of relative risk aversion, and $\varepsilon_{it}$ is a forecast error (in consumption growth rather than consumption changes). The first term on the right-hand side of Equation 11, absent in the quadratic utility case, is always positive and depends on the coefficient of relative prudence, which in the isoelastic case is $(1 + \gamma)$. Along the equilibrium path, an increase in uncertainty (reflected in an increase in the conditional variance of consumption growth) raises consumption growth and therefore current saving.

The model with certainty equivalence and the precautionary saving model share the common prediction that consumption should not respond to anticipated income changes.

However, the implications of the precautionary saving model about the impact of income shocks are more complex because, with isoelastic preferences, there are no closed-form solutions for consumption or consumption growth (e.g., no analog of Equation 5 linking consumption changes to income innovations) regardless of the income process. To study the response of consumption to income shocks, one must therefore rely on approximations of the expectation error, such as the one recently derived by Blundell et al. (2008a):

$$\Delta \ln c_{it} = \frac{\gamma}{2} \mathrm{var}_{t-1}(\Delta \ln c_{it}) + \sum_{k=1}^{K} \varphi^k \pi_{it}^k + \xi_{it}, \tag{12}$$

where $\xi_{it}$ is an approximation error, and we have allowed for a log income process with $K$ different components. The effect of the innovation on the $k$-th income component on consumption growth is measured by the coefficient $\phi^k$, which now depends not only on the persistence of the income component itself and the planning horizon, but also on preference parameters. For example, individuals with preferences characterized by high prudence will have a relatively low value of $\phi^k$ because they have accumulated a buffer of precautionary saving, and therefore an income shock has a lower impact on their consumption.

To evaluate this model, one can rely on the simulation results recently produced by Kaplan & Violante (2009). They simulate a life-cycle model with preferences characterized by constant relative risk aversion, an income process that distinguishes between permanent and transitory income shocks, and a pay-as-you-go pension system. Using realistic assumptions about the parameters of interest, they show that consumers who can freely borrow and save subject to a terminal condition on wealth are able to smooth transitory shocks to a large extent (the marginal propensity to consume out of a transitory income shock is 0.05) and permanent shocks to a much lower extent (the marginal propensity to consume out of a permanent shock is 0.77).[2] When consumers are unable to borrow, both marginal propensities to consume increase considerably (to 0.18 and 0.93, respectively).

In the buffer stock model, the discount rate also affects the sensitivity of consumption to income shocks. Simulation results produced by Carroll (2001) show that if consumers are impatient ($\delta > r$) and log income is the sum of a permanent and an i.i.d. transitory component (and if consumers face a small but positive probability of zero income in each period), the implication that transitory income shocks have a negligible impact on consumption still holds true. Permanent shocks, however, have a somewhat lower impact. In fact, in models with prudent households, a positive income shock reduces the ratio of wealth to permanent income, thus inducing households to spend part of the income increase to raise their buffer of precautionary saving. Under a wide range of parameter values, Carroll shows that, in this class of models, the marginal propensity to consume out of a permanent income shock is approximately 0.9.

## 2.4. Credit and Insurance Markets

The models described above are based on the assumption that consumers operate in perfect credit markets: They can borrow and lend at the same interest rate as long as they do not violate the intertemporal budget constraint and satisfy the terminal condition on wealth. At the same time, consumers do not have access to insurance markets, either formal or

[2]The authors do not investigate how much of this result is because of the presence of a social security system.

informal: The only way to buffer income shocks is by self-insuring, i.e., saving or borrowing in credit markets. Both assumptions are subject to extensive debate and research.

The consequences of removing these assumptions on the main predictions of the theory can be far-reaching. Suppose that consumers do not have access to credit or are limited in the amount of borrowing. In the presence of such liquidity constraints, consumers cannot borrow in anticipation of an income increase, and therefore consumption will change at the time the income increase materializes, in contrast to the permanent income model. With liquidity constraints, the orthogonality test fails, in the sense that the coefficient attached to positive expected income change will be statistically different from zero in Equation 4. However, when income is expected to decline, consumers can still save, and the orthogonality condition holds.

In the model with liquidity constraints, consumption responds asymmetrically also to income shocks because the ability to smooth unexpected and transitory income declines through borrowing can be seriously affected. Consider, for instance, an individual who is temporarily laid off and has no access to credit and no accumulated wealth: The marginal propensity to consume out of negative and transitory shocks in Equation 4 will be higher than predicted by the theory. Alternatively, consumers will still save when they receive an unexpected and transitory income increase.

Insurance opportunities also affect consumption allocations and the response to income shocks. In a benchmark case, known in the literature as the complete-markets model, households can insure ex ante all income shocks through a system of contingent transfers, which can be provided by formal insurance markets, the government (through taxes, transfers, and subsidies), or family networks (through private transfers). It can be shown that in this case consumption growth is constant for all households,

$$\Delta \ln c_{it} = \mu_t, \tag{13}$$

so that individual consumption growth depends only on aggregate components, common to all individuals, and not on idiosyncratic shocks.

One way of implementing the complete-markets equilibrium is through a system of transfers flowing from individuals receiving positive income shocks to those receiving negative shocks. This benchmark case is clearly unrealistic, for at least two reasons. First, it assumes that all shocks are publicly observable. However, when individuals are privately informed about the shocks they receive, those with positive realizations have an incentive to misreport their type even in the presence of full commitment. Similarly, if information is public but there is only limited commitment, individuals receiving positive shocks (especially permanent ones) have an incentive to walk away from their obligations. Either way, the equilibrium becomes unsustainable.

Alternatively, it is well-known that self-insurance is inefficient, even conditioning on private information or limited commitment, and that it is possible to obtain constrained-optimal equilibriums in which consumers are provided with more insurance than in the self-insurance case. The literature has focused on plausible cases of incomplete markets providing partial insurance against income shocks over and above what is warranted by the standard permanent or self-insurance model (for recent surveys, see Attanasio & Weber 2009, Heathcote et al. 2009). These models imply that the parameters $\phi^k$ in Equation 12 also reflect the degree of market completeness: In general, the more complete markets are, the lower the response of consumption to income shocks is.

## 2.5. An Organizing Framework

The previous discussion highlights that consumption should not respond to anticipated income changes but should react to unexpected income shocks, to an extent that depends on the characteristics and persistence of the shocks themselves and on the degree of completeness of credit and insurance markets. As an organizing framework, we summarize the discussion by means of the following expression for consumption growth:

$$\Delta \ln c_{it} = z_{it}'\lambda + \alpha E_{t-1}\Delta \ln y_{it} + \sum_{k=1}^{K} \varphi^k {\pi_{it}}^k + \xi_{it}, \tag{14}$$

where the $z_{it}$ variables capture the effect of preference shifts (such as age and family size) and precautionary savings on consumption growth, and $\xi_{it}$ is an approximation error (which may also include measurement error in consumption).

Depending on the purpose of the analysis, Equation 14 can be used in two ways. One could test the hypothesis that expected income growth does not affect consumption growth (the orthogonality test described above, or $\alpha = 0$), possibly distinguishing between positive and negative expected income growth, without making any specific assumption about the income process (i.e., treating $\sum_{k=1}^{K} \phi^k {\pi_{it}}^k + \xi_{it}$ as a composite error term).

Alternatively, one can neglect the expected income term and focus on the estimation of the marginal propensity to consume with respect to income shocks, i.e., the parameters $\phi^k$. These parameters may be informative not only about the impact of income shocks, but also about the structure of credit and insurance markets. For example, in the complete-markets case, $\phi^k = 0$ for all $k$, regardless of the income process. In the precautionary saving model, consumption responds strongly to permanent income shocks, whereas transitory shocks have negligible effects.[3] The buffer stock model delivers similar implications. Models that allow for insurance opportunities provided by governments, firms, family networks, or other channels predict that consumers are able to insure shocks to a larger extent than in models with only self-insurance, implying lower values for $\phi^k$ (assuming that the provision of public insurance does not crowd out private insurance). In the remaining two sections, we discuss in turn how empirical studies have estimated the $\alpha$ and $\phi^k$ parameters. **Supplemental Table 1** summarizes the results from the various approaches, data used, and main findings of the selected papers that we survey below (follow the Supplemental Material link from the Annual Reviews home page at **http://www.annualreviews.org**).

# 3. THE RESPONSE OF CONSUMPTION TO PREDICTED INCOME CHANGES

In this section we review empirical strategies for testing the prediction that consumption does not respond to anticipated income changes. The earlier literature focused on testing if consumption changes (or consumption growth) are orthogonal to lagged information, an approach directly derived from the consumption Euler equations (Equations 3 and 11). Because predicted income growth was usually estimated on the basis of variables known in previous periods, the approach placed strong restrictions on the data. A second, more recent generation of studies attempts to identify episodes in which future income changes in a

[3]In the precautionary saving model, one can pin down the values of $\phi^k$ only by simulation analysis with specific assumptions about preferences and the income-generating process (see Kaplan & Violante 2009 for an example).

predictable fashion and to test if consumption reacts to such changes. This literature places much fewer restrictions on the data but requires assumptions about what consumers know of their future income.

Even if the tests discussed in this section are not designed to explain the channels through which past income information might affect current consumption, by focusing on the behavior of particular groups (e.g., low-wealth or low-income individuals, renters, and borrowers) and distinguishing between income declines and income increases, one can gain insights about the validity of alternative consumption models (e.g., about the incidence of borrowing constraint) or preference characterizations (such as myopia and nonseparabilities between consumption and leisure) (see also the discussion in Browning & Crossley 2001a).

### 3.1. The Excess Sensitivity Test

Over the past three decades, many authors have performed excess sensitivity tests with macro and micro data, and some have documented the failure of the predictions of the theory. The first such study (Hall 1978) starts from the Euler Equation 1 and tests the hypothesis that consumption growth between period $t-1$ and period $t$ cannot be explained by variables dated $t-1$ and earlier, in particular lagged income growth. As remarked by Deaton (1992), Hall's test initially attracted some perplexity because most economists had become used to the idea that consumption growth does depend on lagged income growth, while the orthogonality test challenged the presence of such link. Ultimately, Hall (1978) finds that the coefficient of lagged income growth was not statistically different from zero, but the orthogonality restriction was rejected for other lagged variables (such as stock market prices).

In a closely related and widely cited paper, Flavin (1981) specifies an income process that she uses to decompose statistically income growth into expected and unexpected components.[4] She then estimates jointly the consumption and income equations, finding evidence of excess sensitivity of consumption to predicted income growth. Although popular in the 1980s, excess sensitivity tests that rely on macroeconomic data were soon abandoned because evidence for excess sensitivity in macro data likely results from aggregation bias, as shown in an influential paper by Attanasio & Weber (1993), among others.

Unfortunately, econometricians quickly discovered that problems with microeconomic data are not less daunting, even disregarding measurement error issues (Altonji & Siow 1987). In particular, the empirical literature faces four kinds of problems in testing the restriction $\alpha = 0$ in Equation 14. First, finding viable instruments for income growth that are truly exogenous and yet have good predictive power is difficult in the extreme, leading empirical economists to approach the problem using out-of-sample information about consumers' expected income changes, rather than a pure statistical procedure. The selected instruments for income growth might be poor because the econometrician has less information than the individual, who may be better informed about events such as promotions or unemployment spells. Hence, it may be more promising to identify episodes of salient, large, expected income changes that are observable to both the individual and the econometrician. We discuss this approach in the next section.

Second, in excess sensitivity tests based on Equation 14, the conditional variance of consumption growth is difficult to observe and is therefore either omitted from the estimation or

[4]Predicted income growth is obtained as the predicted value of a regression of income growth on a variable assumed to be uncorrelated with consumption growth (typically, lagged income growth). In other words, the distinction between anticipated and unanticipated income growth is achieved through an instrumental variables procedure.

subsumed in observable characteristics (the variables $z_{it}$). The problem here is that the conditional variance of consumption growth could be correlated with $E_{t-1}\Delta \ln Y_{it}$, generating spurious evidence of excess sensitivity.[5]

Third, excess sensitivity may result from a failure to control properly for nonseparable preferences. If leisure is an argument of the utility function, and if consumption and leisure are nonseparable, today's consumption decisions will be affected by predictable changes in households' labor supply. This implies that consumption growth is positively correlated with predictable growth in hours of work. Because predicted growth in hours will almost surely correlate with predicted income growth, failure to control for labor supply indicators may lead to spurious evidence of excess sensitivity (that is, it could bias the estimated $\alpha$ coefficient upwards), as shown by Attanasio & Weber (1995) with panel data drawn from the Consumer Expenditure Survey (CEX).

Finally, excess sensitivity may also arise spuriously from the misspecification of the stochastic structure of the forecast errors. According to the permanent income hypothesis with rational expectations, the conditional expectation of the forecast errors must be zero, i.e., $E_{t-1}(\varepsilon_{it}) = 0$ in Equation 4. The empirical analog of this expectation is an average taken over long periods of time, not across a large number of households. In fact, as pointed out by Chamberlain (1984), there is no guarantee that the cross-sectional average of forecast errors will converge to zero as the dimension of the cross-section becomes large. For instance, if the forecast error is the sum of an aggregate and an idiosyncratic shock, then in a short panel the orthogonality condition fails even if the permanent income model is true: Aggregate shocks induce a cross-sectional correlation between expected consumption growth and predicted income growth. The problem is sometimes handled by including time dummies in the Euler equation. But time dummies do not solve the problem either because aggregate shocks might be distributed unevenly in the population.

A more general criticism of excess sensitivity tests is that when the test fails, the rejection does not help to discriminate among alternative consumption models. In the early literature following Hall, excess sensitivity was generally held to result from the presence of credit market imperfections, in the form of interest rate differentials or credit rationing.[6] However, later literature has shown that such dependence would not have to stem from the budget constraint. Similar dependence could be generated by nonseparable preferences between consumption and leisure, habit formation, home production, or durability of goods (see Attanasio 2000 for a survey). Laibson (1997) shows that excess sensitivity can arise in equilibrium for consumers with hyperbolic preferences even in the absence of credit constraints. Whereas the empirical implications for the Euler equation of all these extensions

[5]Carroll (1992) goes one step further and points out that even Zeldes' (1989) sample-splitting approach described below may produce spurious evidence in favor of liquidity constraints if one does not control properly for expected consumption risk. Omitting the conditional variance term creates a spurious correlation between consumption growth and income that is stronger for low-wealth households. Rich households have greater capacity than poor ones to buffer income fluctuations by drawing down their assets, so a finding of excess sensitivity in the group of poor households only—as in Zeldes—could be rationalized once the assumption of certainty equivalence is dropped by the theory of intertemporal choices.

[6]Excess sensitivity may arise also in models in which myopic behavior induces tracking of consumption to income, in precautionary saving models, or in models with precautionary saving and borrowing constraints, and empirically it is difficult to distinguish between them. Furthermore, detecting failures of the theory in models with prudence and borrowing constraints is not easy because the orthogonality condition may not be violated most of the time, as households save in the anticipation of future constraints.

are rather similar to liquidity constraints, intertemporal dependence originating from the preference side has vastly different policy implications than credit constraints.

Researchers have made considerable progress in the study of the impact of credit constraints on consumption by incorporating additional information. The most influential and innovative paper in this respect, Zeldes (1989), relies on an asset-based sample separation rule. Zeldes assumes that the level of assets separates households that are likely to be liquidity constrained (the low-wealth group) from those that have access to credit markets or no need to borrow (the high-wealth group). If the only violation of the model results from the existence of liquidity constraints, excess sensitivity should arise only in the low-asset group. If instead excess sensitivity results from nonseparable preferences or myopia, there is no reason to expect that the results for the two groups should differ. Using panel data on food consumption available in the Panel Study of Income Dynamics (PSID), Zeldes indeed finds a violation of the theory in the low-asset group. Because the coefficient of lagged income in the Euler equation is statistically different from zero and twice as large (in absolute value) as for the high-asset group, he concludes that the rejection of the theory results from the effect of credit constraints.

Whereas adding outside information improves the power of the excess sensitivity test and ties potential rejections more clearly to a specific alternative, splitting the sample on the basis of wealth has a number of drawbacks. First, wealth is a good indicator of liquidity constraints only if there is a roughly monotonic relation between the two. But poor households are not necessarily identical to constrained households. For instance, households that are able to borrow without full collateral have negative wealth but are obviously not credit constrained. Second, sample splits based on wealth are bound to be highly imperfect because assets and asset income are often poorly measured.[7]

### 3.2. Distinguishing Between Income Increases and Income Declines

Variants of the excess sensitivity tests distinguish between positive and negative expected income changes, an approach first proposed by Shea (1995). He notes that different consumption models imply different response of consumption to predicted income increases and declines. Under myopia, consumption tracks income, and consumption should respond equally to predictable income increases and decreases. In the presence of credit constraints, however, households can save when income is expected to fall but cannot borrow when income is expected to rise. Therefore, with credit constraints, consumption should be more strongly correlated with predictable income increases than declines. In his empirical application, Shea (1995) isolates households in the PSID whose heads can be matched to particular long-term union contracts and constructs a household-specific measure of expected wage growth. He finds that consumption responds more strongly to predictable income declines

[7]Jappelli et al. (1998) attempt to identify the impact of liquidity constraints using direct information on borrowing constraints obtained from the 1983 Survey of Consumer Finances (SCF). In a first stage, they estimate probabilities of being constrained, which are then utilized in a second sample (the PSID) to estimate switching regression models for the Euler equation. Contrary to Zeldes (1989), their estimates do not indicate much excess sensitivity associated with the possibility of constraints. However, quantile regressions indicate that the pattern of the conditional distribution of consumption in the constrained and unconstrained regimes is consistent with the hypothesis that liquidity constraints affect food consumption allocations. Aguila et al. (2008) use CEX data on car loans (instead of consumption data) to show that the demand for loans is more sensitive to the quantity of debt (which they measure with loan maturity) than to the price of debt (the interest rate), particularly for poor households. They argue that these results are consistent with the presence of binding credit constraints in the car-loan market.

than to predictable income increases, an asymmetry that is inconsistent with both liquidity constraints and myopia.

Garcia et al. (1997) use a statistical approach to distinguish between positive and negative expected income growth. They predict the probability of being liquidity constrained using a switching regression framework and find that liquidity-constrained consumers are excessively sensitive to past information (but unconstrained consumers also exhibit behavior that is inconsistent with the theory). Jappelli & Pistaferri (2000) use subjective quantitative income expectations available for a sample of Italian households as an instrument for income growth and find no evidence for excess sensitivity to both income increases and declines.

## 3.3. Episodes of Income Increases

One reason why excess sensitivity tests based on pure statistical procedures provide very weak tests of the theory might be that the instruments used to predict income growth (such as lagged income growth) are not be powerful enough. Therefore, applied researchers have tried to identify specific episodes in which predicted income changes are observable by both the consumer and the econometrician. Such episodes can also be classified into expected income increases and expected income declines.

Wilcox (1989) examines the response of aggregate consumption to preannounced increases in social security benefits. He finds that consumption increases not when the income increase is announced, but when it is actually implemented. In particular, he estimates that a 10% increase in social security benefits induces a 1% increase in retail sales in the same month and a 3% increase in durable goods purchase. The limitation of this particular test is that it is difficult to analyze major changes in tax policy using aggregate data on components of retail sales.

In a series of papers, Shapiro & Slemrod use instant-survey data to measure individual responses to actual or hypothetical tax policies. For example, they examine the effectiveness of President George H.W. Bush's temporary reduction in income tax withholding that took place in 1992 (Shapiro & Slemrod 1995).[8] One month after the tax change was implemented, they surveyed approximately 500 taxpayers and asked them (*a*) whether they had realized that income tax withholding had decreased and (*b*) what they were planning to do with the extra money in their paycheck (i.e., mostly save it or mostly spend it). Of the people interviewed, 40% planned to spend the extra take-home pay, suggesting that even a temporary tax change could be moderately effective in increasing household spending. In their analysis of the 2001 income tax rebate (Shapiro & Slemrod 2003), they report a lower estimate of the marginal propensity to consume (only 22% of the interviewed households reported planning to spend the tax rebate) and little evidence of myopia or liquidity constraints. They reach similar conclusions in their analysis of the 2008 tax stimulus (Shapiro & Slemrod 2009). One problem of these studies, common to all research using subjective responses or expectations, is that respondents may have little incentive to answer the questions correctly, may have trouble understanding the wording of the questions, or may in practice behave differently from their reported behavior.

Other studies have used actual consumption data to study temporary tax changes that increase disposable income. Parker (1999) considers the effect on consumption of the

[8]The change was transitory as it was planned to be offset by a smaller tax refund in 1993.

anticipated income increase induced by reaching the social security payroll cap ($106,800 in 2009) at some point during the calendar year.[9] Souleles (1999) studies the anticipated income increase induced by the receipt of tax refunds and in a subsequent paper analyzes how consumption responded to the widely preannounced tax cuts of the Reagan administration era (Souleles 2002). All these studies use data from the CEX, all find evidence of excess sensitivity, and most do not attribute the failure of the theory to liquidity constraints.[10]

In Parker's study, a one-dollar anticipated rise in income increases nondurable consumption by approximately 20 cents. This result is unlikely to result from liquidity constraints because the sample includes only high-income taxpayers. Souleles (1999) finds that 10% of federal tax refunds is spent on nondurables but that the response of total consumption is much larger (65% of refunds), suggesting that most of the refund is spent on durable goods. Because high-wealth individuals are those mostly using the tax refund to spend on durables, he concludes that borrowing constraints can explain only part of the results.[11] Souleles (2002) also points out that liquidity constraints are unlikely to explain his excess sensitivity finding.

Further insights from tax refunds are provided by Johnson et al. (2006), who study the large income tax rebate program provided by the Economic Growth and Tax Relief Reconciliation Act of 2001. The program sent tax rebates, typically $300 or $600 in value, to approximately two-thirds of U.S. households. According to the permanent income hypothesis, a single rebate would have little effect on spending. Furthermore, the theory predicts that, in the absence of liquidity constraints, spending should increase as soon as consumers begin to expect some tax cut, and not increase only after they actually have received the rebate check. Johnson, Parker, and Souleles' analyses use a unique feature of the rebate program. Because it was administratively difficult to print and mail the rebate checks all at once, they were mailed out over a 10-week period from late July to the end of September 2001. Most importantly, the particular week in which a check was mailed depended on the second-to-last digit of the taxpayer's social security number, a number that is effectively randomly assigned (the timing of receipt of the tax rebate was observed in their CEX data, thanks to the addition of a special survey module). This randomization allows the authors to identify the causal effect of the rebate by comparing the spending of households that received the rebate earlier with the spending of households that received it later. The authors find that the average household spent 20%–40% of its 2001 tax rebate on nondurable goods during the three-month period in which the rebate was received. The authors also find that the expenditure responses are largest for households with relatively low liquid wealth and low income, which is consistent with liquidity constraints.

In a related paper, Agarwal & Souleles (2007) use a panel data set of credit card accounts to analyze how consumers responded to the same tax rebate analyzed by Johnson

[9]Parker (1999) also exploits the expected decline in income that high-income taxpayers face in January of each year when the social security payroll tax kicks back in.

[10]Baker et al. (2007) use CEX data to document the effect of dividends in consumption. They find that consumption responds much more strongly to returns in the form of dividends than returns in the form of capital gains and suggest that the results may reflect mental accounting processes of the sort summed up in the adage "consume income, not principal."

[11]Hsieh (2003) studies two episodes affecting the same households: tax refunds (as in Souleles 1999) and payments from the Alaska Permanent Fund, which go only to Alaskan residents. His results are puzzling because he finds excess sensitivity with respect to tax refunds but not with respect to payments from the Alaska Permanent Fund.

et al. (2006). They estimate the month-by-month response of credit card payments, spending, and debt to the rebates, exploiting the randomized timing of the rebates' disbursement to identify their causal effects. They found that, on average, consumers initially saved some of the rebate, by increasing their credit card payments and thereby paying down debt and increasing their liquidity. But soon afterward their spending increased, counter to the implications of the permanent income model.

A paper that stands in contrast to these is Browning & Collado (2001), who use Spanish micro data to examine the consumer response to the payment of institutionalized June and December extra wage payments to full-time workers. Browning & Collado detect no evidence of excess sensitivity and argue that the reason why earlier researchers found a large response of consumption to predicted income changes is because of bounded rationality: Consumers tend to smooth consumption and follow the theory when expected income changes are large but are less likely to do so when the changes are small and the cost of adjusting consumption is not trivial.[12] Suppose, for example, that consumers who want to adjust their consumption upwards in response to an expected income increase need to face the cost of negotiating a loan with a bank. It is likely that the utility loss from not adjusting fully to the new equilibrium is relatively small when the expected income increase is small, which suggests that no adjustment would take place if the transaction cost associated with negotiating a loan is high enough.[13]

This magnitude hypothesis has been formally tested by Scholnick (2010), who uses a large data set provided by a Canadian bank that includes information on both credit card spending as well as mortgage payment records. As in Stephens (2008), he argues that the final mortgage payment represents an expected disposable income shock (that is, income net of precommitted debt service payments). His test of the magnitude hypothesis looks at whether the response of consumption to expected income increases depends on the relative amount of mortgage payments.

Overall, the main limitation of the approach discussed in this section is that it offers little guidance for how consumers would react to different shocks and environments. However, it does offer ways to evaluate why consumption theories fail. For instance, some of the studies examined found that low-wealth consumers react more to predictable income changes than high-wealth consumers, a finding that points to the existence of liquidity constraints.

### 3.4. Episodes of Income Declines

The most useful aspect of analyses that consider the effect of expected income declines on consumption is that any excess sensitivity found in the data cannot be attributed to liquidity constraints because models with credit constraints predict that consumers do not borrow (and rather save) if they expect their income to decline. Whereas borrowing can and does face limits, saving does not.

[12]The magnitude argument could also explain Hsieh's (2003) puzzling findings. Tax refunds are typically smaller than payments from the Alaska Permanent Fund (although the actual amount of the latter is somewhat more uncertain).

[13]Another element that may matter, but that has been neglected in the literature, is the time distance that separates the announcement from the actual income change. The smaller the time distance is, the lower the utility loss from inaction.

The most important predictable decline in one's income occurs at retirement. A powerful test of whether consumption is insensitive to predictable changes in income is thus to compare consumption before and after retirement. The first paper to look at this issue is Banks et al. (1998), who use repeated cross-sectional data drawn from the U.K. Family Expenditure Survey and find a remarkable drop in consumption after retirement. Bernheim et al. (2001) repeat the test for the United States using the PSID and also find evidence of a substantial consumption drop at retirement (24% for the first income quartile, 15% for the second quartile, and 9% of the third and fourth quartiles). The main limitation of this study is that until recently the only information available in the PSID was food consumption.[14] Beginning in 1999, the PSID added new questions about several categories of consumption expenditure. Li et al. (2009) describe the new PSID data and illustrate their quality by comparing them to the expenditure data from the CEX. They show that PSID expenditures for each broad category and for imputed total PSID expenditures align closely with corresponding measures from the CEX. It is therefore likely that we will see increasing reliance on PSID consumption data in the future to provide evidence on the behavior of consumption after retirement and to test other hypotheses on households' behavior.

How do we explain the finding that consumption drops at retirement? One possibility, of course, is that the life-cycle theory is not valid and that consumers are myopic or lack self-control. That is, they fail to anticipate that retirement brings about a steep decline in income. When they realize it, they are forced to adjust their consumption downward. But other explanations do not imply a rejection of the theory. Most of the fall in consumption at retirement may result from the decline of work-related expenses (e.g., transportation and canteen meals), rather than a decline of all consumption categories. A related argument is that, from Equation 2, the theory predicts that individuals smooth the marginal utility of consumption and not necessarily consumption itself. If utility is nonseparable between consumption and leisure, Equation 2 can be written as

$$E_{t-1}u'(c_{it}, L_{it}) = u'(c_{it} - 1, l_{it} - 1).$$

If consumption and leisure are substitutes in utility, the sudden increase in leisure time from the period before retirement ($l$) to the period after retirement ($L$) requires a corresponding sharp adjustment in consumption. Another possibility is that retirement may not be that expected after all, so consumption may legitimately fall because retirement comes as a shock. Haider & Stephens (2007) emphasize that, for most workers, the timing of retirement is uncertain and that it is sometimes forced upon the individuals by events such as prolonged unemployment or disabilities.

A further explanation for a decline in consumption at retirement is home production, an issue stressed in Hurd & Rohwedder (2006) and Aguiar & Hurst (2007). The idea is that consumption (and in particular food consumption) is just an input to a home-production function, which also uses leisure time, shopping, and housework as other factors. Retirement brings about a sharp increase in the amount of time available for shopping and housework, so individuals may choose to substitute tomatoes purchased in a grocery store with tomatoes grown in their own garden, for example. Similarly, they may spend more of

[14]Studies that use more comprehensive consumption measures find little or no consumption drop in the United States. Using a special module in the Health and Retirement Survey, Hurd & Rohwedder (2006) find that there is no consumption drop for the average household. However, their sample size is rather small. Using panel data from the CEX, Aguila et al. (2008) find that food consumption declines by 6% but detect no decline for non-food consumption. These papers also provide a detailed survey of the relevant literature.

their time looking for cheaper items. Indeed, Aguiar & Hurst (2005) use the Continuing Survey of Food Intake of Individuals, collecting information on food expenditure and calories intake, and the National Human Activity Pattern Survey, a time-use survey, to show that although food expenditure does decline at retirement, food intake does not, consistent with the home-production story. In a follow-up paper, Aguiar & Hurst (2007) use individual scanner data on grocery expenses from the ACNielsen's Homescan Survey to find that the elderly shop more frequently and buy cheaper goods (or manage to find the same goods at a lower price) than younger individuals who have less leisure time available.

Retirement is not the only situation in which households expect future resources to decline. Souleles (2000) studies the consumption effect of expected disposable income declines induced by paying for college tuition. Using CEX data, Souleles tests whether households' noneducational consumption decreases in proportion to their college expenditures. The main finding is that households appear to do a relatively good job smoothing their consumption into the academic year, despite large expenses, consistent with the life-cycle hypothesis.

The retirement and college-tuition experiments are cases in which income declines in a predictable way, and therefore the excess sensitivity test is free of complications due to liquidity constraints. In summary, the evidence appears to be in favor of consumption smoothing and the basic tenets of the permanent income hypothesis.

## 4. THE RESPONSE OF CONSUMPTION TO UNANTICIPATED INCOME SHOCKS

In this section we turn to examining tests of the prediction that consumption should respond to unanticipated income changes and that the response should depend on the persistence of the shock and on the degree of imperfections of credit and insurance markets. The literature has considered three approaches. A first method attempts to identify episodes in which income changes unexpectedly and to evaluate in a quasi-experimental setting how consumption reacts to such changes. A second approach estimates the marginal propensity to consume with respect to income shocks using the covariance restrictions that the theory imposes on the joint behavior of consumption and income growth. A third approach estimates the impact of shocks combining realizations and expectations of income or consumption in surveys in which data on subjective expectations are available. Each of these approaches has benefits and disadvantages, as we discuss below.

### 4.1. The Quasi-Experimental Approach

The approach discussed in this section does not require estimating an income process or even observing the individual shocks. Rather, it compares households that are exposed to shocks with households that are not (or the same households before and after the shock) and assumes that the difference in consumption arises from the realization of the shocks.

The first of such attempts dates back to a study by Bodkin (1959), who 50 years ago laid down all the ingredients of the quasi-experimental approach. In this pioneering study, the experiment consists of looking at the consumption behavior of World War II veterans after the receipt of unexpected dividend payments from the National Service Life Insurance. Bodkin assumes that the dividend payments are unanticipated and represent a windfall source of income, and he finds a point estimate of the marginal propensity to consume nondurables out of this windfall income as high as 0.72, a strong violation of the permanent income model.

The subsequent literature has looked at the economic consequences of illness; disability; unemployment; and, in the context of developing countries, weather shocks and crop losses. Some of these shocks are transitory (e.g., temporary job loss), and others are permanent (i.e., disability); some are positive (e.g., dividends payouts), and others are negative (illness). The framework in Section 2 suggests that it is important to distinguish between the effects of these various types of shocks because, according to the theory, consumption should change almost one for one in response to permanent shocks (positive or negative), but it may react asymmetrically if shocks are transitory. Indeed, if households are credit constrained (i.e., they can save but not borrow), they will cut consumption strongly when hit by a negative transitory shock but will not react much to a positive one.

Recent papers in the quasi-experimental framework look at the effect of unemployment shocks on consumption and the smoothing benefits provided by unemployment insurance (UI) schemes. As pointed out by Browning & Crossley (2001b), UI provides two benefits to consumers. First, it provides consumption smoothing benefits for consumers that are liquidity constrained. In the absence of credit constraints, individuals who faced a negative transitory shock such as unemployment would borrow to smooth their consumption. If they are unable to borrow, they would need to adjust their consumption downward considerably. UI provides some liquidity, and hence it has positive welfare effects. Second, UI reduces the conditional variance of consumption growth in Equation 12 and hence the need to accumulate precautionary savings.

One of the earlier attempts to estimate the welfare effects of UI is Gruber (1997). Using the PSID, he constructs a sample of workers who lose their job between period $t-1$ and period $t$ and regresses the change in food spending over the same time span against the UI replacement rate for which an individual is eligible (i.e., potential benefits).[15] Gruber finds a large smoothing effect of UI; in particular, a 10-percentage-point rise in the replacement rate reduces the fall in consumption upon unemployment by approximately 3%.[16] He also finds that the fall in consumption at zero replacement rates is approximately 20%, suggesting that consumers face liquidity constraints.[17]

Browning & Crossley (2001b) extend Gruber's idea to a different country (Canada instead of the United States), using a more comprehensive measure of consumption (instead of just food) and legislated changes in UI (instead of state-time variation). Moreover, their data are rich enough to allow them to identify presumably liquidity-constrained households (in particular, their data set provides information on assets at the time of job loss). Browning & Crossley estimate a small elasticity of expenditures with respect to UI benefit (5%). But this small effect masks substantial heterogeneity, with low-assets households

[15]The use of potential benefits instead of actual benefits is for three reasons: (*a*) the endogeneity of UI receipts, (*b*) the large amount of error in reported UI benefits, and (*c*) the policy interest in the effect of potential UI benefits (which can be manipulated by the government) rather than on the effect of received benefits (which cannot).

[16]The use of a measure of total consumption (rather than just food) would presumably make the estimated effect even larger, given that food is only a share of total consumption.

[17]Gruber also tests whether anticipated layoffs (measured using seasonal and serial layoffs) have no impact on consumption and finds no rejection of this hypothesis. Given that he is considering anticipated income declines, this result is not inconsistent with his finding regarding the large impact of an unemployment shock. Moreover, for some individuals, an unemployment shock could be a persistent one (i.e., individuals close to retirement).

at the time of job loss exhibiting elasticities as high as 20%. This is consistent with the presence of liquidity constraints.

A critique of this approach is that the response of consumption to unemployment shocks is confounded by three set of issues (similar arguments apply to papers that look at unpredictable income changes due to illness or disability, as in Stephens 2001). First, some of these shocks may not come as a surprise, and individuals may have saved in their anticipation. For example, being laid off by Chrysler in 2009 is hardly an unanticipated event. Second, the theory predicts that consumers smooth marginal utility, not consumption per se. If an unemployment shock brings more leisure and if consumption is a substitute for leisure, an excess response of consumption to the transitory shock induced by losing one's job does not necessarily represent a violation of the theory. Finally, even if unemployment shocks are truly fully unanticipated, they may be partially insured through government programs such as UI (and disability insurance in case of disability shocks). An attenuated consumption response to a permanent income shock due to disability may be explained by the availability of government-provided insurance, rather than representing a failure of the theory. Therefore, a complete analysis of the impact of unemployment or disability shocks requires explicit modeling of the type of insurance available to individuals as well as of the possible interactions between public and private insurance.[18]

The above discussion suggests that it might be easier to test the theory in contexts in which insurance over and above self-insurance is not available, such as in developing countries.[19] Gertler & Gruber (2002) look at the effect of income shocks arising from major illness on consumption in Indonesia. They find that whereas people smooth well the effect of minor illnesses (which could be interpreted as transitory shocks, or anticipated events), they experience considerably more difficulty in smoothing the impact of major illnesses (which could be interpreted as permanent shocks).

Wolpin (1982) and Paxson (1993) study the effect of weather shocks in India and Thailand, respectively. In agricultural economies, weather shocks affect income directly through the production function, and deviations from normal weather conditions are truly unanticipated events. Wolpin (1982) uses Indian regional time-series data on rainfall to construct long-run moments as instruments for current income (which is assumed to measure permanent income with error). The estimated permanent income elasticity ranges from 0.91 to 1.02, depending on the measure of consumption, thus supporting strongly the permanent income model. Paxson (1993) uses regional Thai data on weather to measure transitory shocks and finds that Thai consumers have a high propensity to save out of transitory weather shocks, in support of the theory. However, she also finds that they have a propensity to save out of permanent shocks above zero, which rejects a strong version of the permanent income hypothesis.

Studies using quasi-experimental variation to identify shocks to household income have the obvious advantage that the identification strategy is clear and easy to explain and understand. However, these studies' obvious limitation is that they capture only one type of shock at a time (e.g., illness, job loss, rainfall, extreme temperatures, or crop loss). One

[18]Some of these interactions stem from the fact that most welfare programs are means and asset tested. For example, in the United States, individuals with more than $2000 in liquid assets are not eligible to receive food stamps, Medicaid, and other popular welfare programs even if they have no income. The disincentives to save (self-insure) induced by the presence of public insurance (which in most cases are not subject to time limits) have been studied by Hubbard et al. (1995).

[19]Alternatively, there may stronger family networks in these countries.

may wonder, for example, whether the Gruber (1997) and Browning & Crossley (2001b) estimates obtained in a sample of job losers have external validity for examining the effect of other types of shocks (especially those that are much harder to insure, such as shocks to one's productivity).

A second limitation of the approach is that some of the income shocks (in particular, unemployment and disability shocks) cannot be considered as truly exogenous events. For instance, for some people unemployment is a voluntary choice, and for others disability could be reported just to obtain benefits (a moral hazard issue). For this reason, not all income variability is necessarily unanticipated or not acted upon by the agent (Low et al. 2010). The lesson of the literature is that identifying episodes of genuine exogenous and unanticipated income changes is difficult. One such case is weather conditions, to the extent at least to which people do not move to different regions to offset bad weather conditions.

### 4.2. Statistical Decomposition of Income Shocks

A different approach to identify the consumption response to unanticipated income shocks makes specific statistical assumptions about the income process and uses covariance restrictions to identify the parameters that characterize the joint behavior of consumption and income, and in particular the response of consumption to shocks.

But how should income shocks be identified? Two methods have emerged in the literature. A first approach, which we discuss in this section, relies on panel data (or pseudo–panel data) and measures shocks as deviations from observable income determinants. To be valid, this method requires the assumption that each individual conditions on the same set of variables to form expectations, that the individuals and the econometrician have the same information set, and that the econometrician knows the stochastic process that generates individual income expectations. A different strategy relies on quantitative subjective expectations, which we discuss in the next section.

There are several advantages of the statistical decomposition of income shocks. First, it allows estimating simultaneously the marginal propensity to consume with respect to shocks of various nature and persistence. The main variable of interest in the statistical decomposition is income, and therefore one can estimate the response of consumption to all types of income shocks rather than to specific episodes (e.g., weather fluctuations or job loss). Finally, there is a sharper (albeit econometrically derived) distinction between transitory and permanent shocks. There are also drawbacks, however. Because the approach assumes that income and consumption follow a particular process, it is structural in nature and may suffer from specification bias for the consumption rule. The approach is more demanding in terms of data because it requires repeated observations on income and consumption, although not necessarily in the same data set, and not necessarily for the same households. Finally, with this approach, it is more difficult to distinguish between the effects of positive and negative income shocks.

To explain how the method works, consider again a slightly modified version of the consumption rule (Equation 14), to which we append an equation for income growth:

$$\begin{aligned} \Delta \ln c_{it} &= z_{it}'\gamma^c + \varphi^1 \pi_{it}{}^1 + \varphi^2 \pi_{it}{}^2 + \varphi^3 \pi_{it}{}^3 + \Delta\xi_{it}, \\ \Delta \ln y_{it} &= z_{it}'\gamma^y + \pi_{it}{}^1 + \Delta\pi_{it}{}^2 + \Delta\pi_{it}{}^3. \end{aligned} \tag{15}$$

In this specification, $\pi^1$ represents a permanent shock (the innovation of a martingale process), and $\pi^2$ and $\pi^3$ are i.i.d. components, measuring transitory shocks and measurement error in income, respectively. The parameters $\varphi^1$ and $\varphi^2$ measure the marginal propensities to consume with respect to permanent and transitory income shocks, respectively. Recall from the discussion in Sections 2.4 and 2.5 that these parameters can be interpreted as the degree to which households insure income shocks and therefore capture the degree of market completeness. Finally, $\xi$ is a measurement error in consumption. The literature typically imposes $\varphi^3 = 0$ because consumption does not respond to noise in income. But note that this assumption has behavioral content if $\pi^3$ captures anticipated transitory changes in income that are unobserved to the econometrician. In the rest of the section we follow the literature and impose $\varphi^3 = 0$.

The consumption rule (Equation 15) states that consumption growth depends on preference shifts $z$ (such as age and family size), as well as income shocks, and nests many of the models that we discuss above. For instance, according to the permanent income model, consumption responds fully to permanent income shocks ($\varphi^1 = 1$), whereas transitory shocks have negligible effects ($\varphi^2 \approx 0$) because consumers use accumulated assets to smooth temporary income fluctuations. The buffer stock model has similar implications, possibly allowing for slightly lower values of $\varphi^1$. In the complete-markets benchmark model, consumption is completely insulated from transitory as well as permanent shocks ($\varphi^1 = \varphi^2 = 0$). Finally, models with precautionary savings or partial insurance predict that consumers also are able to insure permanent shocks to a larger extent than in the permanent income hypothesis ($0 < \varphi^1 < 1$).

Identification of the model with panel data on income and consumption growth can be approached considering a set of covariance restrictions. Defining the residual term $\Delta \ln \tilde{x}_{it} = \Delta \ln x_{it} - z_{it}'\gamma^x$, the restrictions are

$$\begin{aligned}
\mathrm{var}(\Delta \ln \tilde{c}_{it}) &= (\varphi^1)^2 \sigma^2_{\pi^1} + (\varphi^2)^2 \sigma^2_{\pi^2} + 2\sigma^2_{\xi}, \\
\mathrm{cov}(\Delta \ln \tilde{c}_{it}, \Delta \ln \tilde{c}_{it-1}) &= -\sigma^2_{\xi}, \\
\mathrm{var}(\Delta \ln \tilde{y}_{it}) &= \sigma^2_{\pi^1} + 2\sigma^2_{\pi^2} + 2\sigma^2_{\pi^3}, \\
\mathrm{cov}(\Delta \ln y_{it}, \Delta \ln \tilde{y}_{it-1}) &= -\sigma^2_{\pi^2} - \sigma^2_{\pi^3}, \\
\mathrm{cov}(\Delta \ln \tilde{c}_{it}, \Delta \ln \tilde{y}_{it}) &= \varphi^1 \sigma^2_{\pi^1} + \varphi^1 \sigma^2_{\pi^2}, \\
\mathrm{cov}(\Delta \ln \tilde{c}_{it-1}, \Delta \ln \tilde{y}_{it}) &= -\varphi^1 \sigma^2_{\pi^2}.
\end{aligned}$$

Note that the model is underidentified because, unless $\varphi^2$ is known, the variance of the transitory shock $\sigma^2_{\pi^2}$ and the variance of the measurement error in income $\sigma^2_{\pi^3}$ cannot be identified separately. One way out is to identify $\sigma^2_{\pi^3}$ using outside information, such as results from income validation studies, as suggested by Meghir & Pistaferri (2004).

The first paper to decompose income shocks to estimate the marginal propensity to consume is Hall & Mishkin (1982), who work with PSID data on income and food consumption. Their setup assumes quadratic preferences (and hence looks at consumption and income changes), imposes $\varphi^1 = 1$, and leaves only $\varphi^2$ free for estimation. They find that the response of consumption to innovations in transitory income is 29%, which is too high to be consistent with the theory.

Blundell et al. (2008b) extend the framework to the case of constant relative risk aversion and consider also a shock to higher moments of the earnings distribution. In their study, they create panel data on a comprehensive consumption measure for the PSID using an imputation procedure based on food-demand estimates from the CEX. They find that consumption is nearly insensitive to transitory shocks (the estimated $\phi^2$ parameter is approximately 5%, but is higher among poor households), whereas their estimate of $\phi^1$ is significantly lower than 1 (approximately 0.65, but lower for the college-educated households and those near retirement and higher for poor or less-educated households), suggesting that households are able to insure at least part of the permanent shocks.[20]

The results of Blundell et al. (2008b) can be used to understand why consumption inequality in the United States has grown less than income inequality during the past two decades. Their findings suggest that the widening gap between consumption and income inequality results from the change in the durability of income shocks. In particular, a growth in the variance of permanent shocks in the early 1980s was replaced by a continued growth in the variance of transitory income shocks in the late 1980s. Because they find little evidence that the degree of insurance with respect to shocks of different durability changes over this period, it is the relative increase in the variability of more insurable shocks, rather than greater insurance opportunities, that explains the disjuncture between income and consumption inequality.

A low response of consumption to permanent shocks may reflect not only insurance opportunities, but also advance information. To exemplify, suppose that one finds that consumption responds little to what the econometrician labels a permanent shock. Does this happen because the income change is not really a surprise from the point of view of the consumer (i.e., it was anticipated), or is it because it is mostly insured? The variation measured in the data may reflect both information known to the econometrician and superior information held by the individual. Two recent papers take the information issue seriously. Primiceri & van Rens (2009) assume that consumers are unable to smooth permanent shocks and that any attenuated response measures the amount of advance information that they have about developments in their (permanent) income. Using CEX data, they find that all the increase in income inequality over the 1980–2000 period can be attributed to an increase in the variance of permanent shocks but that most of the permanent income shocks are anticipated by individuals; hence consumption inequality remains flat even though income inequality increases. Although their results challenge the common view that permanent shocks were important only in the early 1980s (see Card & Di Nardo 2002), they could be explained by the poor quality of income data in the CEX.

In related research, Guvenen & Smith (2009) assume that the income process is the sum of a random trend consumers must learn about in Bayesian fashion, an AR(1) process with the AR coefficient below 1, and a serially uncorrelated component. They extend the consumption imputation procedure of Blundell et al. (2008b) to create panel data of income and consumption data in the PSID and find that consumers know quite a lot about the evolution of their income process (approximately 80% of the uncertainty about the random trend component is resolved in the first period).

This discussion suggests that, although the approach based on the covariance restrictions between the income and the consumption processes allows estimation of the

[20]Jappelli & Pistaferri (2006) consider the implications that the theory imposes on the mobility matrix of household consumption and income. Using Italian data from the Italian Survey of Household Income and Wealth, they find considerably less insurance against income shocks than in U.S. applications (the marginal propensity to consume out of permanent shocks is approximately 1 and that with respect to transitory shocks is approximately 0.3). These results are confirmed in a subsequent paper (Jappelli & Pistaferri 2008) using more recent data, which also points out that the marginal propensity to consume out of transitory income shocks is higher among households with lower education (0.315) than among those who completed high school (0.121), suggesting that people with higher education have easier access to credit markets to smooth income fluctuations.

sensitivity of consumption to permanent income shocks, it still does not isolate the reasons why permanent shocks appear to be smoothed. In particular, the approach cannot distinguish between insurance mechanisms and differential information between the individual and the econometrician.

### 4.3. Subjective Expectations

As pointed out in Sections 4.1. and 4.2, identifying income shocks is difficult because people may have information that is not observed by the econometrician. For instance, they may know in advance that they will face a temporary change in their income (such as a seasonal layoff). When the news is realized, the econometrician will measure as a shock what is in fact an expected event. The literature based on subjective expectations attempts to circumvent the problem by asking people to report quantitative information on their expectations, an approach forcefully endorsed by Manski (2004). This literature therefore relies on survey questions, rather than retrospective data as in Section 4.2, to elicit information on the conditional distribution of future income, and measures shocks as deviations of actual realizations from elicited expectations.

Hayashi (1985) is the first study to adopt this approach. He uses a four-quarter panel of Japanese households containing respondents' expectations about expenditure and income in the following quarter. Hayashi works with disaggregate consumers' expenditure, allowing each component to have a different degree of durability. He specifies a consumption rule, and allowing for measurement error in expenditures, estimates the covariances between expected and unexpected changes in consumption and expected and unexpected changes in income. His results are in line with Hall & Mishkin (1982), suggesting a relatively high sensitivity of consumption to income shocks.

Pistaferri (2001) combines income realizations and quantitative subjective income expectations contained in the Italian Survey of Household Income and Wealth to identify separately the transitory and the permanent income shocks. To see how subjective income expectations allow estimating transitory and income shocks for each household, consider the income process of Equations 7 and 8. The assumption of rational expectations implies that the transitory shock at time $t$ can be point identified by

$$\varepsilon_{it} = -E(\Delta y_{it+1}|\Omega_{it}), \tag{16}$$

where $\Omega_{it}$ is the individual's information set at time $t$. Using Equations 7, 8, and 16, the permanent shock at time $t$ is identified by the expression

$$u_{it} = \Delta y_{it} - E\left(\Delta y_{it}|\Omega_{it-1}\right) + E\left(\Delta y_{it+1}|\Omega_{it}\right),$$

e.g., the income innovation at time $t$ adjusted by a factor that takes into account the arrival of new information concerning the change in income between $t$ and $t+1$. Thus, the transitory and permanent shocks can be identified if one observes, for at least two consecutive time periods, the conditional expectation and the realization of income, a requirement satisfied by the 1989–1993 Italian Survey of Household Income and Wealth. Pistaferri estimates Equation 10 and finds that consumers save most of the transitory shocks and very little of the permanent shocks, supporting the saving-for-a-rainy-day model of Section 2.2.

Kaufmann & Pistaferri (2009) use the same Italian survey, but different years (1995–2001), to distinguish the superior information issue from the insurance issue mentioned in Section 4.2. Considering the covariance restrictions implied by the theory on the joint behavior of consumption, income realizations, and subjective quantitative income expectations, they show that the degree of insurance of income shocks is biased upwards. They also find that a large part of the transitory variation in income is either anticipated or the result of measurement error, whereas approximately two-thirds of the permanent variation in income can be labeled as a true innovation.

Studies that use subjective expectations are subject to the usual criticisms about the validity of subjective data, such as their reliability and information content, and in practice it is still the case that subjective expectations are seldom available alongside consumption and income data or confined to special survey modules. However, there is considerable promise in the use of subjective expectations to evaluate the validity of various consumption models.

## 5. CONCLUSIONS

Understanding how household consumption responds to changes in income is an important topic of research, in particular for understanding how consumers would respond to tax or welfare reforms, which is key for the formulation of effective stabilization policies. Above we review empirical approaches to two distinct questions. First, does household consumption respond to changes in income that are anticipated? Second, does consumption respond to unexpected income changes? Although it is difficult to summarize such a vast body of work, some consensus emerges from the literature, on both methods and substance.

On the methods, it is clear that distinguishing between negative and positive income changes and between transitory and permanent income shocks can help shed light not only on the response of consumption to income, but also on the validity of various theories of intertemporal choice. There are a variety of approaches that can be fruitfully explored to analyze these issues, from identification of specific episodes of anticipated income declines or increase, to the estimation of a sophisticated income process to distinguish between transitory and permanent shocks, to use of data with subjective consumption or income expectations. Indeed, here we attempt to classify the various studies along each of these dimensions.

On substance, there is by now considerable evidence that consumption appears to respond to anticipated income increases, over and above what is implied by standard models of consumption smoothing. Although the reasons for this failure of the theory are not yet well understood, there is evidence from diverse sources, studies, and countries that, at least locally, liquidity constraints are an important culprit for this failure. Indeed, consumption appears much less responsive to anticipated income declines (for instance, after retirement), a case in which liquidity constraints have no bearing. Future work should be directed toward understanding which type of credit rationing (quantity versus price rationing) and which model of behavior (adverse selection versus moral hazard) best explain the data.[21]

A second finding that emerges from the literature is that the consumption reaction to permanent shocks is much higher than that to transitory shocks. There is also evidence, at least in the United States, that consumers do not revise their consumption fully in response

[21]Primarily for lack of space, we do not discuss so-called behavioral (or other preference-driven) explanations for these findings [see recent surveys by Angeletos et al. (2001) and Camerer et al. (2005) for a discussion].

to permanent shocks. Taken together, these finding are consistent with the hypothesis that precautionary savings and even perhaps insurance over and above self-insurance (achieved through government welfare programs, family labor supply, or family networks) play an important role in consumption. Here as well, households' heterogeneity is important because liquidity constraints appear to be able to account for the estimated larger marginal propensities to consume, especially in subgroups of the population that are less likely to be able to access credit markets, such as low-income or low-education households. The main challenge for empirical work is to distinguish between information (which might be solved with better data or the specification of an income process that acknowledges the possibility of advance information) and insurance (which may require a better modeling of the sources of consumption smoothing available to consumers over and above own savings; see Attanasio & Pavoni 2007). The large fiscal packages implemented in virtually all countries in response to the recession of 2008 will certainly provide the grounds to gain further insights into the response of consumption to income changes.

## DISCLOSURE STATEMENT

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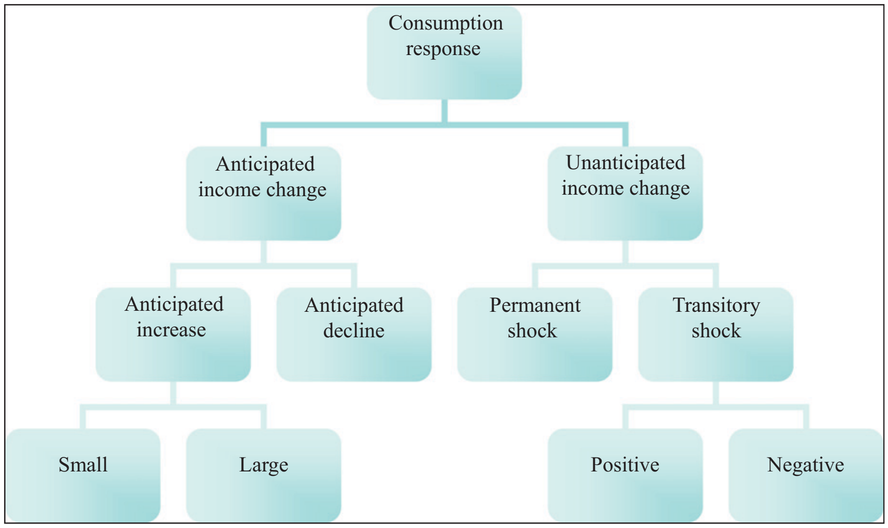


**Figure 1**

A roadmap of the response of consumption to income changes.

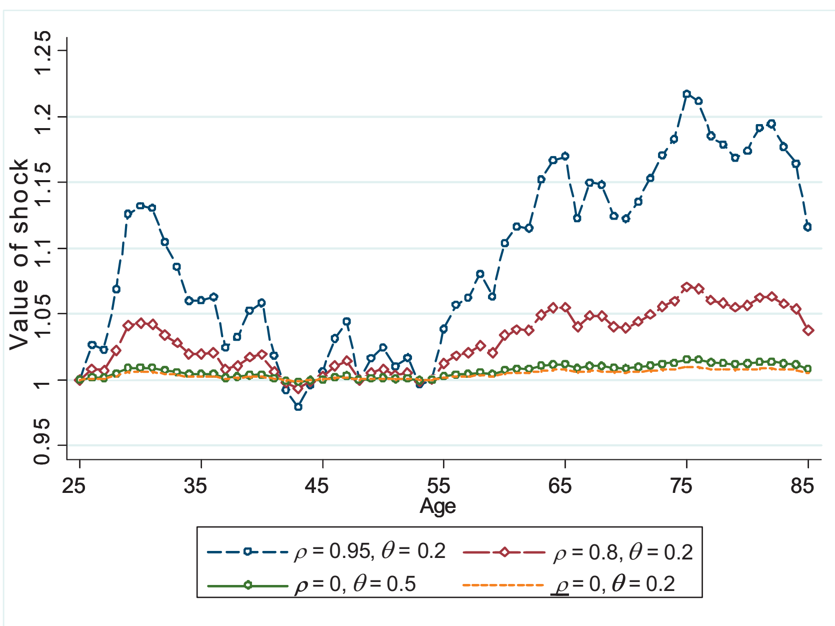


**Figure 2**

Consumption response to income shocks of different persistence.