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Abstract

Various deviations from the Permanent Income consumption model with rational expectations have been discussed in the literature, including loss aversion and liquidity constraints. In the existing literature, these two types of consumption asymmetry are usually considered as mutually exclusive. Using a single data set for US personal consumption, income and wealth, we show that evidence of either loss aversion or liquidity constraints can indeed be produced, depending on the theoretical and econometric framework applied. We then propose a synthetic asymmetric error correction model and find evidence that can be interpreted as indicating both long-run loss aversion and short-run liquidity constraints. This result can also be interpreted in the context of the secular decline in the US personal savings rate over the past decades: although wealth declines can have considerable negative consumption effects in the short run, households have apparently been able, in the longer run, to substantially increase consumption expenditure following income and wealth increases, but to keep the necessary reductions in consumer spending, as a consequence of income and wealth declines, within relatively small limits. Yet, given increasing personal indebtedness, this asymmetric consumption pattern may be unsustainable.

Key Words: Asymmetric error correction model, consumer economics, aggregate consumption and wealth.

JEL classifications: C22, D11, D12, E21

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1. Introduction

National account statistics indicate that the US personal savings rate has steeply declined over the past three decades. There is widespread agreement that this statistical observation corresponds to a real and significant economic phenomenon which many authors perceive as both puzzling and giving rise to concern (Harvey, 2006; Guidolin and La Jeunesse, 2007). Indeed, as consumption has been increasingly credit-financed and personal savings very low (or even negative, according to some statistics) for some time now, there has been a substantial rise in household debt, from around 60 per cent of disposable income in the early 1980s to more than 130 per cent recently, according to NIPA data. This certainly implies that overall financial fragility in the economy has increased.

In this paper, our goal is to contribute to explaining the US "savings puzzle" by means of an asymmetric error correction model, relating personal consumption expenditure to personal disposable income and wealth. Our estimation approach follows the behaviourist insight that "treatments of responses to changes in economic variables should routinely separate the cases of favorable and unfavorable changes. Introducing such distinctions could improve the precision of predictions at a tolerable price in increased complexity." (Kahneman et al., 1991, p. 205)

Our main result is that the long-run effects of positive changes in real per capita disposable income and personal wealth on real per capita personal consumption expenditure have been larger in absolute value than those of negative changes in the respective variables. This result is inconsistent with the rational expectations view of the Permanent Income Hypothesis, but it potentially helps explain the decline in the personal savings rate over the past decades: apparently, private households have managed to considerably expand consumption as income and wealth have increased, but they have not reduced their expenditure in a symmetric fashion following income and wealth declines.

At a theoretical level, this conclusion appears in line with the behaviourist concept of loss aversion (see Kahneman et al., 1991). It may also be explained within a framework of hyperbolic discounting (e.g. Laibson, 1997), when financial innovation, reducing individual savers' capacity of self-restraint, is asymmetrically affected by expansionary and contractionary phases in the real and financial spheres of the economy. Finally, sociological aspects, such as the "keeping up with the Joneses effect", and hierarchical needs (Maslow, 1943; Lavoie, 1994) may contribute to the observed asymmetry in consumption.

On top of the evidence of long-run loss aversion, we find that in the short-run, negative changes in wealth affect consumption more strongly than positive changes, a result that may be attributed to the presence of liquidity constraints or to the time lags involved with learning about new consumption opportunities.

Previous studies have found evidence of short-run asymmetry suggesting the presence of liquidity constraints, but have neglected the possibility of long-run asymmetry (Shirvani and Wilbratte, 2000; Apergis and Miller, 2006). On the other hand, authors who found evidence of loss aversion have regarded their results as mutually exclusive with the notion of liquidity constraints (Shea, 1995, p. 799; see also Romer, 2001, p. 323). The results presented in this paper potentially help reconcile the results from the previous literature, as we apply different estimation strategies to a single data set and find that evidence of either loss aversion or liquidity constraints, or both, can be produced, depending on the theoretical and econometric framework applied.

The paper proceeds as follows. In the next section, we review some of the existing literature on loss aversion and liquidity constraints. In section 3, we discuss different econometric tests for consumption asymmetries previously applied in the literature and propose our own approach allowing for both short-run and long-run asymmetries. Data issues and the estimation results are discussed in section 4. We apply both the IV esti-

mation approach following Campbell and Mankiw (1989) and Shea (1995) and the bounds-testing approach to long-run level relationship advanced by Pesaran et al. (2001) and extended to the asymmetric case by Shin and Yu (2006). In section 5, we take a further look at the data and discuss some robustness issues. Section 6 concludes and briefly discusses the sustainability of the observed consumption asymmetries.

2. Consumption asymmetries: Liquidity constraints versus loss aversion?

According to the rational expectations view of the Permanent Income Hypothesis, consumption should depend solely on permanent income, given by human and other wealth. There have been different attempts to refute this view. On the one hand, it has been argued that the traditional Keynesian link between current income and current consumption is still relevant, due to e.g. the existence of non-Ricardian rule-of-thumb consumers (Campbell and Mankiw, 1989) or to social norms and habits (Lavoie, 1994; Akerlof, 2007). Going one step further, the behaviouristic literature has produced considerable experimental evidence suggesting that individuals (e.g. consumers) tend to react differently to positive and negative changes in economic variables (e.g. income or wealth). Therefore, as argued by Kahneman et al. (1991, p. 205), linear models "predict more symmetry and reversibility than are observed in the world, ignoring potentially large differences in the magnitude of responses to gains and to losses."

One type of consumption asymmetry, which is often discussed in the context of the so-called "wealth effect", refers to the notion of liquidity constrained consumers. When financial wealth changes, permanent income changes so that households, insofar as they smooth consumption over time, will adjust current expenditure. Yet, "whereas consumers can readily reduce consumption in response to stock price declines, some consumers may find it difficult to borrow to increase consumption." (Shirvani and Wilbratte, 2000, p. 43) Also, as asset prices decline, refinancing conditions worsen as banks, due to in-

formation asymmetries and increased insecurity, find it difficult to distinguish good from bad borrowers (e.g. Stiglitz and Weiss, 1981; Mishkin, 1997).

The opposite kind of consumption asymmetry is implied by the notion of loss aversion. For instance, Tversky and Kahneman (1991) develop a model of consumer choice which is based on the hypothesis of an asymmetric S-shaped value function, according to which "losses loom larger than corresponding gains" (p. 1039). As a consequence, consumers can be expected to be more reluctant to reduce consumption as income or wealth decline than to increase consumption following positive wealth or income changes.

In our view, the concept of loss aversion can be rationalised in many different ways. For instance, it can be understood in terms of the principle of the hierarchy of needs (e.g. Maslow, 1943). Indeed, when there is "subordination of needs" (Lavoie, 1994, 2004), stepping down the pyramid of needs and giving up (a particular level of) self-actualisation may be experienced by individuals as an abrupt and incommensurable loss in satisfaction, and not simply as a smooth transition from one utility level to another. It can be expected that consumers try to avoid such a fallback almost at all cost, while they are always willing to discover higher steps of the pyramid, in particular when social norms, advertising, etc. convey the idea of consumption being an important part of the self-actualisation process.[1]

There may also be genuine sociological reasons for why consumers react differently to increases in income and wealth than to decreases. As has been recognised by many

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[1] Keynes (1936, p. 90, 1) suggests that "the amount that the community spends on consumption obviously depends (i) partly on the amount of its income, (ii) partly on the other objective attendant circumstances [such as the amount of wealth, TvT], and (iii) partly on the subjective needs and the psychological propensities and habits of the individuals composing it […]. His prediction "that a higher absolute level of income will tend, as a rule, to widen the gap between income and consumption" (Keynes, 1936, p. 97) and that it may become "necessary to encourage wise consumption" (Keynes, 1943, p. 323) to prevent a secular increase in the propensity to save has clearly proven mistaken for a number of developed economies, and particularly for the US. In fact, current "psychological propensities and habits" rather seem to be very favourable of consumer spending, and may in part be reflected in asymmetric reactions towards wealth and income declines and increases.

authors, "(t)here is a kind of competition in consumption, induced by the desire to impress the Joneses, which makes each family strive to keep up at least an appearance of being as well off as those that they mix with, so that outlay by one induces outlay by others" (Robinson, 1956, p. 251). Now, when competitive pressures are strong and social status depends on conspicuous consumption, it can be expected that individuals will benefit from any increase in income or wealth to expand consumption and "keep up with the Joneses", but will be reluctant to reduce consumption risking to "fall behind the Joneses" (who might be suspected to have larger financial reserves and reduce buffer-stock savings).[2]

A further argument in favour of an asymmetric wealth effect can de derived from the concepts of mental accounting and hyperbolic discounting in the context of financial liberalisation (Laibson, 1997). Laibson (1997, 1998) develops a theory of hyperbolic discounting (in contrast to standard neoclassical exponential discounting), from which it follows that individuals may "undersave" in the absence of appropriate measures of self-control. A typical "instrument for commitment is an investment in an illiquid asset", which prevents individuals from consuming "too much". However, Laibson's (1997) model "suggests that financial innovation may have caused the ongoing decline in U. S. savings rates, since financial innovation increases liquidity and eliminates implicit commitment opportunities" (p. 443). Relating this idea to our context, it may be the case that financial innovation is typically spurred by increases in the volume of wealth and income, which fuel the demand for financial products, but that decreases in

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[2] Our interpretation of the "Joneses-effect" differs from that established by Harbough (1996), who rejects the assertion according to which "(r)ising incomes would appear to induce excessive consumption as consumers attempt to "keep up with the Joneses". […] Rather than increasing consumption, concern for relative consumption can induce a fear of falling behind which raises precautionary savings." In a similar vein, Romer (2001, p. 312) argues that the usual interpretation of the "Joneses-effect" "fails to recognize what saving is: since saving represents future consumption, saving less implies consuming less in the future, and thus falling further behind the Joneses." Walther (2004) points out that this view "is unable to explain 'excess consumption'" (p. 2) and develops the concept of "competitive conspicuous consumption" within the framework of an intertemporal decision model.

income or wealth do not usually cause previous innovations to disappear. This would further strengthen the case for asymmetric wealth and income effects on consumption.

As we discuss in the next section, the econometric literature has produced evidence of both liquidity constraints and loss aversion. However, the two effects are generally treated as mutually exclusive. For instance, Shea (1995, p. 799) concludes that his "findings are inconsistent with myopia and liquidity constraints, but are qualitatively consistent with recent work incorporating loss aversion into intertemporal preferences". Similarly, Bowman et al. (1999, p. 156), maintain that their evidence of loss aversion is "inconsistent with both the Permanent Income Hypothesis and with alternative explanations of other apparent violations of the Permanent Income Hypothesis, such as liquidity constraints or Campbell and Mankiw's (1989) rule-of-thumb behavior." Conversely, Apergis and Miller (2005, p. 17) highlight the relevance of liquidity constraints and emphasise that their "results differ from those reached by Kahneman et al. (1991), Shea (1995), and Bowman et al. (1999)". This alleged inconsistency is, of course, disconcerting at both the theoretical and empirical levels. In the next section, we review the econometric estimation strategies which underlie the aforementioned conclusions and propose a synthetic non-linear error correction model, in which short-run and long-run asymmetries can be distinguished. In particular, it seems theoretically justified to consider the possibility that liquidity constraints are more relevant in the shorter run, while loss aversion determines consumption behaviour in the longer run. On the one hand, declining asset prices may cause sudden "panic" in the banking and household sector, but this effect may be alleviated in the longer run, as consumption demand and lending to creditworthy households gradually recover. On the other hand, consumers' reaction to increases in income and wealth may be slow initially but substantial in the longer run,

as it takes some time to learn about new consumption opportunities and to acquire new habits as purchasing power increases.[3]

3. The econometrics of loss aversion and liquidity constraints

There have been several attempts to analyse asymmetries in econometric models of aggregate consumption. One estimation strategy, applied by Shea (1995), Bowman et al. (1999), and Johansson (2002), implies estimating the following equation:

$$\Delta c_t = \alpha + \lambda^+ * POS * \Delta\hat{y}_t + \lambda^- * NEG * \Delta\hat{y}_t + \varepsilon_t \tag{1}$$

where c_t is the log of consumption, $\hat{y}_t$ is the log of expected income, and ε_t is a white noise process. *POS* and *NEG* are indicator functions which take a value of one for respectively positive and negative expected income growth, and a value of zero otherwise. The framework given by equation (1) generalises the test of the Permanent Income Hypothesis proposed by Campbell and Mankiw (1989, 1990, 1991) and it has been applied by different authors to derive different hypotheses, which may be succinctly summarised as follows (Shea, 1995; Altonji and Siow, 1987; Romer, 2001, pp. 319 et seq.):

Permanent Income Hypothesis/Rational Expectations: $\lambda^+ = \lambda^- = 0$

Myopia: $\lambda = \lambda^+ = \lambda^- > 0$

Loss aversion: $\lambda^+ < \lambda^-$; $\lambda^+, \lambda^- > 0$

Liquidity constraints: $\lambda^+ > \lambda^-$; $\lambda^+, \lambda^- > 0$

Under the Random-Walk Hypothesis (Hall, 1978), *predictable* (expected) changes in future income should not have any effect on consumption,[4] while under myopia con-

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[3] This idea can be related to what Lavoie (1992, 2004) calls the "principle of the growth of needs", which is also linked to the "principle of subordination of needs": "Income increases bring into consideration possibilities that had not been assessed before. Beyond near subsistence levels, where urges rather than preference rule, these possibilities have to be learned. The acquisition of habits prevails over instincts. When incomes are rising, learning prevails over habits. [...] Households save while they learn how to spend their increased purchasing power." (Lavoie, 1992, p. 90)

sumption tracks current income and hence should respond symmetrically to expected income changes. This hypothesis underlies the Campbell-Mankiw test of the Permanent Income Hypothesis. However, the restriction of a unique coefficient λ will be inaccurate under both loss aversion and liquidity constraints. Loss aversion in this framework has been interpreted as follows: "when a person receives good news regarding future income prospects, he may immediately adjust current consumption upward, thereby reducing or even eliminating the possibility of a further increase in future consumption. In contrast, learning today of a negative shock to income in some future state(s) of the world may have no effect on current consumption, implying that future consumption will decrease significantly tomorrow if the shock is realized." (Bowman et al., 1999, p. 156) The opposite kind of asymmetry would be expected under liquidity constraints: when expected income increases, consumers may not be able to increase consumption immediately, but when the increase actually occurs, liquidity constraints are reduced so that consumption grows strongly from one period to the next. Conversely, when expected income declines, households can readily reduce consumption so that consumption growth will respond less to the change in expected income.

Shea (1995) and Bowman et al. (1999) have found evidence of loss aversion. Johannson (2002) partly confirms this result, but concludes that it cannot be easily generalised for survey and international data. In an earlier work, Altonji and Siow (1987) had found evidence of liquidity constraints. One potential reason for these ambiguous re-

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[4] Hall's (1978) hypothesis implies that the level of consumption follows a random walk. It is derived from the maximisation problem of a representative consumer who maximises $E_t \sum_{s=0}^{s} (1+\delta)^{-s} U(C_{t+s})$, with $U' > 0$, $U'' < 0$, E_t = expectations operator, U_t = utility, C_t = consumption, δ = discount rate. Then, when the representative consumer can borrow and lend at the real interest rate r, utility maximisation subject to a set of intertemporal budget constraints of the form: $C_{t+s} + q_{t+s} = w_{t+s} + (1+r_{t+s}) q_{t+s-1}$, with w_t = wage income and q_t = financial wealth, yields the first-order necessary condition for an optimum (or Euler equation) given by $E_t U'(C_{t+1}) = U'(C_t)(1+\delta)/(1+r)$. Assuming $\delta = r$ and that marginal utility is linear yields the random walk result $E_t C_{t+1} = C_t$, implying $\Delta C_t = \varepsilon_t$, with ε_t being a white noise process. For comparability with previous studies, we follow Campbell and Mankiw (1989), Shea (1995), Bowman et al. (1999) in testing the random walk hypothesis for the natural logarithm of consumption (see Campbell and Mankiw, 1989, pp. 187, 190, for a discussion). Note that for many instrument sets estimation of equation (1) yields qualitatively very similar results when level variables are used rather than logarithms.

sults is that expected income growth in equation (1) is unobservable by definition so that it has to be pre-estimated using instrumental variables. However, as recognized by Shea (1995, p. 800), the estimates of λ^+ and λ^- "may be imprecise or even spurious if the instruments have low predictive power for income growth". For instance, Shea (1995, p. 803) suggests that the results by Altonji and Siow (1987) are due to a particular choice of instruments. Yet, it is in general "difficult to find appropriate variables with much predictive power for changes in income" (Romer, 2001, p. 322) and there is no agreement regarding the criteria of relevance (Shea, 1995, pp. 800 et seq.).

In a second strand in the literature, the focus has been on short-run asymmetries due to liquidity constraints (or other arguments implying the same type of short-run asymmetry), based on the assumption of a symmetric long-run (cointegration) relationship between the level of personal consumption, the level of household income and the level of household wealth. This approach involves either the Engle-Granger two step methodology with asymmetric equilibrium errors (Carruth and Dickerson, 2003; Stevans, 2004) or direct estimation of an error correction model with asymmetric short-run dynamics (Shirvani and Wilbratte, 2000; Apergis and Miller, 2006), as in equation (2):

$$\Delta C_t = \alpha + \rho C_{t-1} + \delta Y_{t-1} + \gamma W_{t-1}$$
$$+ \sum_{i=1}^{p} \varphi_i \Delta C_{t-i} + \sum_{j=0}^{q} \psi_j \Delta Y_{t-j} + \sum_{j=0}^{q} \phi_j^+ \Delta W_{t-j}^+ + \sum_{j=0}^{q} \phi_j^- \Delta W_{t-j}^- + \varepsilon_t \tag{2}$$

where C_t, Y_t and W_t are respectively the levels of consumption, income and wealth, and ΔW^+ and ΔW^- respectively are positive and negative changes in wealth, and ε_t is a white noise process. A commonly performed test is whether consumers are liquidity constrained, in which case $\sum_{j=0}^{q} \phi_j^- > \sum_{j=0}^{q} \phi_j^+$. Shirvani and Wilbratte (2000) and Apergis and Miller (2006) find evidence in favour of this hypothesis for the US.

In equation (3), we propose a simple consumption model allowing for both long-run and short-run asymmetry in consumption behaviour:

$$
\begin{aligned}
\Delta C_t = {} & \alpha + \rho C_{t-1} + \delta Y_{t-1} + \gamma W_{t-1} \\
& + \sum_{i=1}^{p} \varphi_i \Delta C_{t-i} + \sum_{j=0}^{q} \psi_j \Delta Y_{t-j} + \sum_{j=0}^{q} \phi_j^+ \Delta W_{t-j}^+ + \sum_{j=0}^{q} \phi_j^- \Delta W_{t-j}^- + \varepsilon_t
\end{aligned}
\tag{3}
$$

where C_t, Y_t and W_t are respectively the levels of consumption, income and wealth, and ε_t is a white noise process. $Y_t^+ = \sum_{j=1}^{t} \Delta Y_j^+$ and $Y_t^- = \sum_{j=1}^{t} \Delta Y_j^-$ are partial sum processes of respectively positive and negative changes in Y_t, with $\Delta Y_t^+ = \max(\Delta Y_t, 0)$ and $\Delta Y_t^- = \min(\Delta Y_t, 0)$, and $Y_t = Y_0 + Y_t^+ + Y_t^-$. W_t^+ and W_t^- are defined analogously. The same methodology has been applied by Shin and Yu (2006) to an analysis of asymmetric unemployment-output relationships, inspired by Schorderet (2001) and Granger and Yoon (2002). It is based on an extension of the ARDL-based bounds-testing approach developed by Pesaran et al. (2001), as discussed in the next section.

While short-run liquidity constraints in this model are defined in the same way as in equation (2), the interpretation of loss aversion is somewhat more straightforward than in equation (1): *actual* increases in the *level* of real income or wealth should affect the *level* of consumption more strongly than decreases in these variables, as households should in general be very reluctant to see their standard of living decline. In terms of estimation, this hypothesis has the advantage that no auxiliary regressions have to be run to determine expected income growth. A constellation that may be considered as reconciling the (long-run) loss aversion hypothesis and the (short-run) liquidity constraints hypothesis would be given by $\delta^+ > \delta^-$ and/or $\gamma^+ > \gamma^-$ together with

$$
\sum_{j=0}^{q} \phi_j^- > \sum_{j=0}^{q} \phi_j^+ .
$$

4. Empirical analysis

We estimate variants of equations (1), (2) and (3). We use quarterly data for the period 1953:1 to 2007:3. Data for consumption and disposable income are taken from the National Income and Product Accounts (NIPA, Bureau of Economic Analysis). Consumption equals personal consumption expenditures (PCE) on nondurables and services. This series is scaled up so that the sample mean matches the sample mean of total PCE.[5] Data for personal wealth are taken from the Flow of Funds Accounts (Federal Reserve Board). We distinguish between stock market wealth, including directly held equity, mutual fund shares, security credit and life insurance and pension fund reserves, and non-stock wealth, defined as total net worth less stock market wealth. All variables are measured in real per capita terms, making use of the PCE deflator.

Equation (1) is estimated with the method of two-stage least squares (2SLS), following Campbell and Mankiw (1989, 1990, 1991), Shea (1995), and Bowman et al. (1999). Table 1 reports the results for both the symmetric case (imposing $\lambda^+ = \lambda^-$) and the asymmetric case, using different instrument lists. Compared to earlier studies for the US by Campbell and Mankiw and Shea, our sample size is about 20 years longer.[6] For this larger sample, we found that including more lags and adding changes in stock market wealth as instruments improved estimation in some cases.

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[5] It is common practice to exclude durable goods from the consumption series. As argued e.g. by Lettau and Ludvigson (2004, p. 280), durables are included in household wealth and so cannot be seen purely as an expenditure. The total flow of consumption is unobservable, because we lack observations on the service flow from the durables stock. A compromise pursued in some studies is to scale up the series on nondurables and services. This increases the size of the estimates (for equations estimated in levels), but does not affect their statistical significance, nor their relative size.

[6] Bowman et al.'s (1999) estimations do not include the US.

Table 1: Estimates of Equation 1, Using Different Sets of Instruments

Model	Instruments	$\overline{R}^2_{\Delta y}$	$\overline{R}^2_{\Delta c}$	λ	λ^+	λ^-	F-Test $\lambda^+ = \lambda^-$	Quarters $\Delta\hat{y}_t < 0$
1.1	None (OLS)	–	0.2403	0.2549 (8.20)	0.2020 (4.56)	0.3772 (4.74)	2.78*	49
1.2	$\Delta i_{t-2},...,\Delta i_{t-6}$: $r_{t-2},...,r_{t-6}$;	0.0456	0.0989	0.4593 (4.05)	0.3231 (2.66)	3.0238 (3.35)	8.18***	5
1.3	$\Delta i_{t-2},...,\Delta i_{t-8}$: $r_{t-2},...,r_{t-8}$; $\Delta s_{t-2},...,\Delta s_{t-8}$	0.0491	0.1311	0.4348 (4.89)	0.3015 (3.07)	1.9630 (3.74)	8.71***	10
1.4	$\Delta c_{t-2},...,\Delta c_{t-8}$; $\Delta i_{t-2},...,\Delta i_{t-8}$; $r_{t-2},...,r_{t-8}$	0.0740	0.1614	0.4748 (5.87)	0.3522 (3.81)	1.3497 (3.92)	6.81***	13
1.5	$\Delta c_{t-2},...,\Delta c_{t-6}$; $r_{t-2},...,r_{t-6}$	0.0321	0.0687	0.5122 (4.20)	0.5221 (3.95)	0.3055 (0.29)	0.04	5
1.6	$\Delta y_{t-2},...,\Delta y_{t-6}$; $r_{t-2},...,r_{t-6}$	0.0130	0.0372	0.4023 (2.82)	0.4889 (3.18)	-1.947 (-1.20)	2.12	4
1.7	$\Delta c_{t-2},...,\Delta c_{t-8}$; $r_{t-2},...,r_{t-8}$; $\Delta s_{t-2},...,\Delta s_{t-8}$	0.0345	0.1270	0.5139 (5.60)	0.4609 (4.37)	1.0970 (1.89)	1.04	12
1.8	$\Delta y_{t-2},...,\Delta y_{t-8}$; $r_{t-2},...,r_{t-8}$; $\Delta s_{t-2},...,\Delta s_{t-8}$	0.0060	0.0843	0.4790 (4.58)	0.4516 (3.91)	0.9545 (1.12)	0.32	6
1.9	$\Delta c_{t-2},...,\Delta c_{t-8}$; $\Delta y_{t-2},...,\Delta y_{t-8}$; $c_{t-2} - y_{t-2}$; $\Delta i_{t-2},...,\Delta i_{t-8}$; $r_{t-2},...,r_{t-8}$	0.0630	0.1265	0.3928 (5.59)	0.2879 (3.51)	1.1208 (3.61)	5.80**	17
1.10	$\Delta c_{t-2},...,\Delta c_{t-8}$; $\Delta y_{t-2},...,\Delta y_{t-8}$; $c_{t-2} - y_{t-2}$	0.0525	0.0588	0.3407 (3.40)	0.2690 (2.51)	2.3244 (2.13)	3.34*	5
1.11	$\Delta c_{t-2},...,\Delta c_{t-8}$; $\Delta y_{t-2},...,\Delta y_{t-8}$; $c_{t-2} - y_{t-2}$; $r_{t-2},...,r_{t-8}$; $\Delta s_{t-2},...,\Delta s_{t-8}$	0.0357	0.1178	0.3932 (4.78)	0.2821 (3.06)	1.7303 (3.25)	6.47***	13

Note: i = nominal yield on 3-months treasury bills (Federal Reserve Statistical Release, H.15); r = real interest rate (nominal yield on 3-months treasury bills minus inflation calculated from PCE deflator); s = log of stock market wealth. Numbers in parentheses are t-values. Significance at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

The estimates reported in table 1 largely confirm the results previously produced in the literature. First of all, Hall's (1978) Random Walk Hypothesis is strongly rejected, in accordance with the results by Campbell and Mankiw (1989, 1990, 1991), who concluded on the basis of very similar estimates for λ that around 50 per cent of consumers were 'rule-of-thumb' consumers. Also, there is some evidence of loss aversion, as reported also by Shea (1995) and Bowman et al. (1999), and in a majority of cases the hypothesis $\lambda^+ = \lambda^-$ can be rejected at reasonable significance levels. For some instrument sets, however, the F-test fails to reject the null hypothesis of symmetry. As noted by Shea (1995), it is not surprising that λ^- is estimated imprecisely and takes a wide range of values, as negative expected income growth is not very frequent. As discussed above, this problem seems to be linked to the intrinsic difficulty of finding accurate instruments for expected income growth. Note that the $\overline{R}^2$ statistics from regressions of consumption and income growth on the instruments are small, a finding also obtained in all previous studies.

Equations (2) and (3) are estimated as auto-regressive distributed lag (ARDL) error correction models. The results are reported in tables 2 and 3. In an attempt to ensure robustness, we estimate different variants of these two equations, combining different asymmetry assumptions with different definitions of wealth. First, we run a simple benchmark regression, in which both income and wealth are assumed to affect consumption symmetrically both in the long run and in the short run. Then, we consider the possibility that only the short-run dynamics are asymmetric, as analysed by Stevans (2004), Shirvani and Wilbratte (2000), Apergis and Miller (2006). Finally, we also allow for long-run asymmetric income and wealth effects. For comparability with the results by Shirvani and Wilbratte (2000) and Apergis and Miller (2006), we are particularly interested in asymmetric stock market wealth effects. Therefore, in some regres-

sions, private net worth, *NW*, is decomposed into stock market wealth, *S*, and net non-stock wealth, *NS*, as in e.g. Shirvani and Wilbratte (2002), Lettau and Ludvigson (2004). In each case, we initially run regressions with 8 lags (p=q=8 in equations (2) and (3)), and then sequentially drop insignificant regressors (at the 10 per cent level), while verifying that the regressions do not show any signs of serial correlation.

We follow the bounds-testing approach to long-run level relationships advanced by Pesaran et al. (2001), which is a generalisation of standard cointegration tests, e.g. as developed by Banerjee et al. (1998). The main advantage of the tests derived by Pesaran et al. (2001) is that they allow testing for long-run relationships between level variables irrespective of whether the underlying regressors are *I*(0), *I*(1), or mutually cointegrated. As an illustration, in equation (3) the null hypothesis of no long-run relationship would be given by either $\rho = 0$ (t_{BDM}-test) or by $\rho = \delta^+ = \delta^- = \gamma^+ = \gamma^- = 0$ (F_{PSS}-test). For each test, Pesaran et al. (2001) have tabulated two sets of critical values, one assuming that all the regressors contain a unit root, the other assuming that they are all stationary. Whenever the test statistics fall outside the critical value bounds, valid inference can be made without making assumptions about the order of integration of the underlying variables. This is a particularly useful innovation, as the power of unit root test (e.g. ADF, KPSS tests) and cointegration tests (e.g. Johansen tests) is notoriously small.[7] Pesaran et al. (2001) have shown that, when existence of a long-run relationship is inferred, the implied estimated long-run coefficients, $\hat{L}_Y^+ = -\hat{\delta}^+ / \hat{\rho}$, $\hat{L}_Y^- = -\hat{\delta}^- / \hat{\rho}$, $\hat{L}_W^+ = -\hat{\gamma}^+ / \hat{\rho}$ and $\hat{L}_W^- = -\hat{\gamma}^- / \hat{\rho}$, are T-consistent (super-consistent) and follow the limiting normal distribution, while all the short-run parameters are $\sqrt{T}$-consistent and have the asymptotic normal distribution. Shin and Yu (2006) have concluded that these properties are also valid in the asymmetric case, applied in equation (3) above.

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[7] Standard tests indicate that the variables used in the estimations follow unit root processes.

Table 2 shows the results for equation 2. In models 2.1 and 2.2, consumption is assumed to react symmetrically to positive and negative movements in income and wealth both in the long run and in the short run, while in models 2.3 and 2.4 it is allowed for asymmetric short-run dynamics. We report the long-run coefficients and Wald tests for short-run asymmetry.

Table 2: Estimates of Equation 2

Model	2.1	2.2		2.3	2.4
	Symmetric short-run dynamics			**Asymmetric short-run dynamics**	
C =	C(Y,W)	C(Y,S,NS)		C (Y,W)	C(Y,S,NS)
L_Y	0.6383 (8.96)	0.8190 (6.30)		0.6348 (10.76)	0.7956 (8.20)
L_W	0.0795 (5.25)			0.0770 (6.28)	
L_S		0.0694 (4.89)			0.0713 (6.44)
L_{NS}		0.0269 (0.74)			0.0294 (1.06)
t_{BDM}	-3.04	-3.08		-3.65*	-3.98**
F_{PSS}	11.74***	9.69***		12.09***	14.13***
$\overline{R}^2$	0.5182	0.5419		0.5266	0.5465
Wald test: null hypothesis of symmetric short-run dynamics			ΔW (1, 4, 8 lags)	3.39* 3.39* 0.032	
			ΔS (1, 4, 8 lags)		22.66*** 22.66*** 4.54**

Note: Numbers in parentheses are t-values. Significance at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively. Critical values for the t_{BDM}-test and the F_{PSS}-test are taken from Pesaran et al. (2001) (case III).

The estimated long-run marginal propensities to consume out of wealth fall in the upper range of commonly cited previous results (e.g. Altissimo et al., 2005; Boone et al., 1998). However, due to issues of sample period and data construction, these estimates cannot be compared on a one-to-one basis. Note, in particular, that the relatively large estimate for the propensity to consume out of wealth seems to be disproportionately influenced by the recent past when personal consumption increased particularly

strongly.[8] As another variation, labour income can be used instead of disposable income.[9] This variation may also alleviate the lack of significance of coefficients on non-stock wealth, encountered also in other studies (Boone et al., 1998). Many authors include only stock market wealth without controlling for non-stock wealth (Shirvani and Wilbratte, 2000; Apergis and Miller, 2006). Such sensitivity issues have been extensively discussed by Davis and Palumbo (2001). In what follows, we shall focus only on the qualitative results regarding the hypothesised consumption asymmetries. Therefore, we follow the suggestions of Davis and Palumbo (2001, p. 32) by using "disposable personal income as measured in the national accounts […] in the interest of generating easily replicable results" and by using the longest span of data available:[10] "Due to the properties of cointegration, the long-run statistical relationships between consumption, income, and wealth are better estimated when a longer span of time series data are used." In the next section, we discuss the implications of using labour instead of disposable income.

In models 2.3 and 2.4, negative changes in wealth have a very strong negative effect on consumption in the short run, whereas the effect of positive changes is weaker. Relevant Wald tests indicate that this short-run asymmetry is statistically significant. This can also be seen in figure 1, where the responses of consumption to stock market wealth shocks are shown graphically for the symmetric and for the asymmetric case. As can be observed in panel b) of figure 2, the asymmetry of the wealth effect can be regarded as statistically significant during approximately two years after the shock (in all our experiments, shocks occur in 1995:1). Shirvani and Wilbratte (2000, p. 48) have reached a

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[8] When models 2.1 and 2.2 are run for the period 1953:1 to 2001:4, the estimated (stock market) wealth effect is 0.0597 (0.0499) (and 0.0523 (0.0437), when the consumption series is not scaled up).
[9] This gives estimated propensities to consume out of income and wealth of respectively 0.8361 and 0.0826 in model 2.1 for the whole sample period.
[10] Data are available for the period from 1952:1 onwards. However, as recommended by e.g. Campbell and Mankiw (1989) and Shea (1995), we start our estimations only in 1953:1 in order to avoid some oddities in the earlier data linked to the Korean war.

very similar conclusion indicating that "the unequal (stock market) wealth effects are essentially short-run phenomena. For each country, the inequality of wealth effects seems to disappear as the lag length extends beyond seven quarters." This result, also close to that obtained by Apergis and Miller (2006), seems to conform to the notion of liquidity constrained consumers.

Figure 1: Impulse Response Functions for Models 2.2 and 2.4
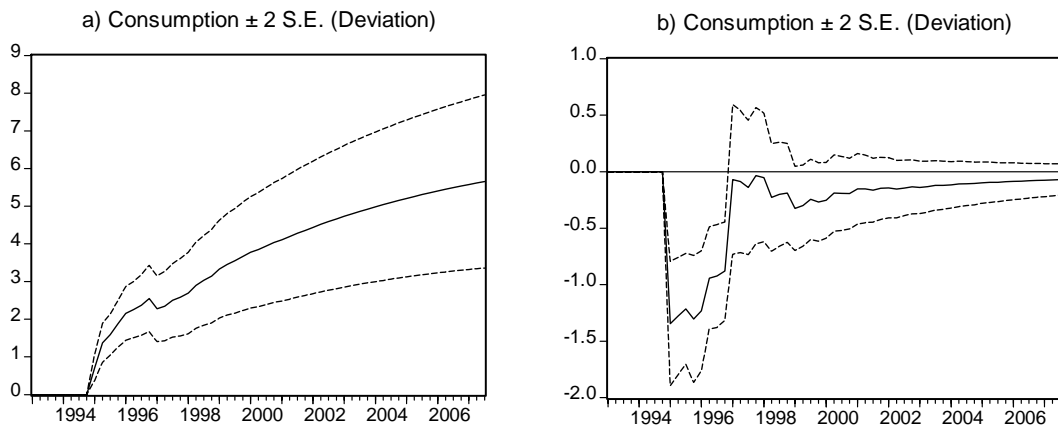
Note: Panel a) is based on model 2.2 and shows the deviation of consumption from baseline following a 100 dollar increase of stock market wealth. Panel b) is based on model 2.4 and shows the difference between deviation of consumption from baseline following a positive shock and deviation from baseline (in absolute value) following a negative shock.

The picture becomes more complex when also long-run asymmetries are allowed for (see table 3 and figure 2). There is still evidence of short-run liquidity constraints, but in the long run the asymmetry of income and wealth effects rather points in the direction of loss aversion. The respective Wald tests are highly significant and reject both short-run and long-run symmetry for the wealth effect. The income effect also seems to be asymmetric in the long run, while the evidence is mixed for the short term. Note that the precision of estimation generally increases with the extent to which asymmetry is allowed for.

Figure 2 visualises the remarks made above for model 3.4. In panel e), it can be seen that a decline in stock market wealth first leads to a strong negative response in con-
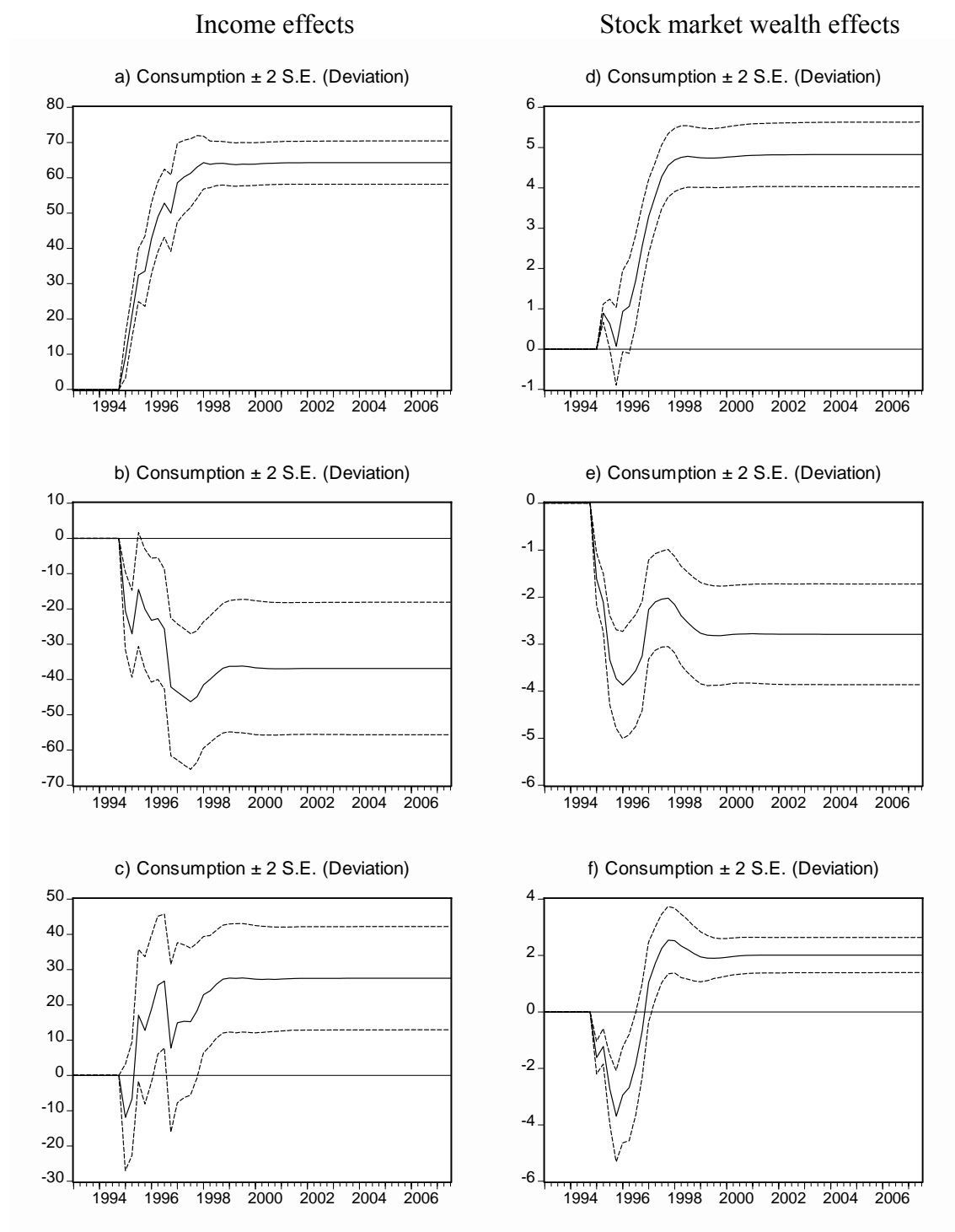
sumption (overshooting), but the long-run impact is only rather moderate. Conversely, the effect of a stock market wealth increase, shown in panel d), is not statistically significant during the first quarters, but approaches its final level of approximately 5 cents on the dollar after 3 or 4 years or so.[11] Note also that adjustment to target spending is relatively smooth after positive income and wealth changes, but much more turbulent after negative changes (see Stevans, 2004, for a similar result in a different framework).

Table 3: Estimates of Equation 3

Model	3.1	3.2		3.3	3.4
C =	$C(Y,W^+,W^-)$	$C(Y,S^+,S^-,NS)$		$C(Y^+,Y^-,W^+,W^-)$	$C(Y^+,Y^-,S^+,S^-,NS)$
L_Y	0.5914 (17.27)	0.6895 (11.70)	L_Y^+	0.5451 (25.50)	0.6417 (21.18)
			L_Y^-	0.2890 (3.09)	0.3613 (3.98)
L_W^+	0.0595 (9.40)		L_W^+	0.0526 (11.22)	
L_W^-	0.0367 (3.68)		L_W^-	0.0315 (4.99)	
L_S^+		0.0539 (9.34)	L_S^+		0.0480 (12.68)
L_S^-		0.0259 (3.04)	L_S^-		0.0276 (5.26)
L_{NS}		0.0155 (0.95)	L_{NS}		0.0168 (2.16)
t_{BDM}	-4.67***	-4.64***	t_{BDM}	-6.32***	-7.40***
F_{PSS}	12.33***	13.82***	F_{PSS}	11.79***	13.88***
$\overline{R}^2$	0.5342	0.5562	$\overline{R}^2$	0.5502	0.6017
Wald test: null hypothesis of symmetric long-run coefficients					
$L_Y^+ = L_Y^-$				9.64***	13.90***
$L_W^+ = L_W^-$	15.49***			41.12***	
$L_S^+ = L_S^-$		30.15***			44.76***
Wald test: null hypothesis of symmetric short-run dynamics					
ΔY (1, 4, 8 lags)				0.97 / 0.30 / 0.30	2.64* / 0.11 / 1.82
ΔW (1, 4, 8 lags)	4.67** / 4.67** / 0.24			1.21 / 11.84*** / 7.57***	
ΔS (1, 4, 8 lags)		27.04*** / 27.04*** / 27.04***			32.33*** / 35.04*** / 30.06***

Note: Numbers in parentheses are t-values. Significance at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively. Critical values for the t_{BDM}-test and the F_{PSS}-test are taken from Pesaran et al. (2001) (case III).

[11] For the unscaled data, the estimated stock market wealth effects are respectively 0.0420 and 0.0241.

Figure 2: Impulse Response Functions for Model 3.4

Income effects   Stock market wealth effects

a) Consumption ± 2 S.E. (Deviation)

d) Consumption ± 2 S.E. (Deviation)

b) Consumption ± 2 S.E. (Deviation)

e) Consumption ± 2 S.E. (Deviation)

c) Consumption ± 2 S.E. (Deviation)

f) Consumption ± 2 S.E. (Deviation)

Note: Panels a) and b) show the deviation of consumption from baseline following a 100 dollar increase or decrease, respectively, of disposable income. Panel c) shows the difference between deviation of consumption from baseline following a positive income shock and deviation from baseline (in absolute value) following a negative shock. Panels d) to f) show the analogous effects of stock market wealth shocks.

5. A Further Look at Consumption, Labour and Property Income, and Wealth

Of course, it is difficult, on the basis of our estimations, to determine with certainty the precise underlying behavioural reasons for the observed aggregate consumption asymmetries. Yet, our results do allow some tentative interpretation of the steep decline in the personal savings rate observed in the US over the past decades.

Figure 3: Wealth, Income, and Consumption, USA, 1953-2007
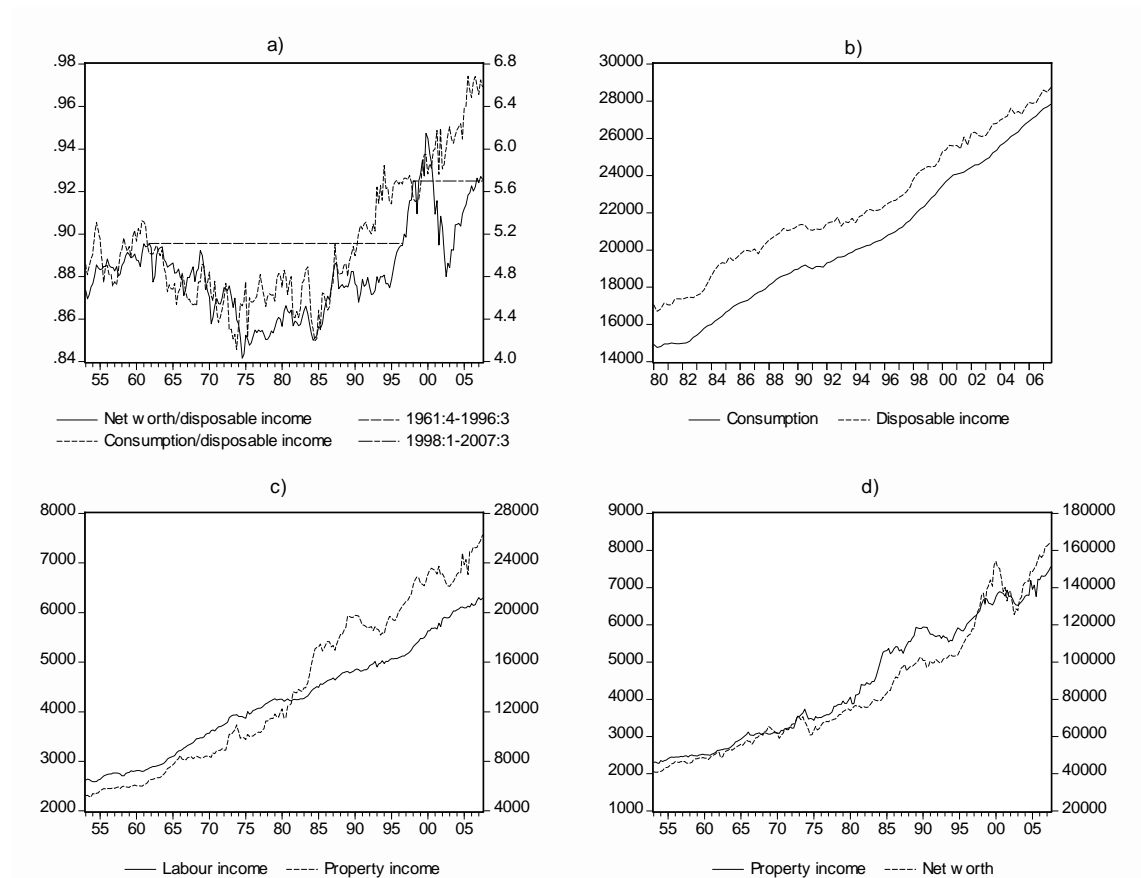
Note: Consumption is defined as above. Property income is the sum of proprietors' income, rental income and income receipts on assets minus personal current taxes times the share of property income in pre-tax personal income. Labour income is the difference between disposable income and property income.

Source: NIPA, Flow of Funds.

As figure 3 a) suggests, visual inspection of the net worth-to-income and of the consumption-to-income series lends support to the hypothesis of asymmetric wealth effects. For instance, the ratio of real per capita net worth to real per capita disposable income declined from the early 1960s to the mid 1970s, and recovered to its initial level only in

the mid-1990s. At the same time, the personal consumption rate first declined somewhat together with the decline in the wealth-to-income ratio, but then, until the mid-1990s (1996:3 in the figure), increased well beyond its initial level from the early 1960s (1961:4 in the figure). Similarly, during the stock market boom of the late 1990s, consumption first heavily increased relative to income, but then did not react in the same fashion, except for the very short run, during the decline in wealth following the stock market downturn starting in 2000. Yet, as soon as the wealth-to-income ratio started to rise again, so did the consumption rate. As an illustration of this ratchet effect, the consumption rate was much higher in 2007:3 than it was in 1998:1, when the net worth-to-income ratio was approximately at the same level.[12] Similarly, figure 3 gives credence to the hypothesised asymmetry in the relationship between consumption and income. As panel b) shows for the period since 1980, periods of decreasing disposable income have been more frequent and more pronounced than periods of decreasing consumption.

As discussed by Davis and Palumbo (2001, p. 32) some authors have argued that labour income rather than household disposable income should be included in a consumption equation because, "according to the life cycle theory, property income equals the return earned on financial wealth, and so should not be included in the proxy for human wealth." The bottom part of figure 3 indicates that movements in labour income and property income do indeed follow somewhat different patterns. Also, the evolution of property income, including interest and dividends, derives at least in part from changes of wealth. As noted by Davis and Palumbo (2001, p. 32), "by this line of reasoning, property income should not be held 'constant' when wealth adopts a different path". Yet, they also remark that "in the data, property income – such as dividends and interest – does not move in lock step with household net worth, somewhat mitigating the force

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[12] Part of this asymmetry may stem from the fact that capital gains, unlike taxes paid on capital gains, are not included in the NIPA definition of disposable income. Yet, as argued by Guidolin and La Jeunesse (2007, p. 499), "it is difficult to conclude that these discrepancies entirely explain the declining trend in the NIPA measure" of the savings rate.

of this issue" (p. 32). Also, when property income is excluded from the consumption

model of equation (3), some omitted variable bias may arise, as it is effectively assumed

that households consume only from wages and wealth, but not out of proprietors' in-

come, rental income and income receipts on assets.

Table 4: Estimates of Equation 3, With Labour Income Instead of Disposable Income

Model	3.5	3.6	3.7
Dependent variable is ΔC_t			
C =	$C(LI^+,LI^-, W^+,W^-)$	$C(LI^+,LI^-,S^+,S^-,NS)$	$C(LI^+,LI^-,S^+,S^-,NS^+, NS^-)$
L_{LI}^+	0.6985 (14.75)	0.6038 (7.73)	0.6325 (8.28)
L_{LI}^-	0.0435 (0.21)	-0.3298 (-1.21)	-0.0170 (-0.05)
L_W^+	0.0670 (8.52)		
L_W^-	0.0587 (5.29)		
L_S^+		0.0508 (7.02)	0.0636 (9.52)
L_S^-		0.0348 (3.63)	0.0506 (5.17)
L_{NS}		0.0683 (4.56)	
L_{NS}^+			0.0728 (4.62)
L_{NS}^-			0.0695 (1.51)
t_{BDM}	-4.68***	-4.04*	-5.48***
F_{PSS}	9.79***	5.91***	9.90***
$\overline{R}^2$	0.5644	0.5762	0.5711
Wald test: null hypothesis of symmetric long-run coefficients			
$L_{LI}^+ = L_L^-$	12.18***	15.29***	3.45*
$L_W^+ = L_W^-$	1.89		
$L_S^+ = L_S^-$		6.22***	6.07***
$L_{NS}^+ = L_{NS}^-$			0.00
Wald test: null hypothesis of symmetric short-run dynamics			
ΔY	3.87**	0.35	8.22***
(1, 4, 8 lags)	3.61*	2.76*	11.70***
	1.45	1.08	11.13***
ΔW	0.26		
(1, 4, 8 lags)	7.94***		
	17.65***		
ΔS		22.13***	17.55***
(1, 4, 8 lags)		3.33*	16.93***
		3.33*	16.32***
ΔNS			−
(1, 4, 8 lags)			−
			0.84

Note: Numbers in parentheses are t-values. Significance at the 10%, 5%, and 1% level is denoted by [*], [**], and [***], respectively. Critical values for the t_{BDM}-test and the F_{PSS}-test are taken from Pesaran et al. (2001) (case III).

Despite these reservations, and as a further robustness check, we also estimate equation (3) with labour income included rather than disposable income. Again, we consider different decompositions of wealth. The estimation results are reported in table 4. We still find strong evidence of short-run liquidity constraints. The long-run asymmetry of the wealth effect is now somewhat weaker, but the long-run asymmetry of the propensity to consume out of labour income becomes dramatic. The estimated long-run coefficient on the negative partial sum process for labour income is insignificant in all the different specifications and even of the "wrong" sign in models 3.6 and 3.7. Yet, there is still statistically significant evidence of both short-run and long-run asymmetric income and wealth effects. Note also that the long-run estimate on non-stock wealth is larger than previously, which seems to be due to its correlation with property income. However, we do not find any statistically significant asymmetry in the effect of non-stock wealth. Note that the lack of precision of the estimated coefficient on the negative partial sum process on non-stock wealth may be linked to the relatively small variance of this series. Hence, there remains some uncertainty regarding the effects of a decline in non-stock wealth, including housing wealth, on consumption.

Overall, the dynamics of the model remain qualitatively very similar to those shown in table 3 and figure 2 above, and we conclude from our various estimations that the evidence of short-run liquidity constraints and long-run loss aversion is robust.

6. Conclusions

It is now commonly held that the Permanent Income Hypothesis with rational expectations is not an accurate description of aggregate consumption behaviour. Various deviations from the standard model have been discussed in the literature, including loss aversion and liquidity constraints. In this paper, we have applied different estimation approaches to a single data set and shown that, depending on the approach chosen, evi-

dence of either loss aversion or liquidity constraints can be produced. We have then proposed a simple asymmetric error correction model and found statistical evidence that can be interpreted as indicating both long-run loss aversion and short-run liquidity constraints.

It seems that in the short run, a decline in income and wealth can have very substantial negative effects on consumption, and hence on economic activity. However, in the longer run, US private households apparently have managed to translate income and wealth increases into relatively large increases in consumption expenditure, while they have been able to keep reductions in consumer spending, as a consequence of income and wealth declines, within relatively small limits. This helps to explain, for instance, why the same level of the net worth-to-income ratio has been compatible with both a relatively low consumption-to-income ratio in the 1960s and a much higher ratio in the 1990s or 2000s.

As observed in the introduction, the secular trend towards higher consumer spending in the US has been accompanied by an enormous expansion of personal debt, and it seems that the observed asymmetries in consumption behaviour have been facilitated by financial deregulation and "generous" lending practices. It is doubtful whether this pattern can be regarded as sustainable and it is likely that private households may not be able, at some point in the future, to further increase consumption, relative to income, even if asset prices further appreciated. It will also be interesting to observe the consumption effects of future declines in housing wealth, which has almost monotonously increased in the recent past.

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