How does Household Consumption Respond to Income Shocks?

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Extremely preliminary

Abstract

In this paper we first use the Italian Survey of Household Income and Wealth to document how various household choices (including consumption and wealth) change in response to an income change. We show that these responses are not consistent with simple benchmark models (i.e. complete markets or hands to mouth consumers). In particular, we find evidence of significant asymmetries in how consumption and wealth respond to income change. We also find that these responses have changed significantly over time. We then explore how existing partial risk sharing models can account for this evidence. Preliminary work suggest that such a model, especially if one wants to explain more recent data, will have to include better insurance means than the standard incomplete markets but substantially less than a model with a full set of contingent assets.

1 Introduction

In microfounded macro models households face one fundamental decision problem, namely how to choose consumption and saving in the presence of labor income changes, may they be deterministic or stochastic. The consumption-savings choices available to households depend on the menu of assets available to them. Existing models make a variety of different assumptions regarding this menu, ranging from the total absence of assets (hands to mouth consumers) to the presence of a full set of state contingent assets without any short sale constraint (this is the underlying assumption of any representative agent macro model). These assumptions are crucial for many positive and normative questions as they affect the household risk sharing possibilities, and hence they determine, for example, how the economy respond to different types of shocks and policy interventions, or how different of assets are priced.

The objective of the paper is twofold. First, we use a unique panel data set that contains detailed information about household income, consumption and wealth, the Italian Survey of Household Income and Wealth to document how various household choices (including consumption and wealth) change in response to an income change. We show that these responses are not consistent with simple benchmark models (i.e. complete markets or hands to mouth consumers). We find evidence of significant asymmetries in how consumption and wealth respond to income changes, and we find that these responses have changed significantly over time.

Second in order to fully understand the economic mechanism underlying the facts we explore how existing partial risk sharing models can account for this evidence. The ultimate goal is to construct
a model with is consistent with the entire evidence described above and thus could be used to with
certainty for normative and positive analysis. Preliminary work suggest that such a model, especially
if one wants to explain more recent data, will have to include better insurance means than the standard
incomplete markets but substantially less than a model with a full set of contingent assets. The key
innovation relative to previous research is that we do not simply propose to test the permanent income
hypothesis (and thus test a particular type of insurance model against a specific type of shock) but we
would like to search for a joint specification of shocks and insurance possibilities that is able to rationalize
the observed patterns of income changes and household consumption responses to these income changes.

2 Evidence

In this section we briefly describe the household consumption and income data we use in our analysis
and then discuss the (preliminary) stylized empirical facts that motivate the theoretical and quantitative
analysis.

2.1 Data Description

The main data set we will use is the Survey of Household Income and Wealth (henceforth SHIW) con-
ducted by the Bank of Italy. The survey is conducted every two years and it includes about 8000
households per year, chosen to be representative of the whole Italian population. From 1987 on the
survey has a panel structure and a fraction of households in the sample are present in the survey for
repeated years. This data set is valuable and unique for our purposes as it contains panel information
for many categories of income and consumption for each household. The panel dimension on income
is particularly helpful for assessing the nature (i.e. permanent or temporary) and symmetry of income
changes. The fact that the data contains, for the same household, panel information on both income
and consumption is crucial for inferring how a given household adjusts its consumption in response to an
income change of a given type.

Since the focus of this project is on the effects of earnings changes for households who are active in
the labor market we select only households who are in the survey for at least two consecutive periods,
who report positive labor or business income in both periods and whose head is between the age 25 and
60 and is not retired. This leaves us with a sample of 11749 households over the period 1987-2004.

2.2 Consumption Responses to Income Changes

We first document the size of income changes experienced by households in our sample. Figure 1 reports
the histogram of percentage annualized income changes for all households in our sample. The concept of

\footnote{A recent paper by Jappelli and Pistaferri (2006) makes intensive use of the panel dimension for income and consumption
in this dataset for estimating a stochastic process for household income and one for household consumption mobility.}

\footnote{The US consumer expenditure (CEX) survey has a panel dimension but the fact that it is short (only two periods) and
observation periods for income and consumption do not perfectly coincide (see Gervais and Klein (2006) for a treatment of
this problem) makes it of limited use for our purposes. The US panel study on income dynamics (PSID) on the other hand
contains a long panel for income but only has information on food consumption, again making it hard to comprehensively
assess the full impact of income shocks on consumption.}
income we use is total after tax labor income plus net after tax business income, all per adult equivalent (using the OECD equivalence scale). Notice that changes in income are fairly symmetric and large. For example, over 20% of the households experience a percentage change in per adult equivalent income which is larger, in absolute value, than 20%.

Next we document how households who experience income changes adjust their consumption. To visualize this we rank households in a given year by their income growth, then divide them in 10 equally populated bins, and then we measure the average income and consumption growth in each bin. Our consumption measure includes household consumption of nondurable goods and services per adult equivalent. The results are reported in figure 2. Notice that on average consumption growth co-moves positively with income growth, even though fairly large percentage changes in income are associated with much smaller percentage changes in consumption. Notice also that consumption responses to income changes are asymmetric: households which experience positive income growth on average have positive consumption growth while households which experience negative income growth on average display no consumption growth.

We now make this analysis more precise by estimating the following relations for our full sample

\[ \hat{c}_{it} = \alpha \hat{y}_{it} + \gamma X_{it} + \varepsilon_{it} \]

where \( \hat{c}_{it} \) and \( \hat{y}_{it} \) are consumption and income growth of household \( i \) in period \( t \), \( X_{it} \) is a vector of controls which includes time dummies and a quartic in the age of the household head, \( \varepsilon_{it} \) is a normally distributed disturbance and \( \alpha, \gamma \) are coefficients to be estimated. The coefficient \( \alpha \) represents the average response of consumption growth to income growth. This coefficient has been estimated using US data from the CEX (see for example Mace, 1991 and Dynarski and Gruber, 1997) or the PSID (see for example Altonji and Siow, 1987). These authors have highlighted the potential attenuation bias in the estimate of the
coefficient $\alpha$ stemming from the presence of measurement error in income. Here we repeat their exercise using alternative specifications and estimation methods. Table 1 below reports the results.

Table 1. The Response of Consumption to Income Changes

<table>
<thead>
<tr>
<th></th>
<th>OLS, $g_{t,t-2}$</th>
<th>OLS, $\Delta_{t,t-2}$</th>
<th>LAD, $g_{t,t-2}$</th>
<th>IV, $g_{t,t-2}$</th>
<th>Small sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.17</td>
<td>0.10</td>
<td>0.18</td>
<td>0.28</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.004)</td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.05</td>
<td>0.05</td>
<td>0.03</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>$Obs.$</td>
<td>11749</td>
<td>11749</td>
<td>11749</td>
<td>11749</td>
<td>3211</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All regressions include time dummies and age controls.

Notice that in all cases the coefficient is significantly different from 0. Household consumption growth does respond to income growth, suggesting that the simple complete markets model with separable preferences (which provides a foundation to the representative agent construct) is not consistent with this evidence. Note also that all estimates are very far from 1, so the simple hands to mouth consumption model is also equally rejected. The first and second columns report OLS estimates of the coefficient, using growth rates (the first column) and changes (the second column) in income and consumption. These two estimates have a simple economic interpretation: on average households who experience a 10% change in income adjust their non durable consumption in the same direction by 1.7% and households who experience, say, a 10 Euros change in their income on average adjust their non durable consumption by 1 Euro. The third column reports the estimate of $\alpha$ using least absolute deviations (LAD) in order to control for the effect of outliers and shows that it barely changes the OLS estimates. The fourth column reports the estimate of $\alpha$ obtained using instrumental variables. In particular since SHIW contains
detailed information on labor supply, employment status (i.e. employee, self-employed, non employed) and employee status (i.e. blue collar, white collar, junior manager, manager) of adult household members, we use changes in these variables to instrument for growth in household income. Notice how the use of IV significantly raises the estimated for $\alpha$. This suggest that measurement error and/or non separabilities in preference between consumption and leisure are important. This is because our instruments (as the ones used by Altonji and Siow, 1987) basically measure change in labor supply and thus, if leisure and consumption are not separable we would expect them to be correlated with change in consumption and thus to increase the IV estimate of $\alpha$. The last 3 columns use a different strategy for dealing more precisely with measurement error in income which exploits the presence of a long panel for both panel and consumption. The strategy simply involves using growth rates over longer time horizons. To see this consider the simple case in which the log of income $y_t$ is equal to a random walk, $z_t = z_{t-1} + \varepsilon_t$ plus measurement error $\eta_t$ so that $y_t = z_t + \eta_t$. Suppose now that consumers set $c_t = z_t$ so that the “true” $\alpha$ coefficient is equal to 1. It is easy to show that the estimated $\alpha$ coefficient, $\hat{\alpha}$ between period $t$ and $t-k$ is given by

$$\hat{\alpha} = \frac{\text{cov}(y_t - y_{t-k}, c_t - c_{t-k})}{\text{Var}(y_t - y_{t-k})} = \frac{k\text{Var}(\eta)}{k\text{Var}(\eta) + 2\text{Var}(\varepsilon)}$$

the equation shows that the presence of measurement error induces a downward bias in the estimate of $\alpha$ but at the same time by increasing $k$ the bias gets reduced. Unfortunately in our data set increasing $k$ comes at the cost of reduced sample size, as in each period many households drop from the panel. In the estimates in the last three columns of table 1 we have considered the sample of all households which are in the panel for at least 4 consecutive periods so that we can evaluate, on the same sample, the effect of increasing the time horizon of the growth rate from 1 to 3. Notice how increasing the time horizon does indeed increase the estimate of $\alpha$, suggesting that measurement error is important, but notice how the size of the increase is much smaller than the one we obtain going from OLS to IV, suggesting that the increase in the estimate of $\alpha$ coming from IV captures not only measurement error but also other factors such as non separabilities.

Next we focus on the asymmetry in consumption responses and estimate the following simple extension of equation 1

$$\hat{c}_{it} = \alpha^+ \hat{y}_{it} I(\hat{y}_{it} \geq \kappa) + \alpha^- \hat{y}_{it} I(\hat{y}_{it} < -\kappa) + \gamma X_{it} + \varepsilon_{it}$$

where $I(\hat{y}_{it} \geq \kappa)$ ($I(\hat{y}_{it} < -\kappa)$) represents a dummy variable which takes a value of 1 if $\hat{y}_{it}$ is $\geq$ ($<$) than a positive threshold level $\kappa$ and 0 otherwise. In the first 3 columns of table 2 we report how the estimates for $\alpha^+$ and $\alpha^-$ change as we change the threshold $\kappa$ from 0 (in which we estimate a different $\alpha$ for positive and negative income growth observations) to 0.2 (in which we estimate a separate $\alpha$ for positive or negative income observations larger than 20%). The rationale for choosing a $\kappa > 0$ is that by selecting only large (in absolute value) growth observations we are likely drop observations that switch sign because of measurement error and thus we are more likely to correctly quantify the degree of asymmetry (if any) in the response of consumption to positive or negative income growth.
Table 2. Asymmetries and Time Variations in Consumption Responses

<table>
<thead>
<tr>
<th></th>
<th>OLS, $\kappa = 0$</th>
<th>OLS, $\kappa = 0.1$</th>
<th>OLS, $\kappa = 0.2$</th>
<th>OLS, $\kappa = 0.87 - 91$</th>
<th>OLS, $\kappa = 0.02 - 04$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha^+$</td>
<td>0.20</td>
<td>0.18</td>
<td>0.20</td>
<td>0.38</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.04)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>$\alpha^-$</td>
<td>0.14</td>
<td>0.15</td>
<td>0.11</td>
<td>0.37</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>$\alpha^+ = \alpha^-$</td>
<td>Reject (5%)</td>
<td>Not Reject</td>
<td>Reject (5%)</td>
<td>Not Reject</td>
<td>Reject (5%)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.06</td>
<td>0.07</td>
<td>0.10</td>
<td>0.19</td>
<td>0.03</td>
</tr>
<tr>
<td>Obs.</td>
<td>11749</td>
<td>5900</td>
<td>3030</td>
<td>1852</td>
<td>3168</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All regressions include time dummies and age controls.

The table confirms what figure 2 suggested, namely that consumption responds more strongly to positive income changes than to negative ones.\(^3\)

The final piece of evidence in this section regards how the response of consumption to labor income has evolved over time. In the last 2 columns of table 2 we explore this issue simply by running the basic regression of the first column separately on the first 3 periods of the panel (1987,1989,1991) and on the last 2 years (2002 and 2004). The numbers show that indeed there has been a remarkable change. The early sample shows that the response of consumption to income changes is almost twice the response estimated in the later part of the sample. Moreover there is no asymmetry in the first period, while there is a substantial one in the second. This evidence suggests that the substantial financial liberalization Italy experienced throughout the 1990s is potentially an important factor in order to fully understand the consumption response and its evolution.

2.3 Responses of Other Variables to Income Changes

The facts presented in the previous section suggest that the consumption response to income changes is significantly different from 0, not very large and slightly asymmetric. A very large class of theories is consistent with these facts. One of the goals of our project is to distinguish between these theories and in order to do so more data need to be brought to the forefront. First we focus on the size of the consumption response to income changes.

2.3.1 Understanding Average Consumption Responses

Simple budget constraint logic implies that if non durable consumption does not respond much to income changes other components of the budget will adjust. In particular we assess how the following 4 components, pensions and transfers (including private transfers), property income (including financial income), expenditure on durable goods and changes in total wealth (including the net value of owned residence),

\(^3\)The evidence on asymmetries in consumption responses to income changes is quite mixed. Three papers focus on predictable income changes. Altonjii and Siow (1987) find evidence that income increases have a larger impact on consumption than income declines, while Shea (1995) and Garcia and al (1997) find the opposite. Using early CEX data Dynarski and Gruber (1997) find the effect of income declines on consumption to be slightly larger than the effect of income increases (but not statistically significant). Krueger and Perri (2006) using more recent US CEX data find the response of consumption to be fairly symmetric.
move in response to income changes. In particular let $w_{it}$ be a given budget component, say end of period wealth, for household $i$ in period $t$. We then run the following regression

$$\frac{w_{it} - w_{it-1}}{y_{it-1}} = \alpha \tilde{y}_{it} + \gamma X_{it} + \varepsilon_{it}$$

so to assess how change in that budget component, as a proportion of initial income, respond to the income growth. Table 3 report some results

<table>
<thead>
<tr>
<th>Table 3. Response of Budget Components to Income Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfers</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>OLS</td>
</tr>
<tr>
<td>$\alpha$</td>
</tr>
<tr>
<td>(0.004)</td>
</tr>
<tr>
<td>$R^2$</td>
</tr>
<tr>
<td>Obs.</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All regressions include time dummies and age controls.

Note how all coefficients are strongly significant. Transfers and expenditure on durables can explain a part of the small response of non durable consumption, as when labor income, say, increases by 10%, the reduction in transfers and the increase in durable expenditure reduce disposable labor income by approximately 1.5%, but that still gives a net increase in income of 8.5%, while non durable consumption increases much less. Property income moves very little and it co-moves positively with labor income, so it cannot explain the size of the consumption response. Wealth on the other hand moves a great deal in response to income changes. Notice how the OLS estimation gives an (implausibly) large coefficient equal 3, suggesting that when income increases by 10% wealth increase by 30%. But this estimate is very likely to be driven by outliers in wealth change, which is a very noisy measure. This problem is partly addressed by using least absolute deviation regression (the last column in table 3) which gives a more plausible coefficient of 0.6, suggesting than a 10% increase in income is associated with a 6% increase in wealth. Such an increase could obviously be a key factor in explaining why consumption moves so little in response to income changes.

2.3.2 Understanding the Asymmetry

Our last piece of evidence explore whether the response of different components of the budget constraint can help us understand the asymmetric consumption response. In order to do so we repeat the exercise reported in table 2 where instead of consumption we estimate the response of various budget components to positive ($\alpha^+$) or negative($\alpha^-$) labor income shocks.
Table 4. Asymmetries in budget component responses

<table>
<thead>
<tr>
<th></th>
<th>Transfers (OLS)</th>
<th>Exp. on Dur (OLS)</th>
<th>Prop. income (OLS)</th>
<th>Chg in wealth (LAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha^+$</td>
<td>−0.06 (0.01)</td>
<td>0.12 (0.02)</td>
<td>0.09 (0.02)</td>
<td>1.40 (0.06)</td>
</tr>
<tr>
<td>$\alpha^-$</td>
<td>−0.07 (0.01)</td>
<td>0.07 (0.02)</td>
<td>0.0 (0.02)</td>
<td>0.24 (0.06)</td>
</tr>
<tr>
<td>$\alpha^+ = \alpha^-$</td>
<td>Not Reject</td>
<td>Not Reject</td>
<td>Reject (5%)</td>
<td>Reject (5%)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Obs.</td>
<td>11749</td>
<td>11749</td>
<td>11749</td>
<td>11749</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All regressions include time dummies and age controls.

Table 4 suggests, as table 3, that most action in response to an income shock takes place in the change in wealth. Moreover the table suggest that this response seems strongly dependent on whether the income change is positive or negative, with positive income changes being associated with much larger changes in wealth than income declines. These facts alone cannot yet rationalize the observed asymmetric consumption response, but they suggest that a closer investigation of the various component of wealth change (which is feasible in the Italian data) is crucial for understanding the channels through which households insulate their consumption from income fluctuations.

So far we have documented, for a panel of Italian households, how consumption and other budget components respond to labor income changes and how this response has evolved through time. The ultimate goal is now to find a model with is consistent with the evidence described above and thus could be used to with confidence for normative and positive analysis. In the next section we move the first steps in that direction.

3 Theory

We first consider a pure exchange economy with a continuum of agents of measure 1 that face idiosyncratic, and potentially aggregate, income shocks. Different models are distinguished by the structure of financial markets or other arrangements through which households can (self-) insure consumption from random labor income shocks.\(^4\)

3.1 Physical Environment

We denote the current idiosyncratic shock by \(y_t \in Y\), and the current aggregate shock (if present) by \(z_t \in Z\), with \(Z\) and \(Y\) finite. Let \(z^t = (z_0, \ldots, z_t)\) and \(y^t = (y_0, \ldots, y_t)\) denote the history of aggregate and idiosyncratic shocks. We use the notation \(s_t = (y_t, z_t)\) and \(s^t = (y^t, z^t)\) and let the economy start at initial node \(z_0\). Conditional on idiosyncratic shock \(y_0\) and thus \(s_0 = (y_0, z_0)\), the probability of a history \(s^t\) is given by \(\pi_t(s^t|s_0)\). Individual endowments are given by \(e_t(s^t)\).

At time 0 households are indexed by their idiosyncratic income shock \(y_0\) and their initial asset position \(a_0\).

\(^4\)In what follows we use the words endowment and labor income interchangeably.
Consumers rank stochastic consumption streams \( \{c_t(a_0, s^t)\} \) according to

\[
U(c)(s_0) = \sum_{t=0}^{\infty} \sum_{s^t \geq s_0} \beta^t \pi(s^t | s_0) c_t(a_0, s^t)^{1-\gamma} \frac{1}{1-\gamma}
\]

where \( \gamma > 0 \) is the coefficient of relative risk aversion and \( \beta \in (0, 1) \) is the constant time discount factor. The resource constraint equates aggregate consumption to the aggregate endowment.

### 3.2 Risk Sharing Arrangements

Our main focus is on models where agents insulate consumption from random labor income fluctuations through trade in assets on financial markets. We now spell these out formally.

#### 3.2.1 Standard Incomplete Markets Model (SIM)

In the standard incomplete markets model in which households can only trade a single, noncontingent bond. The price of the bond is given by \( q_t(z^t) \) and depends only on the aggregate shock history. A household pays \( q_t(z^t) \) units of consumption today for one unit of consumption tomorrow in all states of the world. The budget constraints read as

\[
c_t(s^t) + q_t(z^t)a_t(s^t) = e_t(s^t) + a_t(s^{t-1})
\]

In addition the household faces borrowing constraints \( \{J(a_0, s^t)\} \) that may be tighter than the natural borrowing limit.\(^5\)

#### 3.2.2 Limited Commitment Model (LCM)

In this model households can trade a full set of state-contingent Arrow securities \( a_t(s^t, s_{t+1}) \) at prices \( q_t(s^t, s_{t+1}) \). Thus the budget constraints read as

\[
c_t(s^t) + \sum_{s_{t+1}} q_t(s^t, s_{t+1})a_t(s^t, s_{t+1}) = e_t(s^t) + a_t(s^t).
\]

The shortsale of these assets is endogenously limited by a solvency constraint that is not too tight, in the way defined by Alvarez and Jermann (2000). That is, the limit on each security is that amount of state-contingent debt at which households are exactly indifferent between honoring their debt and defaulting, with the punishment of default entailing some restrictions to access financial markets in the future.\(^6\) For a sufficient severe punishment of default (e.g. losing permanently a large fraction of the endowment after default) the LCM model has implications that are identical to the complete markets model.

\(^5\) Partial equilibrium versions of this class of models were studied by Deaton (1991), Carroll (1992, 1997), Gourinchas and Parker (2002), Blundell et al. (2004), among many others. Our general equilibrium treatment is most related to Aiyagari (1994), Huggett (1993) and Heathcote et al. (2004, 2007).

\(^6\) Punishment is modeled either complete exclusion from financial markets, so that the agent has to live in autarchy after default (see e.g. Kehoe and Levine (1993, 2001), Kocherlakota (1996) or Alvarez and Jermann (2000), or households are restricted to borrow, but allowed to save at some noncontingent interest rate, as in Krueger and Perri (2006).
4 Empirical Evaluation of Model Allocations

In this section we describe the implications of several models of (self-) insurance for the response of household consumption to positive and negative income shocks. We then discuss which of the models is consistent with the empirical evidence from section 2. Finally we lay out the next steps in our analysis, which include to bring alternative models to bear on our facts.

4.1 Standard Incomplete Markets Model and Limited Commitment Model

Both the SIM and the LCM feature imperfect consumption insurance for plausible model parameters. These models need to be solved numerically in general, for which it is necessary to specify particular preference parameters, take a stand on the determinants of the borrowing/solvency constraints as well as the stochastic income process. As part of our project we plan to exploit the panel dimension of our Italian data to estimate a stochastic income process directly. In order to obtain a first rough sense for the quantitative implications of the models for the question we used a discretized version of a simple AR(1) process with annual persistence of ρ = 0.98. The period utility function is logarithmic and the time discount factor is chosen such that the stationary equilibrium interest rate is 2.5% per year in both models.

4.1.1 Consumption Response to Income Shocks

In Figure 3 we display the average percentage consumption response (the y-axis) to a percentage income change of a particular magnitude (the x-axis) for both the LCM and the SIM model. In order to achieve comparability with the data we report two-year consumption changes in response to two-year income changes in the models as we did for the data.

We make three main observations. First, consumption responds to income substantially less strongly (independent of the sign of the income change) in the LCM model than in the SIM model. Second, comparing these findings to the estimates from Figure 2 suggests that the LCM model understates these responses (at all levels of income changes) while the SIM model overstates them. Finally, both models suggest that consumption responds more strongly to income increases than to income drops as in the data. For the LCM, househoulds with declines in income between today and tomorrow do not have a strong incentive to default tomorrow. As a consequence the limited enforcement constraint is not binding in these states. Since absent these constraints the LCM boils down to a complete markets (CM) model, for these states the LCM shares the CM prediction that consumption growth does not depend on individual income growth. On the other hand, for households with income increases the limited enforcement constraint binds, and thus consumption growth is positively correlated with income growth for these states. Figure 3 displays this fact.

For the SIM, Figure 3 also shows that consumption responds slightly more to income the larger the income change is. For example, a 80% fall in income induces only an about 60% decline in consumption, whereas an increase of equal size implies an increase of about 70%. This result may at first seem

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7 For the analysis in this section (only) aggregate shocks are omitted.
8 Analytical solutions of either model are available only in very special cases.
counterintuitive, since consumption, as a function of cash at hand (the sum of financial wealth and current income), is a strictly concave function. This seems to suggest that a similar percentage decline in income ought to imply a larger consumption response than an increase. However, households with low income have, on average, low wealth (and thus cash at hand) and, because of mean reversion in income, high income growth. Similarly high income households tend to have high cash at hand and negative income growth. It is then exactly the concavity of the consumption function that implies the asymmetric consumption response displayed in the figure.

Figure 3: Consumption Response to Income Shock in LCM and SIM

Another way to measure the consumption response to income changes is to run the same regression as in section 2 on model-generated data. The results are summarized in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>SIM</th>
<th>LCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.17</td>
<td>0.79</td>
<td>0.07</td>
</tr>
<tr>
<td>$\alpha^+$</td>
<td>0.20</td>
<td>0.91</td>
<td>0.18</td>
</tr>
<tr>
<td>$\alpha^-$</td>
<td>0.15</td>
<td>0.63</td>
<td>0.0</td>
</tr>
</tbody>
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We do not claim that the direction of the asymmetric consumption response in both models, and certainly not its size that we have documented so far are features of all conceivable calibrations of both models. Having performed a sizeable number of sensitivity analyses suggests the following

Claim 1 If log-income follows a persistent, symmetric, mean reverting process then in the SIM consumption responds more strongly to income increases than to income falls. The size of the responses is at the

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9 See Carroll and Kimball (1996) for a proof of this for a general environment.
10 This argument also suggests that when running the consumption growth rate regression with current wealth as one of the covariates, the asymmetry in the model reverses. Investigating this further in both models and data is part of this research project we propose.
high end of the empirical estimates if income is even moderately persistent, and substantially larger for income processes estimated in the empirical literature for the U.S.\textsuperscript{11}

Claim 2 If log-income follows a symmetric, mean reverting process then in the LCM consumption responds more strongly to income increases than to income falls.\textsuperscript{12} The size of the responses is lower than empirically observed responses even if the consequences of default are weak (in the sense of allowing households to save after default).

4.1.2 More on the Mechanisms of Consumption Smoothing

The different models above rely on different consumption smoothing or risk sharing mechanisms. In order to map both class of models to the data and to compare changes in wealth, financial income and transfers in the model to the facts from section 2 we have to specify how these entities are defined in the models. In a stationary equilibrium of the SIM model the bond price \( q = \frac{1}{R} \) is constant and thus the budget constraint \((3)\) in that model can be rewritten as

\[
c + \frac{1}{R} \left[ a' - a \right] = e(y) + \frac{R - 1}{R} a
\]

We identify \( \frac{1}{R} [a' - a] \) with the change in net wealth from the data and \( \frac{R-1}{R} a \) with financial (property) income. Transfers are zero in this model by assumption.

In a stationary equilibrium of any complete markets model with a continuum of agents (with or without frictions) the price of an Arrow security that pays in idiosyncratic state \( y' \) tomorrow, conditional on the idiosyncratic state today being \( y \), is given by \( q(y'|y) = \frac{\pi(y'|y)}{R} \), that is, factors into an intertemporal price \( \frac{1}{R} \) and the probability of payout, \( \pi(y'|y) \). The budget constraint \((4)\) can then be written as

\[
c + \frac{1}{R} \left[ E_ya' - E_{y-1} a \right] = e(y) + \frac{R - 1}{R} E_{y-1} a + \left[ a(y) - E_{y-1} a \right]
\]

where \( E_ya = \sum_{y'} \pi(y'|y)a(y') \) is the expected payout of the portfolio of Arrow securities tomorrow. As in the SIM model above we define \( \frac{1}{R} \left[ E_ya' - E_{y-1} a \right] \) as change in net wealth, \( \frac{R-1}{R} E_{y-1} a \) as financial income and \( \left[ a(y) - E_{y-1} a \right] \) as transfers.

The empirical part has identified the potential importance of adjustments in the three components (a) change in net wealth (b) financial income and (c) transfers for the household consumption response to income changes. The next step in our analysis is to document the quantitative importance of these three mechanisms in the models discussed above and compare it to the empirical facts from section 2.

4.2 Next Steps in the Analysis

The previous analysis has analyzed two popular consumption risk-sharing models. At least for one plausible parameterization both models quantitatively fail to capture the most fundamental response of

\textsuperscript{11}This is certainly the case for \( \rho \geq 0.8 \), a number at the low end of the values that seem empirically plausible (see Guvenen, 2005, 2007).

\textsuperscript{12}The asymmetry is strict as long as the equilibrium does not imply autarchy or perfect consumption insurance. For the iid case this result was shown theoretically by Krueger and Perri (2005, 2007).
consumption to income changes suggested by the data. The LCM model predict to much consumption insurance, the SIM too little. Furthermore both the SIM and LCM are qualitatively consistent with stronger consumption responses to income increases than to income falls. Quantitatively, however, the asymmetry in either model appears to be too small, relative to the data, at least for the most recent periods of the sample. These findings either call for using a different set of (versions of the) models, or for a different set of “inputs” into either the LCM or SIM model.

4.2.1 Asymmetric Income Process

So far we have used income processes (motivated by American data) that are symmetric, in the sense that income drops are equally big and persistent as income increases. Part of our project will estimate a stochastic income process from the Italian panel data directly. Our preliminary evidence (not discussed for space reasons) suggests that income declines are more persistent than income increases in this data. If this fact is borne out in subsequent analysis, it makes it more difficult for both models to generate a significantly larger consumption response to income increases than to income declines, potentially deepening the need for alternative models or model elements to explain the facts.

4.2.2 Production and Capital in Positive Net Supply

As argued by Storesletten et al. (2004a), and confirmed in our own work, Krueger and Perri (2006), the degree to which households can self-insure against idiosyncratic income risk depends crucially on the aggregate net supply of assets in the economy. In the previous pure exchange economy this net supply was by construction equal to zero. One immediate next step of our analysis will be to incorporate the estimated income process from Italian data into a production economy in which the net supply of assets equals the capital stock of the economy. We will then construct an estimate of average net wealth holdings from the Italian data set and calibrate the production economy such that the net demand of assets in the model, relative to average income, matches that in the Italian data.

Table 3 contains results from such an exercise when the simple AR(1) income process employed above is used and the net wealth to output ratio is calibrated to U.S. NIPA data. We observe that, at least for a U.S. model calibration the SIM matches the Italian data quite well, both in terms of the absolute size of the consumption response as well as in terms of the asymmetry of this response. The production LCM, on the other hand, while predicting the appropriate asymmetric response, implies too much consumption insurance. It is an open question that the proposed project will answer whether these results continue to hold when the models are calibrated to our Italian data; in light of the potential asymmetry of the income process alluded to above the answer is less than clear a priori.

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<th>Table 6: Regression Results</th>
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<tr>
<td>Data</td>
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<tr>
<td>α</td>
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<td>α⁺</td>
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4.2.3 Different Models

**Hybrid (Full Information) Models**  Findings by Storesletten et al. (2004a) and Blundell et al. (2004) suggest that households can smooth consumption better than implied by (realistically calibrated versions of) the SIM. Results from Krueger and Perri (2006) imply that the extent of risk-sharing predicted by quantitative versions of the LCM is too large, relative to what the data suggest. Our own results above confirm these conclusions, with the potential exception of the production SIM.

In the light of the potential shortcomings of both models we therefore also plan to investigate the prediction of models whose asset market structure and shortsale constraints lie somewhere between the SIM and the LCM. Households in this class of models can trade a restricted set of assets (relative to the full set of Arrow securities in LCM), and these asset trades are subject to shortsale constraints that may binding in equilibrium. We plan to parameterize the degree of market incompleteness by a single parameter as in Mendoza et al. (2007) and document for which degree of incompleteness (if any) the hybrid model can generate a plausible (in size and asymmetry) consumption response to income shocks.

**Nonseparable Preferences**  There is growing evidence (see for example Aguiar and Hurst, 2005) that both non time separability in consumption and non separability between consumption and leisure are important to understand joint movements of consumption and income. Our evidence discussed above on the importance of changes in labor supply for predicting changes in consumption suggest that those issues are important for understanding our data as well. We plan to explore the role non separable preferences and to assess whether they are important, alone or together the partial risk sharing models, in understanding our key stylized facts.

**References**


