DNB Working Paper
No. 551 / March 2017

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DeNederlandscheBank
EUROSYSTEEM

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 551

March 2017

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Asymmetric consumption effects of transitory income shocks*

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9 February 2017

Abstract

We use the responses of a representative sample of Dutch households to survey questions that ask how much they would consume of an unexpected, transitory, and positive income change, and by how much they would reduce their consumption in response to an unexpected, transitory, and negative income change. The questionnaire distinguishes between relatively small income changes (a one-month increase or drop in income), and relatively larger ones (equal to three months of income). The results are broadly in line with models of intertemporal choice with precautionary saving, borrowing constraints, and finite horizons.

Keywords: Transitory Income Shocks, Positive and Negative Income Shocks, Marginal Propensity to Consume.
JEL classifications: D12, D14, E21.

* We thank Yichen Su for excellent research assistance. We also thank seminar participants at the 2017 ASSA meetings and the University of Birmingham for helpful suggestions and comments. Christelis and Jappelli acknowledge financial support from the Italian Ministry of University and Research. The opinions expressed in the paper are those of the authors and do not necessarily reflect the views of the European Central Bank or De Nederlandsche Bank.

1. Introduction

Evaluating the effect of a broad set of policy interventions, including fiscal and monetary policies, on household and aggregate consumption requires reliable estimates of the consumption response to income shocks, i.e., the marginal propensity to consume (MPC). Distinguishing whether consumption responds differently to positive and negative income changes, and whether the response depends on the size of the shock are equally important questions.

To address these issues, we use the responses from a representative sample of Dutch households to survey questions that ask how much they would consume of an unexpected, transitory, and positive income change, and by how much they would reduce their consumption in response to an unexpected, transitory, and negative income change. In addition, the survey questionnaire allows respondents to distinguish between relatively small income changes (an increase or reduction equivalent to roughly one month of income), and relatively larger ones (equivalent to three months of income).

The survey allows us to characterize empirically the distribution of the MPC in response to unexpected, transitory income changes (positive and negative), and compare the findings with the predictions of intertemporal consumption models. Specifically, we test whether the consumption response to income shocks declines with economic resources, whether the MPC is smaller if the consumer has a relatively long time horizon, whether the consumption response to positive income shocks and negative income shocks differs, and whether the response is stronger for more salient and larger income shocks. The main advantage of using our survey is that it allows us to compare the responses *of the same household* to a hypothetical positive and negative income shock, hence replicating a quasi-experimental setting. In contrast, a realized income shock is either positive or negative, and therefore, comparing the consumption responses to realized positive and negative shocks reflects also the different characteristics (observed and unobserved) of the selected sample that is subjected to a given type of shock (and in most cases, the business cycle context in which the shocks occur).

Our empirical findings are broadly in line with models of intertemporal choice with precautionary saving, borrowing constraints and finite horizons. The average MPC is in the range of 15-25 percentage points; it is larger for negative income shocks, is larger at low levels of

economic resources, and it increases with age. We find also that the MPC distribution is in line with two of the predictions of models with liquidity constraints. First, as shown by simple simulation analysis of a model with income risk and precautionary saving, in the presence of liquidity constraints the MPC from negative income shocks is larger than the MPC from positive shocks. Second, in the presence of liquidity constraints the size of the shock also matters. In the case of large income increases, liquidity constrained consumers are more likely to overcome the constraint (and therefore, the MPC is lower than in the case of small increases) while in the case of income decreases the MPC should be equal to 1 irrespective of the size of the negative income shock. The survey allows us to test these important, and as yet unexplored implications of liquidity constraints.

From a methodological point of view, we contribute to the literature on MPC estimation based on income shocks. One of the difficulties affecting estimation of the MPC is isolating the exogenous income shocks needed to track consumption behavior following a shock. The literature suggests three approaches to deal with this issue (for a survey, see Jappelli and Pistaferri, 2011). The first approach identifies episodes in which income changes due to exogenous events such as unemployment, disability, or tax rebates, and evaluates in a quasi-experimental setting how consumption reacts to such changes (see for instance Browning and Crossley, 2001; Stephens, 2001; Souleles, 1999; 2002; Agarwal et al., 2007; Misra and Surico, 2014). The second approach relies on the statistical decomposition of income shocks and the covariance restrictions imposed by the theory on the joint behavior of income and consumption, in combination with long panel data to relate income shocks to consumption growth (Blundell et al., 2008). Survey questions which measure the responses to actual or hypothetical income changes are the third approach.[1] For instance, Shapiro and Slemrod (1995; 2003) and Sahm et al. (2010; 2015) asked US households to report how their consumption changed in response to tax rebates, tax credits, and payroll tax changes in the previous 15 years. Jappelli and Pistaferri (2014) analyze how a hypothetical tax rebate affects consumption, and find an inverse relation between MPC and cash-on-hand, which is

[1] Parker and Souleles (2017) compare reported preferences for spending in response to various tax policies with actual follow-up spending behavior and find that the two are well aligned. In addition, Smith et al. (2014) use brain imaging technologies and find that subjects' reported preferences over a set of food items is a good predictor for their follow-up actual food choice.

consistent with models with liquidity constraints and precautionary saving. However, none of these studies benefits from information on the MPC from negative income changes, and therefore, cannot investigate whether the MPCs from positive and negative changes are symmetric.

The present paper is organized as follows. Section 2 discusses the theoretical predictions related to the MPC, and presents a simple simulation analysis of the effect of positive and negative income shocks on consumption in models with precautionary saving and liquidity constraints. Section 3 describes the data and presents the questions used in our survey to elicit the MPC. Section 4 provides a descriptive analysis, and the regression results obtained when relating the MPC to demographic variables and household resources. In Section 5 we compare directly the distribution of positive and negative income shocks, and use information on the size of the shock to draw implications about the prevalence of liquidity constraints. Section 6 tests the robustness of the empirical results, and section 7 concludes.

2. Theoretical predictions

In a standard life-cycle permanent income model with perfect credit markets, quadratic utility and an infinite horizon, consumption is proportional to lifetime disposable resources, and hence, all consumers respond in the same way to income shocks; that is, there is no heterogeneity in the MPC. Models with a finite horizon introduce a first important source of heterogeneity: the MPC is larger for households with short horizons (typically, older households). In models with precautionary savings and borrowing constraints the relation between cash-on-hand and consumption is concave, and consumers respond differently to changes in their economic resources. Indeed, MPCs are lower for the rich than for the poor, and liquidity constrained consumers exhibit a higher MPC than households that can access credit markets to smooth consumption.

In addition to these level effects, the composition of household resources can also matter. For instance, households burdened with large debt amounts react to a positive change in income by reducing their debt rather than spending (Dynan, 2012; Mian and Sufi, 2010). Moreover, if most of household wealth is locked into illiquid assets, households should reduce consumption even in

the face of a negative transitory income shock (Kaplan and Violante, 2014). In this section, we explore the implications of liquidity constraints and precautionary saving for the consumption response to positive and negative income shocks.

2.1. Liquidity constraints

The standard life-cycle permanent income with a perfect capital markets assumption suggests that the MPC is the same for both negative and positive income shocks. Indeed, individuals can borrow and save at the same interest rate to buffer income fluctuations. However, in the presence of liquidity constraints, the MPC distribution of negative income shocks dominates the MPC distribution of positive shocks.

To see why, let us consider a simple two-period model with consumption in the two periods denoted c_t and c_{t+1}. The utility function is quadratic so there are no precautionary saving effects. Figure 1 shows how consumption responds to a change in first-period income, given second-period income. The 45-degree line is the locus of all solutions where consumption is constant over time ($c_t = c_{t+1}$). The initial distribution of resources is given by $\{ y_t^a , y_{t+1} \}$, and first-period income is lower than second-period income. With a zero interest rate and a zero rate of time preference, the optimal solution in the absence of constraints is to keep consumption constant in the two periods. If a liquidity constraint is imposed, it will be binding, and households will choose $c_t = y_t^a$ and $c_{t+1} = y_{t+1}$ (the corner solution corresponding to point A in Figure 1).

Suppose now that first-period income increases from y_t^a to y_t^b. Since lifetime income increases, the household revises its optimal consumption plan upwards. Despite the rise in income, however, the liquidity constraint is still binding and the solution is still a corner one (point B). Since the liquidity constraint is binding, the household attempts to close the gap between desired and actual consumption. To reduce this intertemporal distortion, income changes are entirely consumed (MPC=1). Notice that since the interest rate is equal to the discount factor, if there were no liquidity constraints, the MPC would be equal to 0.5 because the increase in income would be divided equally between the two periods.

To overcome the distortions induced by liquidity constraints, income needs to increase substantially. For example, if income rises to y_t^c, the increase is large enough that the constraint no longer binds. In this situation, the household decides to save in the first period, and the MPC is less than 1. In other words, suppose that first-period income increases by an amount Δ for everyone. Households with first-period income at or below $y_{t+1} - \Delta$ have an MPC of 1; those with income at or above y_{t+1} have an MPC of 0.5; and those with income in the $\{y_{t+1} - \Delta, y_{t+1}\}$ interval have an MPC of $\left(1 - 0.5\frac{y_t - (y_{t+1} - \Delta)}{\Delta}\right)$. If first-period income is uniformly distributed over the $\{0, \bar{y}\}$ interval, for example, the average MPC in response to a positive income change is $MPC^+ = \frac{2(y_{t+1} + \bar{y}) - \Delta}{4\bar{y}}$. It follows that the average MPC decreases with the size of the income increase.

Consider now a situation in which first-period income drops from y_t^b to a lower level y_t^a. In this case the household can only move to another corner solution, thus MPC=1 regardless of the size of the income shock. But for richer households whose constraint does not currently bind, the MPC takes lower values. More generally, suppose that income declines by an amount Δ for everyone. Households with first-period income at or below y_{t+1} have an MPC of 1; those with income at or above $y_{t+1} + \Delta$ have an MPC of 0.5; and those with income in the $\{y_{t+1}, y_{t+1} + \Delta\}$ range have an MPC of $\left(1 - 0.5\frac{(y_t - y_{t+1})}{\Delta}\right)$. If first-period income is uniformly distributed over the $\{0, \bar{y}\}$ interval, then the average MPC in response to a negative income change is $MPC^- = \frac{2(y_{t+1} + \bar{y}) + \Delta}{4\bar{y}}$. Hence, the average MPC increases with the size of the income reduction. Moreover, the average MPC in response to income reductions exceeds the average MPC in response to income increases ($MPC^- > MPC^+$).

This discussion suggests that liquidity constraints have two implications for the MPC in the case of negative and positive income shocks. First, the MPC in response to negative income changes is greater than the MPC in response to positive changes. Second, with liquidity constraints the size of the shock also matters. For large increases in income, households are more likely to

overcome the constraint, and therefore, the associated MPC is likely to be lower than in the case of small changes. In the case of income decreases the opposite is true, and larger declines in income induce, on average, a larger MPC than smaller declines. Our specially designed set of questions allows us to test these important, and still unexplored, implications of liquidity constraints.[2]

2.2. Precautionary saving

Liquidity constraints are not the only reason for explaining MPC asymmetries in response to positive and negative income shocks. Indeed, models in which the utility function exhibits prudence predict that the MPC will depend on the level of the household's resources. Carroll (1996) and Carroll and Kimball (1996) show that adding income uncertainty to a standard optimization problem with preferences characterized by prudence produces a concave consumption function in which the MPC from cash-on-hand declines with the level of the cash-on-hand. The intuition is that consumers with less wealth have less ability to protect their consumption against income shocks. Therefore, an unanticipated increase in income, by increasing cash-on-hand, has a smaller effect on consumption than a reduction in income.

To gauge the importance of the asymmetric responses of consumption to income shocks, we simulate the MPC in a version of Aiyagari's (1994) model populated by heterogeneous agents with constant relative risk aversion preferences. The model includes an exogenous borrowing constraint preventing wealth from being negative, and an income process featuring a stochastic component given by the sum of an AR(1) process and an i.i.d. transitory shock.[3] The model is similar to that used by Jappelli and Pistaferri (2014) to characterize the shape of the relation between cash-on-hand and the MPC.

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[2] Altonji and Siow (1987) and Shea (1995) note that with liquidity constraints the response of consumption to *anticipated* income changes should be asymmetric, and that "households are more likely to violate the permanent income model when income is expected to grow than when income is expected to fall, since liquidity constraints inhibit borrowing but not saving" (Shea, 1995, p. 196). Altonji and Siow find empirically that households expecting their income to rise exhibit a higher sensitivity of consumption to predictable income than households expecting their income to fall, while Shea finds the opposite pattern. While these papers point to important asymmetries in consumption, their findings are not relevant in our context because they refer to anticipated income changes, while we examine unanticipated income shocks.

[3] A detailed description of the model is provided in the Appendix.

After solving the model using standard calibrated parameters (an interest rate of 4 percent, a discount factor of 0.95, a risk aversion of 2, an AR parameter of 0.98, a standard deviation of the persistent shock of 0.03, and a standard deviation of the transitory shock of 0.01), we calculate the optimal consumption rule. To mimic the hypothetical income windfall equivalent to 1/12 of the yearly income (as per the survey question), we normalize the mean income to 1, set the transitory shock to 0.1, and compute the distribution of the MPC with respect to transitory shocks implied by the model. We repeat the exercise setting the transitory shock to -0.1. Finally, we increase the size of the shock to 0.3 and -0.3 to mimic larger income shocks.

Figure 2 plots the MPC from positive income shocks. The approximately horizontal line corresponds to the case of no liquidity constraints, and thus, the MPC is virtually identical to the interest rate (4 percent), regardless of the level of cash-on-hand and the size of the shock.[4] With liquidity constraints and precautionary saving, the consumption function is concave, and the MPC is a decreasing function of cash-on-hand, and ranges from values of 35 percent for low levels of cash-on-hand, to approximately 4 percent for levels of cash-on-hand more than three times larger than the median disposable income. Figure 2 shows also that at low levels of cash-on-hand the MPC from a small positive income shock is larger than the MPC from a large shock. This is because a large income shock makes it more likely that the liquidity constraint is no longer binding.

Figure 3 plots the MPCs in response to negative income shocks. Again, the horizontal line denotes the MPC in the certainty equivalence case, and is identical to the corresponding line in Figure 2, that is, in this case there are no asymmetric effects of income shocks. Introducing liquidity constraints and precautionary saving makes the MPC a negative function of cash-on-hand in the case of negative income shocks too. Moreover, at low levels of cash-on-hand, the MPC from a large negative shock is greater than the MPC from a small negative shock since the liquidity constraint is more likely to be binding in the former case. Finally, comparison of Figure 2 and Figure 3 shows that at low levels of cash-on-hand the MPC in response to a negative shock is much larger than the MPC in response to a positive shock.

[4] With quadratic utlity and no liquidity constraints the relation between consumption and cash-on-hand is linear, and the line in Figure 2 would be horizontal. With isoelastic utlity and no liquidity constraints the consumption function is concave, which explains the decreasing part of the MPC at low levels of cash-on-hand.

These simple simulations have several implications which we can test empirically: (1) the MPC is higher at low levels of cash-on-hand; (2) the MPC in response to a negative income shock is larger than the MPC in response to a positive shock; (3) the size of the shock introduces further asymmetries in the MPC.

3. The data

We use data from the CentER Internet panel, a project sponsored by the Dutch National Bank and maintained by CentERdata at Tilburg University. The baseline survey is conducted once a year via the Internet, and collects detailed information on a range of demographics and asset holdings for a representative sample of Dutch-speaking households in the Netherlands. In addition to the baseline survey, households may be asked, during the year, to participate in special purpose surveys.

We designed a special purpose survey including questions aimed at measuring the MPC in response to positive and negative income changes, and to relatively small and relatively large income changes. The survey questions allow us to gauge separately the response of non-durable consumption, durable expenditure, debt repayment, and saving. Specifically, we characterize the MPC based on four separate questions asked to the financial respondent (i.e., the person responsible for the household's finances) in each household participating in the CentER survey.

In July 2015, we administered the first survey, which included two questions asking how people would respond to positive and negative income shocks of a relatively small size, respectively. To avoid influencing the respondents' reports, in October 2015 we administered a follow-up survey that asked how people would respond to positive and negative income shocks of a relatively larger size. To minimize framing concerns, we placed the questions referring to positive and negative changes in different parts of the survey questionnaire.

The two questions on positive income changes refer to a one-off bonus received from the government:

Imagine you unexpectedly receive a one-time bonus from the government equal to the amount of net income your household earns in (one-month / three months). In the next 12 months, how would you use this unexpected income transfer? Distribute 100 points over these four possible uses:

1. Save for future expenses [0,…,100]
2. Repay debt [0,…,100]
3. Purchase within 12 months durable goods (cars, home improvement, furniture, jewelry, other durable good) that you otherwise would not have purchased or that you would have purchased later [0,…,100]
4. Purchase within 12 months non-durable goods and services that do not last in time (food, clothes, travel, vacation, etc.) [0,…,100]
[ ] Do not know

The two questions for negative changes refer to a one-off tax:

Imagine you unexpectedly have to pay a one-time tax to the government equal to the net income your household earns in (one month / three months). In the next 12 months, how would you react to this unexpected reduction in your net income? Distribute 100 points over these four possible actions:

1. Reduce your saving for future expenses [0,…,100]
2. Borrow more money or repay less debt [0,…,100]
3. Cancel or postpone the purchase of durable goods (cars, home improvement, furniture, jewelry, other durable goods) that you otherwise would have purchased in the next 12 months [0,…,100]
4. Reduce spending in the next 12 months on non-durable goods and services that do not last in time (food, clothes, travel, vacation, etc.) [0,…,100]
[ ] Do not know

The survey is a cross-section of 1,543 households. It also asks information about demographics, household income, and wealth (broken down into real assets, financial assets, and debt). Note that, in contrast to questions that elicit qualitative information ("mostly save/mostly spend") on how people spend temporary tax rebates, the responses to the questions we posed provide quantitative metrics for a proposed scenario (people are asked what percentage of the bonus they would spend, and what they would save). Similar to the "mostly spend/mostly save" questions posed in Shapiro and Slemrod (1995; 2003), our questions refer to a bonus, or to a tax, and thus, reflect real-life situations.

The advantage of quantitative survey responses is that they overcome problems related to comparing responses across individuals who might interpret the statement "mostly save/mostly spend" in different ways. Another advantage is that if one ties the transfer to income, aggregation

is straightforward: the aggregate MPC from a transitory income shock (i.e., the response of aggregate consumption with respect to an increase in national income) is just the sample average of the individual MPCs. In contrast, asking for a numerical value of income (in euro) requires additional and ad hoc assumptions to obtain the aggregate MPC.

The design of the survey questions also addresses the following potential problem: asking how the respondent would spend a fixed sum of money (i.e., a 500-euro tax rebate) may suffer from a size effect, if the magnitude of the rebate is small relative to the incomes of many households. To overcome this issue, the survey question ties the amount of the transfer received to the monthly income.[5]

Finally, the survey allows us to characterize the MPC for positive and negative income shocks for the same household. Quasi-experimental data or retrospective data on income shocks identify households who have experienced positive shocks or households who have experienced negative shocks. This makes it difficult to compare the resulting two MPC distributions because the two samples are likely to represent different segments of the population differing in terms of resources, socioeconomic characteristics, and preferences. Thus, by asking hypothetical questions referring to both income increases and decreases to each respondent, the analysis in this paper does not suffer from this problem.

Several features of the survey questions are noteworthy. First, the questions ask about consumption of non-durables and durables separately (questions on the latter mention cars, home improvements, furniture and jewelry) which allows us to distinguish between the MPC and the marginal propensity to spend.[6] This distinction might be especially relevant for the "three-month income changes" questions, as a bonus equivalent to three months' income might allow the household to purchase more expensive durable goods, while a tax equivalent to three months' income might make it more likely that the household reduces or postpones planned expenditure on durable goods.

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[5] Parker et al. (2013) and Sahm, Shapiro and Slemrod (2010) try to tease out the "size effect" by looking at rebates relative to income. Here, we ask different questions for one-month and three-month income changes.

[6] Parker et al. (2013) highlight the importance of distinguishing between non-durable and total spending, and find that households spent between 12 percent and 30 percent of their 2008 U.S. stimulus payments on non-durable goods, and this rose to 50-90 percent when durable goods are included. This result is somewhat puzzling in light of a previous study which found that most spending goes on non-durables (Johnson et al., 2006).

Second, consumers are asked by how much they would increase or cut spending "in the next 12 months". This allows us to rule out that differences in the MPC that arise from differences in the timing of planned spending. Each of the reported MPCs can be interpreted as the consumption response to an income change in the coming year. Of course, further adjustments in subsequent years cannot be ruled out. In principle, it would be useful to post similar questions with other timings (e.g., how would consumption change in the second year) but this would increase the complexity of the questionnaire considerably.

Third, the questionnaire was administered in July and October 2015. In 2015, real GDP growth in the Netherlands was 2 percent and GDP was projected to grow by 1.7 percent in 2016 and 2 percent in 2017. In other words, the interviews took place several years after the financial crisis (GDP decreased by 4 percent in 2009) and the 2011-12 recession. Although business cycle effects can never be ruled out, the period in which the survey was administered should have weakened their impact.

Finally, a possible caveat common to all research eliciting subjective expectations or behavior in hypothetical scenarios, is that respondents might not have correctly understood the questions; consequently, they might display quite different behavior from the reported behavior. To gauge the empirical importance of this issue, we check the robustness of the results by controlling for respondents' financial literacy.

4. MPC distributions

In this section, we report descriptive statistics of the distribution of responses to hypothetical income changes, distinguishing between non-durable consumption, durable consumption, debt repayment and saving. We summarize the empirical correlations by employing regression analysis to examine how the MPC on non-durables varies with certain household characteristics.

4.1. Descriptive analysis

Table 1 reports summary statistics of the responses to the survey questions. It should be remembered, when evaluating responses, that the size of the income change is household-specific, and that the average net monthly household income is 2,833 euro. Following a one-month income increase, the average respondent would allocate 19.6 percent of the additional income to non-durable consumption, 19.2 percent to durable consumption, 14.7 percent to debt reduction, and save the remaining 46.5 percent. The distribution for a one-month income decline indicates a stronger consumption response: 23.8 percent of the income drop is absorbed by non-durable consumption, 25.8 percent by durables, 7.0 percent by a debt increase and 43.5 percent by reduced saving. Focusing on the MPC on non-durables, the median MPC from positive income changes is 10 percentage points, while it is 20 percentage points for negative changes. This pattern provides qualitative support for the insights from the simulations of the intertemporal model with precautionary saving and liquidity constraints, suggesting that the MPC in response to negative income shocks is higher than the MPC in response to positive shocks.

The MPC distributions for larger income changes highlight some interesting features: an assumed three-month rise in income is associated with a MPC on non-durables of 14.3 percentage points while the MPC associated with an income decline is 24.0 percentage points. Therefore, the MPC gap between positive and negative income changes is wider for large changes, again supporting the insights from the model.

Reassuringly, the magnitudes of the average MPCs on non-durables are consistent with the estimated average MPCs out of transitory income shocks reported in Johnson et al. (2009), Parker et al. (2013) and, for the case of the Netherlands, Carroll et al. (2014).

An average MPC on non-durables of 19.6 percentage points associated with a one-month income increase is higher than implied by a standard model of intertemporal choice with certainty equivalence. However, the average hides substantial heterogeneity among the responses, and the median (10 percentage points) is more in line with the predictions of models where households smooth a large fraction of the shock. Figure 4 plots the cross-sectional distribution of the MPC on non-durables due to a one-month income increase (upper left panel), a one-month income decline

(upper right panel), a three-month income increase (lower left), and a three-month income decline (lower right).

The upper left histogram in Figure 4 shows that 36 percent of respondents reported that they would not spend any of the bonus, and another 15 percent said they would spend 10 percent or less. Only 3 percent reported that they would spend more than 90 percent of the bonus, and only 2.8 percent said they would spend the entire bonus (MPC=1). The histogram also shows a "heaping" at rounded values (5 percentage points, 10 percentage points, etc.). It is interesting that heaping is not concentrated in the "50 percentage points" response, which often is interpreted as indicating respondent indecisiveness. We take this as an indication that the responses to the MPC questions are reliable.

The upper-right panel in Figure 4 reports the MPC distribution for one-month negative income changes. We noted that the average MPC corresponding to negative changes is higher (23.8 percentage points) than the average MPC corresponding to positive changes (19.6 percentage points). This higher average is due to a lower fraction of respondents reporting a low MPC (42 percent report that they would cut consumption by 10 percent of the income drop or less), and a higher fraction of households reporting that they would cut consumption substantially (4 percent reported they would cut consumption by more than 90 percent of the income drop, and 3.4 percent reported an MPC equal to 1).

The lower two histograms in Figure 4 report similar distributions for larger income changes. The MPC distribution corresponding to a three-month negative income change is similar to the one-month change distribution. In the case of positive income changes, the most visible and interesting feature of the histogram is that only 1 percent of the sample reported an MPC from a three-month income increase of over 50 percentage points, as opposed to the 7 percent reporting a MPC from a one-month income change above 50 percentage points.

Figure 5 reports the MPC distribution corresponding to durables consumption, and shows that around 30 percent of the sample does not intend to spend on durables; only 10 percent intends to spend more than 50 percent of the income change on durables. Figure 6 plots the distribution of the MPC on all goods (derived by summing the MPC on durables and non-durables). Even considering this larger aggregate, the upper-left panel shows that 30 percent of the sample intends to spend less than 10 percent of the income change, and that only 10 percent of the sample intends

to devote more than 90 percent of the income change to total consumption. Finally, Figure 7 shows that most respondents intend neither to increase nor reduce debt following an income shock.

4.2. Cash-on-hand and age profiles

The next step is to relate the MPC to household resources, which we measure empirically using cash-on-hand, defined as the sum of current income and financial wealth, net of consumer debt. Figure 8 plots the average MPC on non-durables by quartiles of cash-on-hand. Surprisingly, there is no clear relation between the MPC and cash-on-hand for positive income changes, regardless of the size of the shock (one or three-month of income). In contrast, and consistently with theoretical predictions, the MPC in response to income declines is higher at low levels of cash-on-hand, for both one- and three-month income changes.

Figure 9 plots the MPC on non-durables against age (grouped in 10-year intervals). Theory predicts a positive relation between age and the MPC (as older people have a shorter horizon over which to smooth a transitory income change), and indeed we find that in all four graphs the relationships are upward sloping. For instance, the MPC in response to small positive income changes increases from 14 percentage points for the youngest age group (less than 30 years old), to 23 percentage points for the oldest group (over 80 years old). The MPC in response to a one-month income decline increases only for the oldest group. The age-MPC relation for three-month positive and negative changes is also upward sloping, as shown in the lower two graphs in Figure 9.

4.3. Regression analysis

To properly characterize the various factors affecting the variability of the MPC, we rely on regression analysis. Summary statistics of the main variables used in the estimation are presented in Table 2. Table 3 presents the baseline OLS regression results for MPC on non-durables for each of the four scenarios: small negative and positive shocks (columns 1 and 2) and large negative and positive shocks (columns 3 and 4).

Our baseline specification includes age dummies (the base category is the oldest age group), the financial respondent's gender, family size, and dummies for cash-on-hand quartiles (the base category is the fourth quartile). The number of observations is not the same in each of the regressions, due to the different number of missing values in the responses to the four questions related to non-durable consumption (positive and negative changes, one and three-month changes).

The age coefficients in Table 3 are generally negative and statistically different from zero except for those in column 1, indicating that the youngest group (less than 35 years old) has a lower MPC than the oldest group (65 and over). This pattern corroborates, at least qualitatively, the predictions of standard consumption models that the MPC in response to transitory shocks increases with age (and confirms the simple bivariate evidence of Figure 9).

The most interesting relation is with cash-on-hand. We find that the MPC is negatively associated with cash-on-hand for negative income changes, but there is no relation between the MPC and cash-on-hand for positive changes. In particular, in column 1 the coefficient of the first quartile of cash-on-hand is 5.9 percentage points, and is statistically different from zero at the 1 percent level (6.5 percentage points in column 3 for the three-month income drop). Thus, the pattern of the coefficients of the cash-on-hand quartile dummies confirms the descriptive analysis discussed above.

5. Tests of liquidity constraints

As discussed in section 2, liquidity constraints are likely to have important effects on the MPC distribution. In particular, the distribution of negative income shocks is expected to stochastically dominate the MPC distribution of positive shocks, as suggested by the simulation results of our theoretical model shown in Figures 2 and 3. Furthermore, in the case of positive income shocks, the MPC from relatively small (one-month) shocks should be greater than the MPC from relatively large (three-month) shocks. For negative shocks, we expect the opposite.

In this section, we provide direct evidence supporting these theoretical predictions. Figure 10 presents two quantile-quantile (Q-Q) plots which compare the MPC distributions for positive income changes (measured on the horizontal axis) and negative ones (measured on the vertical

axis) by plotting the percentiles of the one distribution against those of the other (once more, this is made possible by the fact that people respond to *both* questions). In the left-hand side, we show the results for one-month income changes, and in the right-hand side the results for the three-month changes. In each graph, we also plot the 45-degree line.

The striking fact is that in both graphs the empirical plots are above the 45-degree line, which implies that percentiles of the MPC distribution due to negative income changes are matched to smaller percentiles of the MPC distribution corresponding to positive income changes. In other words, the MPC distribution due to negative changes stochastically dominates the distribution induced by positive changes. Note also that this stochastic dominance is larger for three-month than for one-month changes. These results provide suggestive evidence that households with a high MPC are likely to be liquidity constrained.

Figure 11 provides similar Q-Q plots comparing the MPC distributions for three-month income changes (measured on the horizontal axis) and one-month changes (measured on the vertical axis). We note that in the case of positive income changes (shown in the left panel) the plot is well above the 45-degree line, which implies that the distribution of the MPC due to the smaller income increase stochastically dominates the one due to the larger income increase. This pattern is consistent with the fact that larger income increases make liquidity constraints less likely to bind. In contrast, the QQ plot on the right panel of Figure 11 follows closely the 45-degree line, suggesting that the MPC distributions due to one- and three-month income decreases are quite similar.

For households that are liquidity constrained, one would expect that both MPCs from income decreases would be fairly high, perhaps close to 100 percentage points. As for unconstrained households, the similarity of the two MPC distributions is consistent with standard models of intertemporal choice. In section 2.2 we showed that the MPC does not depend on the size of the shock when liquidity constraints are not binding (as is apparent from the horizontal line in Figure 3).

We also provide formal evidence for the comparison of the MPC distribution from negative income changes to the corresponding distribution from positive changes, as well as the comparison of the MPC distributions due to small and large income changes, by performing Kolmogorov-Smirnov (K-S) tests of stochastic dominance. The K-S test has three parts: the first part tests the

hypothesis that one MPC distribution dominates the other (the null denotes no stochastic dominance); the second part tests the reverse hypothesis (again, the null denotes no stochastic dominance); and the third part tests the hypothesis that the two MPC distributions are equal.

The results, reported in Table 4, are quite clear. The first test evaluates the hypothesis that the MPC due to an income increase dominates that due to an income decrease and fails to reject the null (p-value of 1), while the second and third tests strongly reject the null (regardless of whether we look at one- or three-month income changes). Hence, the K-S test results confirm the graphical results in Figure 10, and suggest the existence of liquidity constrained consumers, especially at the top of the MPC distributions.

In Table 5, we show the results of comparing the MPC distribution induced by positive vs. negative income changes. Column 1 shows the results due to an income increase. The MPC distribution when the income decline is modest stochastically dominates the one induced by a more substantial increase, while the reverse is not true. On the other hand, the results for the MPC distributions due to income decreases (shown in column 2) do not provide any evidence for stochastic dominance either way. Hence, the test results in Table 5 provide statistical support for the relationships between the MPC distributions shown in Figure 11.

Finally, we provide further evidence that the MPC distributions are consistent with the presence of liquidity constraints by regressing the *difference* between the MPC in response to negative income changes and the MPC in response to positive changes (to ensure comparability, both MPCs take values ranging from 0 to 100). Since each household reports both MPCs, by differencing we can effectively eliminate the influence of household fixed unobservable effects (such as preferences, or financial sophistication) which might affect both distributions. Table 6 reports results for one- and three-month changes, shown in columns 1 and 2, respectively. Interestingly, the coefficients of the lower cash-on-hand quartiles are positive, indicating that the MPC in response to negative income changes has a stronger negative association with cash-on-hand than the MPC in response to positive changes, and thus tends to be larger at low levels of economic resources, a result in line with the simulations shown in Figures 2 and 3.

In columns 3 and 4 of Table 6, we show the results for the differences in MPCs between one- and three-month income changes. In the case of income increases (shown in column 3) the constant is large and statistically significant, which suggests that the MPC due to a one-month income

increase is larger than the one due to a three-month increase, with the exception of the youngest population segment (the relevant coefficient is negative and statistically different from zero). On the other hand, no coefficient is statistically different from zero at the 5 percent level in the case of income decreases, as shown in column 4. Both sets of results are in line with the patterns shown in Figures 10 and 11, and the K-S results of Tables 4 and 5.

6. Robustness

To check the sensitivity of our results, we perform various robustness checks.[7] First, we add control variables to our baseline regression specification for non-durable consumption; we include two dummy variables for tertiary and secondary education, and some regional dummies. Their inclusion does not alter the results for the MPC on non-durables (see Table 7).

As a second check, we focus on households with financial respondents aged 60 or less, as they may experience different constraints and shocks to their resources (e.g., income and unemployment shocks) with respect to their older counterparts for whom health shocks, bequest motives, and survival risk play more important roles. Excluding households older than 60 makes our results for non-durables slightly stronger for the case of a three-month income decline and a corresponding increase, and slightly weaker for one-month income declines.

The third check is related to the possibility that respondents might find the questions difficult to understand because they might lack knowledge of basic economic concepts. To address this concern, we include in our specifications an indicator of financial literacy, derived from the responses to three financial literacy questions widely used in the literature.[8] We measure financial

[7] For reasons of space, we do not show all the results of these tests here but they are available upon request from the authors.

[8] These questions are widely used in the literature on financial sophistication, see Lusardi and Mitchell (2011). The first question is: "Suppose you had 100 euro in a savings account and the interest rate was 2 percent per year. After 5 years, how much do you think you would have in the account if you left the money to grow? (More than 102 / exactly 102 / less than $102)." The second question is: "Imagine that the interest rate on your savings account was 1 percent per year and inflation was 2 percent per year. After 1 year, how much would you be able to buy with the money in this account? (More than today / the same / less)." The third question is "Please tell me whether this statement is true or false: Buying a single company's stock usually provides a safer return than a stock mutual fund (True / false)."

literacy using the number of correct answers to these three questions (i.e., this variable takes values from zero to 3). We find that controlling for financial literacy does not affect our results in a significant way.

Given that a sizeable share of households in our sample report zero MPCs as Figures 4-7 suggest, we examine whether our estimates are robust to censoring by running tobit regressions; our results are unaffected when taking account of censoring of our outcome variables.

Finally, we exclude from our estimation households reporting responses equal to 50 percentage points which could indicate that they do not know how to respond to the question rather than giving a genuine response (see, e.g., Fischhoff and Bruine de Bruin, 1999). This reduces our estimation samples by 70 to 150 observations depending on the outcome variable. Again, the results are barely affected.

7. Conclusions

We use a representative survey of the Dutch population to characterize empirically the distribution of the MPC in response to unexpected transitory positive and negative income changes, and to check several predictions of intertemporal consumption models. We find that the consumption response to income shocks declines with economic resources, and that the MPC is smaller if consumers have relatively long horizons. Most importantly, we detect significant asymmetries between the MPC in response to positive and negative income shocks. The main advantage of the survey questions is that they allow us to compare the responses to a hypothetical positive and negative income shock for the same household. Instead, in studies of real situations the income shock is either positive or negative. Thus, results obtained comparing the consumption responses of those facing positive shocks with the consumption responses of those facing negative shocks may confound genuine MPC heterogeneity with the heterogeneity of the households subject to the different types of shock.

Our results are broadly in line with models of intertemporal choice with precautionary saving, borrowing constraints and finite horizons. The average MPC corresponding to non-durable consumption is in the range 15 to 25 percentage points, it increases with age, and it is larger at low

levels of economic resources. We also find that the MPC distribution is in line with two important predictions of models with liquidity constraints. The empirical estimates confirm the results from a simple simulation analysis of a model with income risk and precautionary saving showing that in the presence of liquidity constraints the MPC in response to a negative income shock is larger than the MPC in response to a positive shock. In addition, in the presence of liquidity constraints the size of the shock also matters. For large increases in income, consumers are more likely to overcome the constraint (and therefore, the MPC is lower than for small increases).

Our findings have important implications for predicting consumption responses to a broad set of policy interventions that may change household incomes. Such interventions could range from direct government money transfers to tax reforms and to other redistributive policies. The results also provide evidence on the potential responses of consumers to direct money transfers from the central bank, thus contributing to the debate on the effectiveness of such policies in a low-interest rate environment.

Appendix. The simulated model

We assume that agents solve the following problem:

$$\max \sum_t \beta^t \frac{c_t^{1-\gamma}-1}{1-\gamma}$$

subject to

$$c_t + a_{t+1} \leq y_t + a_t(1+r)$$

$$a_{t+1} \geq 0$$

We assume the following income process:

$$y_t = \exp(z_t + \varepsilon_t)$$

$$z_t = \rho z_{t-1} + \eta_t$$

where ε_t and η_t are i.i.d. normal processes with mean zero and respective standard deviations of σ_ε and σ_η. Let $c(a,z,\varepsilon)$ and $a'(a,z,\varepsilon)$ be the optimal decision rules. Normalizing income to 1, an increase (or decline) of ε_t of 10 percent ($\bar{\varepsilon}$=0.1) is akin to the one-month bonus or tax considered in the survey question. An increase (or decline) of ε_t of 30 percent ($\bar{\varepsilon}$=0.3) is akin to the three-month bonus or tax considered in the survey question.

From the budget constraint, we have that

$$\left(c(a,z,\bar{\varepsilon}) - c(a,z,0)\right) + \left(a'(a,z,\bar{\varepsilon}) - a'(a,z,0)\right) = \exp(z)\bar{\varepsilon}$$

Hence, the model's equivalent of the MPC can be obtained directly from the decision rule as:

$$MPC(a,z)^* = \frac{c(a,z,\bar{\varepsilon}) - c(a,z,0)}{\exp(z)\bar{\varepsilon}}$$

For calibration purposes, we use the following parameter values: r=0.04, β=0.95, γ=2, ρ=0.98, σ_ε=0.01, σ_η=0.03. These parameter configurations generate the MPC distributions shown in Figures 2 and 3, normalizing cash-on-hand by the median income.

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Figure 1: The response of consumption with liquidity constraints

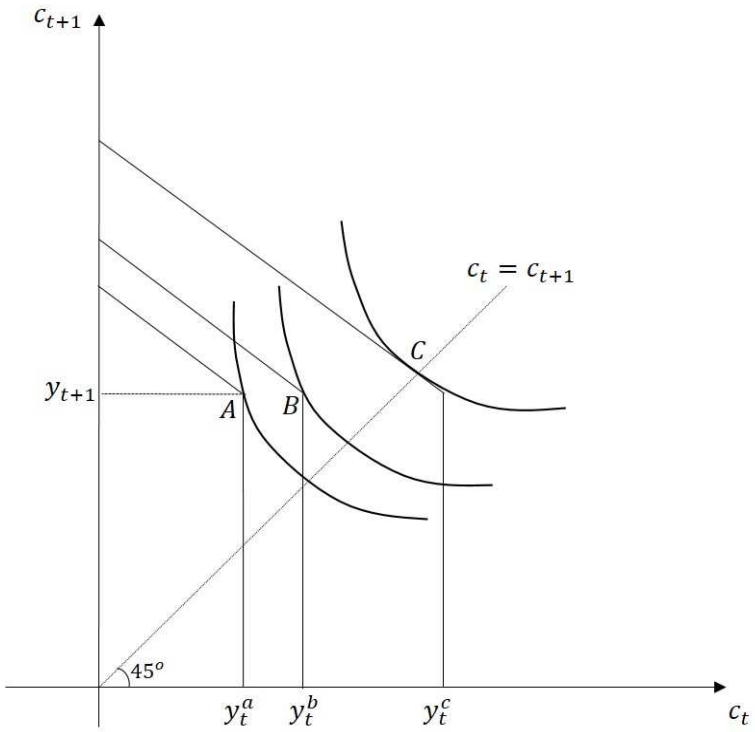


Figure 2. The response of consumption to positive income shocks

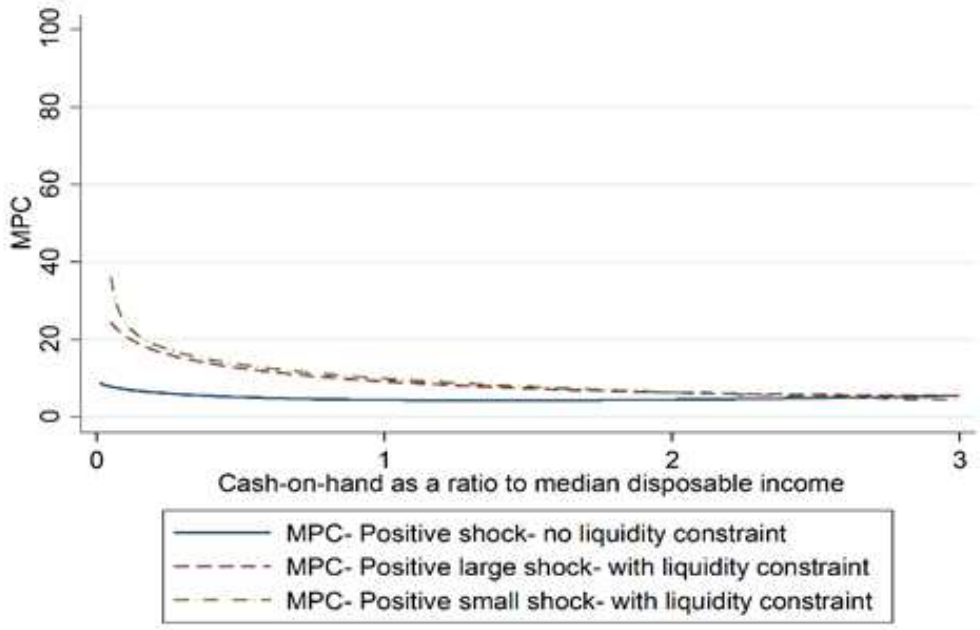


Figure 3. The response of consumption to negative income shocks

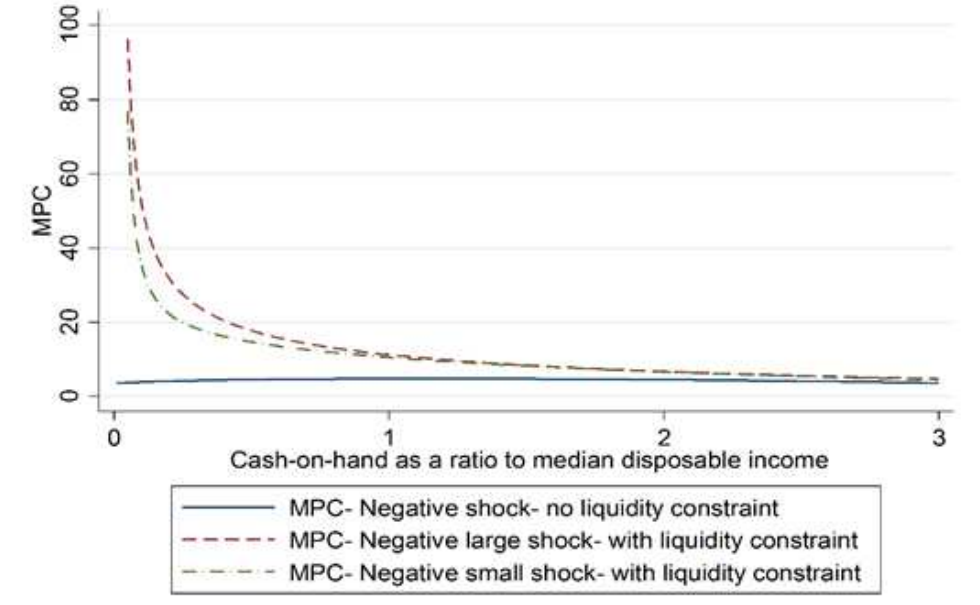


Figure 4. Non-durable consumption

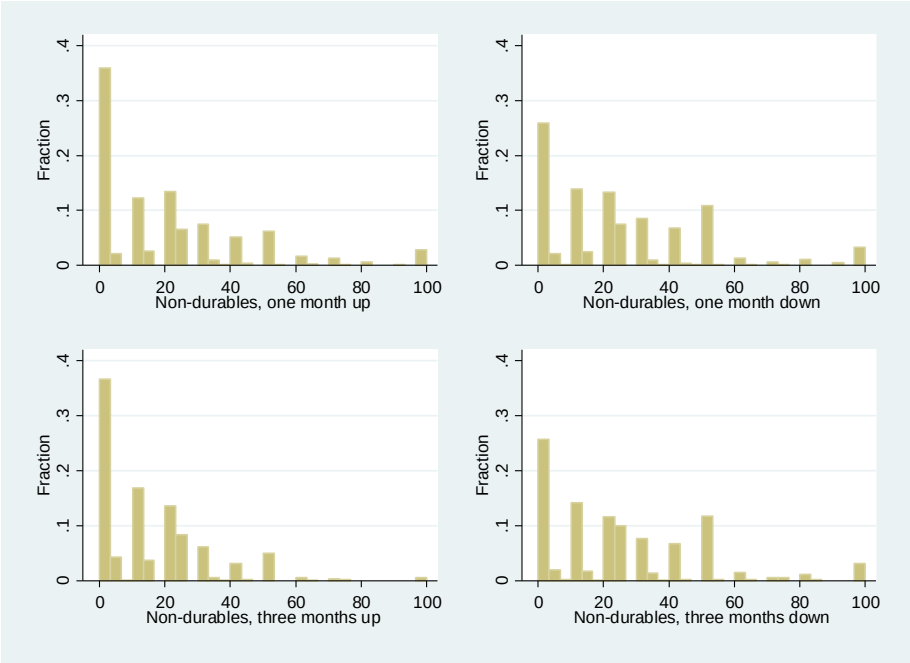


Figure 5. Durable consumption

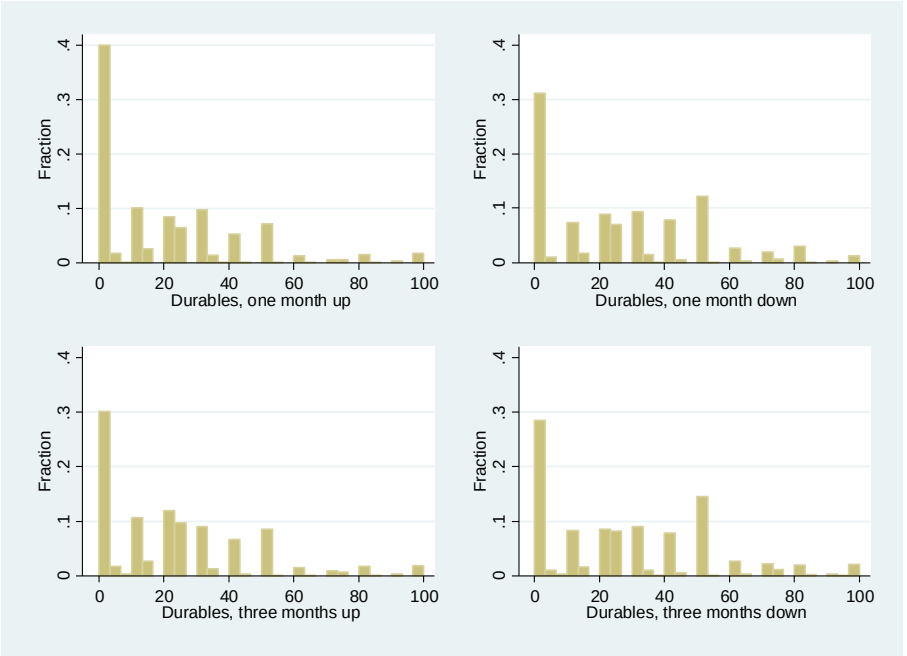


Figure 6. Total consumption

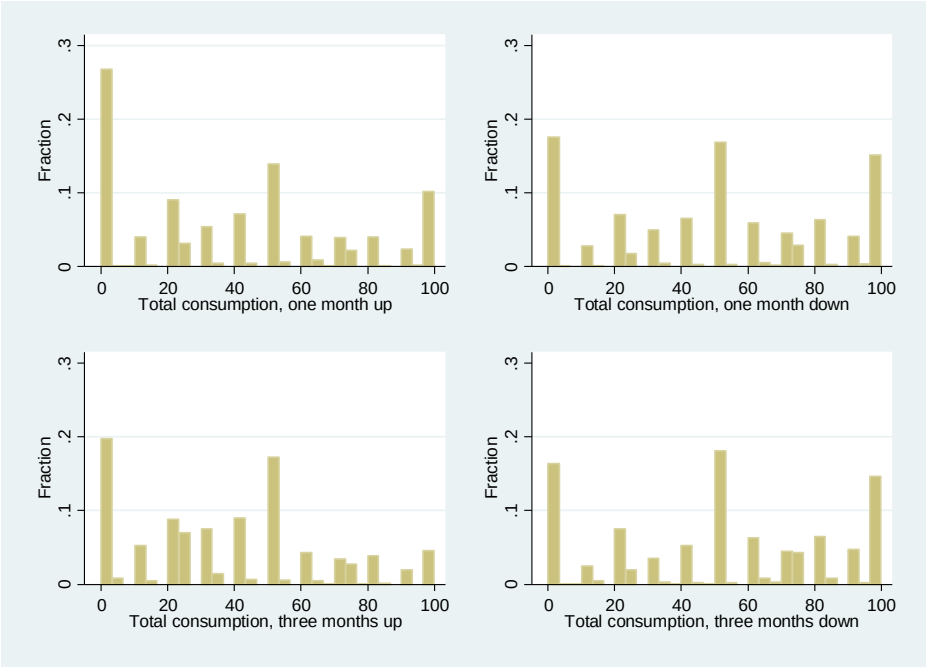


Figure 7. Debt

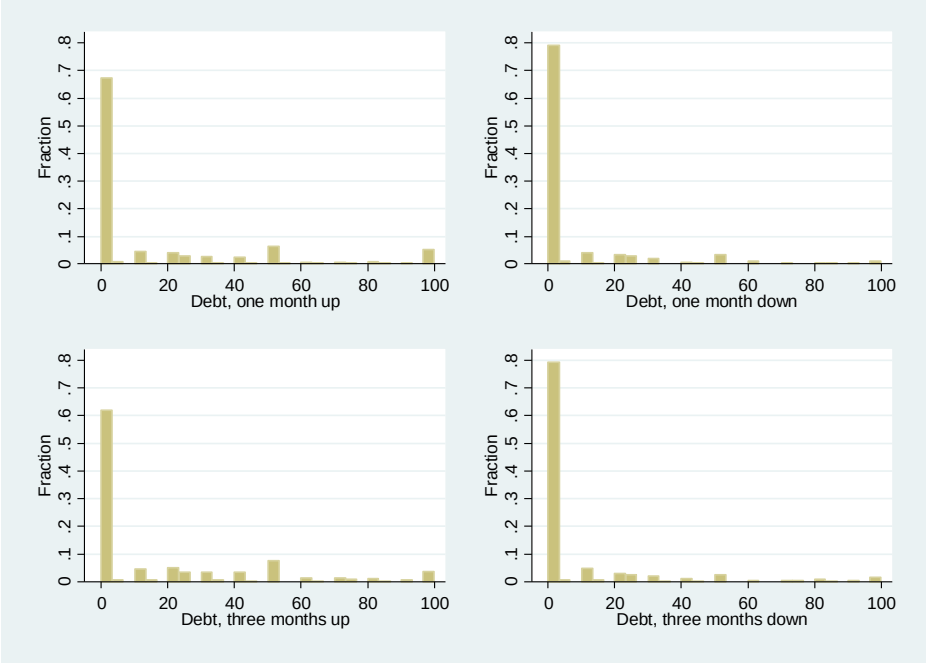
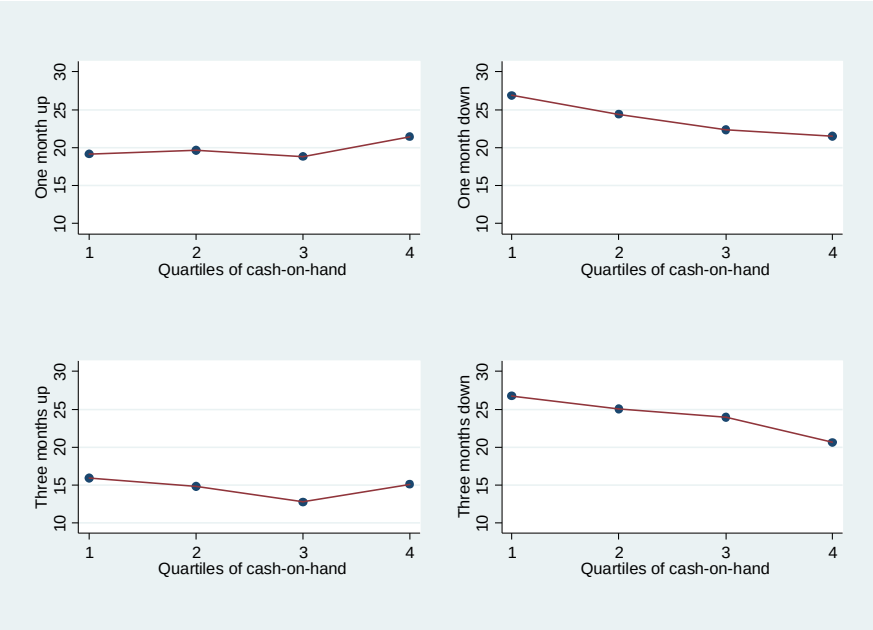
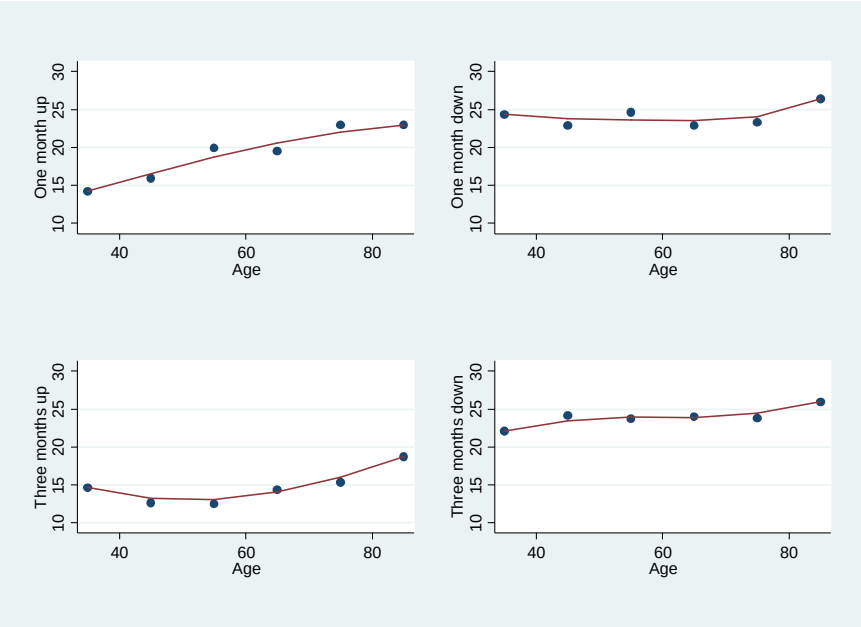


Figure 8. Non-durable consumption, by cash-on-hand quartiles



Note: The line in each graph is derived using local weighted regression.

Figure 9. Non-durable consumption, by age



Note: The line in each graph is derived using local weighted regression.

Figure 10. Q-Q plot comparing MPC from positive and negative income shocks

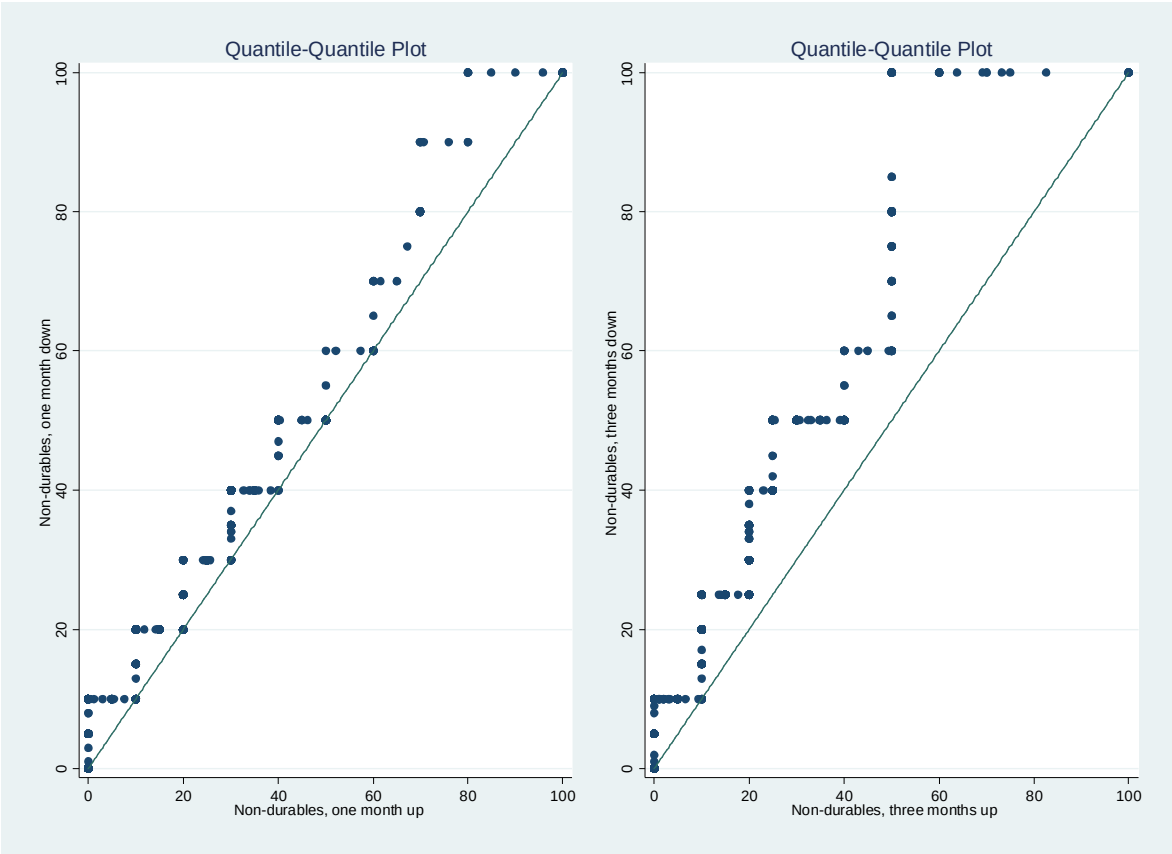


Figure 11. Q-Q plot comparing MPC from one- and three-month income shocks

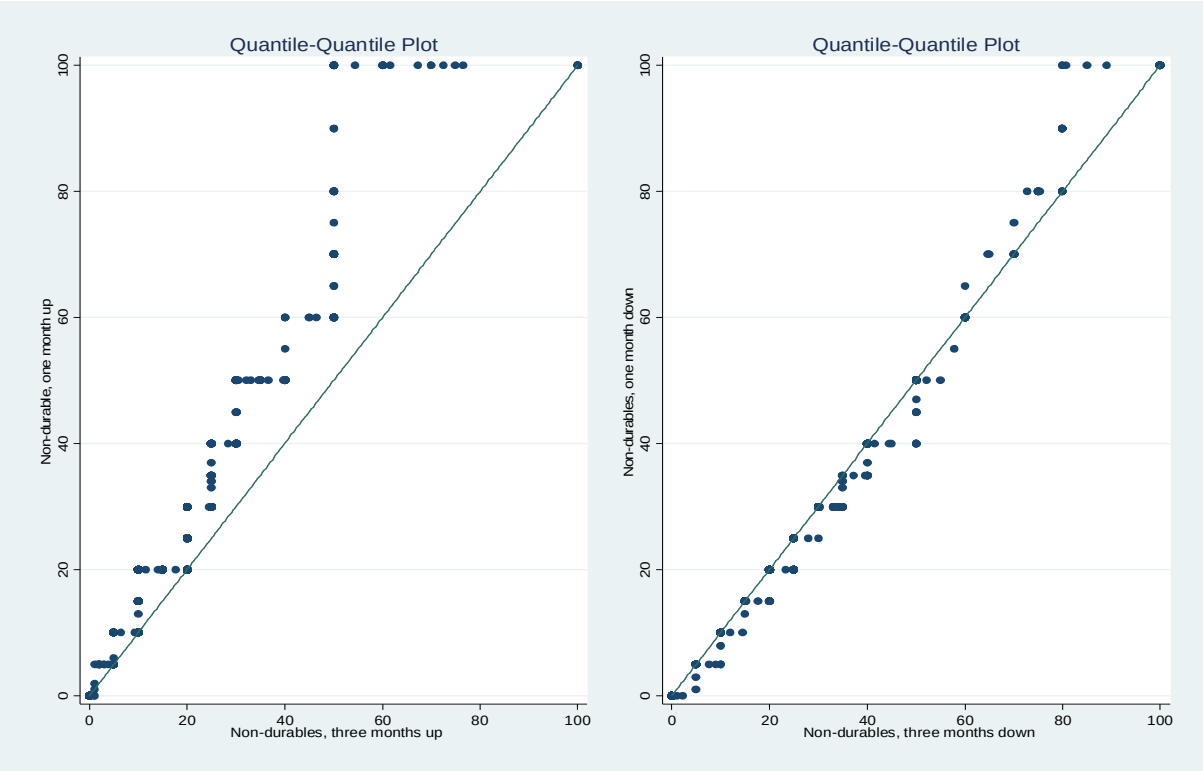


Table 1. Summary statistics

	Mean	*Median*	*Standard deviation*	*Number of observations*
One-month income change				
Income increase				
Increase non-durable consumption	19.59	10	23.01	1,319
Increase durable expenditures	19.24	10	22.87	1,319
Reduce debt	14.71	0	27.33	1,319
Increase saving	46.45	50	34.63	1,319
Income decline				
Reduce non-durable consumption	23.75	20	23.93	1,268
Reduce durable expenditures	25.76	20	24.71	1,268
Increase debt	6.98	0	17.61	1,268
Reduce saving	43.5	40	33.97	1,268
Three-month income change				
Income increase				
Increase non-durable consumption	14.34	10	16.28	1,484
Increase durable expenditures	22.28	20	22.81	1,484
Reduce debt	16.24	0	26.54	1,484
Increase saving	46.96	50	30.51	1,484
Income decline				
Reduce non-durable consumption	23.97	20	23.57	1,358
Reduce durable expenditures	26.99	25	25.02	1,358
Increase debt	7.30	0	18.94	1,358
Reduce saving	41.74	40	33.43	1,358

Note. Mean and median refer to the percentage use of the income change.

Table 2. Sample statistics of variables used in the empirical analysis

Variable	*Mean*	*Standard deviation*	*Number of observations*
Age	56.75	14.57	1,543
Male	0.56	0.50	1,543
Family size	2.30	1.19	1,543
Cash-on-hand	45,798	107,756	1,385
College degree	0.40	0.49	1,543
High school degree	0.32	0.47	1,543
Unemployed	0.03	0.18	1,474
Financial literacy	2.31	0.90	1,434

Table 3. Regressions for the MPC on non-durable consumption

Variable	*(1)* *One month down*	*(2)* *One month up*	*(3)* *Three months down*	*(4)* *Three months up*
Age<35	-3.095	-10.447	-5.499	-3.581
	(2.838)	(2.694)***	(2.673)**	(1.816)**
35<=Age<50	-2.760	-5.876	-3.352	-4.268
	(2.092)	(1.997)***	(2.004)*	(1.352)***
50<=Age<65	-3.276	-4.233	-1.817	-2.996
	(1.742)*	(1.661)**	(1.693)	(1.139)***
Male	-1.369	-2.895	-4.155	-2.871
	(1.446)	(1.371)**	(1.384)***	(0.929)***
Family size	0.244	-0.117	0.424	-0.446
	(0.680)	(0.631)	(0.627)	(0.422)
I cash-on-hand quartile	5.932	-0.796	6.487	1.383
	(2.048)***	(1.947)	(1.967)***	(1.313)
II cash-on-hand quartile	3.146	-1.068	4.453	0.116
	(1.968)	(1.882)	(1.895)**	(1.293)
III cash-on-hand quartile	0.876	-2.183	3.320	-2.287
	(1.927)	(1.838)	(1.872)*	(1.279)*
Constant	23.656	26.616	23.943	19.998
	(2.201)***	(2.097)***	(2.148)***	(1.440)***
R^2	0.01	0.02	0.02	0.02
N	1,160	1,208	1,230	1,332

Note. Standard errors are reported in parenthesis. *, **, *** indicate significance level at 10%, 5%, and 1%, respectively.

Table 4. Kolmogorov-Smirnov (K-S) tests of stochastic dominance, MPC on non-durables: positive versus negative income changes

Comparison	*(1)* *One-month income change* *p-value*	*(2)* *Three-month income change* *p-value*
Up dominates Down	1.000	1.000
Down dominates Up	0.000	0.000
Equality of the two distributions	0.000	0.000

Table 5. Kolmogorov-Smirnov (K-S) tests of stochastic dominance, MPC on non-durables: one-month versus three-month changes

Comparison	*(1)* *Income increase* *p-value*	*(2)* *Income decrease* *p-value*
Three-month change dominates one-month change	0.997	0.359
One-month change dominates three-month change	0.000	0.986
Equality of the two distributions	0.000	0.667

Table 6. Regressions for the difference in the MPC between negative and positive income changes

Variable	*(1)* *Down minus Up, one-month change*	*(2)* *Down minus Up, three-month change*	*(3)* *Up, one- minus three-month change*	*(4)* *Down, one- minus three-month change*
Age<35	7.722	-1.913	-7.271	3.530
	(3.234)**	(2.986)	(2.761)***	(3.615)
35<=Age<50	3.704	0.837	-1.684	1.731
	(2.379)	(2.236)	(2.043)	(2.676)
50<=Age<65	1.404	1.465	-1.358	-0.036
	(1.982)	(1.896)	(1.710)	(2.245)
Male	1.543	-1.499	0.285	3.502
	(1.642)	(1.544)	(1.408)	(1.856)*
Family size	0.308	0.881	0.321	0.169
	(0.769)	(0.698)	(0.644)	(0.867)
I cash-on-hand quartile	6.009	5.029	-2.027	-2.829
	(2.327)***	(2.202)**	(2.001)	(2.663)
II cash-on-hand quartile	4.218	4.745	-1.723	-0.921
	(2.238)*	(2.119)**	(1.935)	(2.504)
III cash-on-hand quartile	2.197	6.018	-0.699	-2.639
	(2.191)	(2.095)***	(1.893)	(2.454)
Constant	-2.862	3.836	7.143	-2.101
	(2.502)	(2.399)	(2.161)***	(2.836)
R^2	0.02	0.01	0.01	0.01
N	1,142	1,216	1,182	1,085

Note. Standard errors are reported in parenthesis. *, **, *** indicate significance level at 10%, 5%, and 1%, respectively.

Table 7. Regressions for the MPC on non-durable consumption: extended specification

Variable	*(1)* *One month down*	*(2)* *One month up*	*(3)* *Three months down*	*(4)* *Three months up*
Age<35	-1.759	-9.435	-3.706	-2.386
	(2.975)	(2.830)***	(2.813)	(1.900)
35<=Age<50	-2.410	-4.944	-2.087	-3.297
	(2.183)	(2.085)**	(2.094)	(1.405)**
50<=Age<65	-3.202	-4.065	-1.346	-2.779
	(1.765)*	(1.683)**	(1.717)	(1.152)**
Male	-1.277	-2.736	-4.006	-2.746
	(1.464)	(1.391)**	(1.400)***	(0.937)***
Family size	0.363	0.122	0.546	-0.293
	(0.693)	(0.643)	(0.637)	(0.428)
I cash-on-hand quartile	5.405	-1.642	5.718	0.967
	(2.095)**	(1.996)	(2.021)***	(1.343)
II cash-on-hand quartile	2.724	-1.688	4.235	-0.184
	(2.005)	(1.923)	(1.931)**	(1.313)
III cash-on-hand quartile	0.440	-2.537	3.128	-2.451
	(1.950)	(1.859)	(1.890)*	(1.289)*
College	-2.818	-3.999	-3.444	-3.106
	(1.842)	(1.755)**	(1.778)*	(1.186)***
High school	-1.230	-3.101	-3.186	-3.154
	(1.908)	(1.810)*	(1.813)*	(1.206)***
Region 1	3.466	4.526	1.960	3.772
	(2.314)	(2.208)**	(2.212)	(1.488)**
Region 2	2.069	1.886	2.140	0.942
	(1.917)	(1.820)	(1.833)	(1.237)
Region 3	-0.461	-0.139	-2.579	-1.625
	(2.457)	(2.327)	(2.358)	(1.573)
Region 4	1.860	1.664	1.368	0.415
	(2.119)	(2.014)	(2.011)	(1.353)
Constant	23.702	27.222	24.850	20.997
	(2.682)***	(2.547)***	(2.606)***	(1.742)***
R^2	0.02	0.03	0.03	0.04
N	1,147	1,196	1,219	1,318

Note. Standard errors are reported in parenthesis. *, **, *** indicate significance level at 10%, 5%, and 1%, respectively.

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