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Consumption Adjustment Under Negative Income Shocks: A Constrained Optimisation and Experimental Framework

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Abstract

This paper proposes a constrained optimisation and experimental framework to study how individuals adjust consumption after negative disposable income shocks. Standard consumer theory predicts that households should re-optimize consumption when income changes, but behavioural frictions such as habits, inertia, limited attention, and resistance to downward adjustment may prevent individuals from moving immediately towards a new optimal allocation.

The framework considers expenditure allocation across heterogeneous goods subject to a budget constraint and category-specific bounds. A negative income shock generates a new benchmark allocation, which is compared with the allocation chosen by participants in a proposed experimental setting. The design includes three stages: a baseline allocation, a spontaneous post-shock allocation, and a guided post-shock allocation. Spending guidance is introduced as a simplified decision aid derived from the benchmark optimisation model.

The main outcome is the distance between observed allocations and the model-implied benchmark allocation, together with category-specific expenditure responses. The paper therefore focuses not only on whether consumption falls after an income shock, but also on how expenditure is redistributed across essential and discretionary categories. By linking constrained optimisation, heterogeneous goods, and behavioural frictions, the paper contributes to the analysis of consumption adjustment under shocks and provides a basis for future experimental and macroeconomic extensions.

JEL Classification: D12, D91, C91, E21

Keywords: consumption adjustment; income shocks; household consumption; experimental economics; behavioural frictions; optimal consumption

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1 Introduction

The motivation for this paper comes from a simple observation: households often appear to adjust more easily when income rises than when income falls. An increase in disposable income expands the set of feasible consumption choices and usually allows individuals to improve or diversify their consumption bundle. A decrease in disposable income, by contrast, requires households to reduce, postpone, or reorganise existing expenditure patterns. This downward adjustment may be difficult because consumption is not shaped only by prices and income, but also by habits, routines, expectations, and previous standards of living.

This issue is particularly relevant in contexts of inflation, unemployment, rising interest rates, or sudden reductions in household income. When financial conditions deteriorate, households may continue to follow established spending patterns even when those patterns become harder to sustain. In such cases, consumption adjustment may be gradual, incomplete, or concentrated in categories that are easier to reduce in the short run, rather than in categories where reductions would be more consistent with an optimal allocation of resources.

Standard consumer theory predicts that individuals revise their consumption choices when disposable income changes. Under a new budget constraint, the consumer should re-optimize and choose a new allocation of expenditure across goods. However, this prediction may not fully describe actual behaviour. In practice, individuals may face behavioural frictions such as inertia, limited attention, decision fatigue, and resistance to reducing previously established consumption levels. These frictions can prevent households from adjusting immediately or efficiently after a negative income shock.

Most standard presentations of the consumer problem rely on simplified settings, often involving two goods or broad aggregate categories. While these models are useful for theoretical exposition, real household budgeting decisions involve several expenditure categories at the same time. Households must decide not only how much to reduce total expenditure, but also how to distribute those reductions across housing, food, transport, health, leisure, and other categories. This makes the composition of adjustment an important part of the consumption response.

This paper studies consumption adjustment after negative disposable income shocks in a setting with heterogeneous goods. I develop a benchmark optimisation framework in which individuals allocate expenditure across multiple categories subject to a budget constraint and category-specific lower and upper bounds. The model generates a reference allocation after an income loss. This allocation is then used to design simple spending guidance that may help individuals adjust their consumption decisions more effectively.

The paper combines this theoretical framework with an experimental economics design.

In the proposed experiment, participants first allocate a baseline budget across several expenditure categories. They are then exposed to a negative income shock and asked to revise their allocation. Finally, they receive spending guidance based on the benchmark allocation and make a further consumption decision. This structure makes it possible to compare spontaneous adjustment with guided adjustment after the same income shock.

The main research question is:

Does spending guidance improve the reallocation of consumption after a negative disposable income shock?

More specifically, the paper examines whether spending guidance moves observed consumption choices closer to the allocation predicted by the benchmark optimisation model. The analysis also considers whether guidance affects the composition of adjustment, especially by encouraging stronger reductions in discretionary expenditure relative to essential expenditure.

The paper is positioned at the intersection of three issues: downward consumption adjustment, heterogeneous expenditure categories, and the use of simple guidance as a decision aid. It focuses on negative income shocks because these shocks require individuals to reduce or reorganise existing spending patterns. It also studies adjustment across several categories rather than treating consumption only as an aggregate variable. Finally, it examines whether a model-based recommendation can help participants move closer to a benchmark allocation after an adverse income shock.

The remainder of the paper is organised as follows. Section 2 reviews the related literature on consumer theory, income shocks, behavioural frictions, and decision guidance. Section 3 presents the conceptual framework. Section 4 states the main hypotheses. Section 5 describes the proposed experimental design. Section 6 discusses the measurement strategy. Section 7 discusses the main interpretation of the proposed framework. Section 8 presents the limitations and possible extensions of the study. Section 9 provides concluding remarks.

2 Literature Review

This section reviews the literature most directly related to the paper. The discussion focuses on three points: the standard consumer optimisation framework, the evidence on consumption responses to income shocks, and the role of behavioural frictions and decision guidance in household adjustment.

2.1 Consumer Theory and Consumption Adjustment

The starting point of the paper is the standard consumer problem, in which households allocate expenditure across goods subject to a budget constraint. In the traditional framework, consumers are expected to maximise utility given prices and income, and changes in disposable income should lead to a new optimal consumption bundle (Varian, 1992). This provides the basic theoretical benchmark used in the present study.

However, the standard model is often presented in simplified settings, usually with two goods or highly aggregated consumption categories. This simplification is useful analytically, but it does not fully capture the way households make budgeting decisions in practice. Real households allocate resources across several categories at the same time, including housing, food, transport, health, leisure, and other expenditures. A negative income shock therefore does not only require a reduction in total spending; it also requires a reallocation of expenditure across categories.

Recent work has extended the standard framework by introducing uncertainty, stochastic income, labour choices, taxation, and heterogeneity across agents (Bensoussan, 2025; Jeon, 2024; Zhang, 2023; Spiritus, 2025; Koehne, 2018). These contributions show that optimal consumption decisions depend on more than current income alone. They also depend on risk, institutions, intertemporal choices, and individual characteristics. Other studies emphasise that differences in income and wealth may generate different consumption responses across households (Dioikitopoulos, 2020; Sun, 2018).

The present paper builds on this literature but focuses on a narrower question. Instead of studying optimal consumption only as a theoretical allocation problem, it asks whether individuals actually move towards a benchmark allocation after a negative income shock, and whether simple spending guidance can help them do so.

2.2 Income Shocks and Heterogeneous Responses

A central prediction of consumer theory is that households should adjust consumption when income changes. Empirical and experimental evidence, however, suggests that this adjustment is often incomplete or uneven. Studies on income and expense shocks show that individuals do respond to changes in financial conditions, but not always in the immediate or fully optimising way predicted by the standard model (Wang-Ly, 2024; Larsen, 2023). Similarly, evidence on wealth, income, and interest-rate shocks suggests that consumption responses may be non-linear and may depend on the type and size of the shock (Coskun, 2022).

This is important for the present paper because a negative income shock creates a different

behavioural problem from a positive income shock. When income rises, households can expand consumption without giving up previous habits. When income falls, adjustment requires reducing or reorganising existing expenditure. The difficulty is therefore not only financial, but also behavioural. Households may know that they need to spend less, but may still find it difficult to decide where and how to reduce expenditure.

The macroeconomic literature also highlights the role of expectations and uncertainty in consumption decisions. Households react not only to current income, but also to expectations about future income, inflation, employment, and financial conditions (Carroll, 2020; Nam, 2021). At the same time, wealth effects and consumption responses differ across individuals (Christelis, 2021; Atanasov, 2020). These findings reinforce the idea that adjustment after income shocks is unlikely to be uniform across households.

The main limitation of this literature, for the purpose of this paper, is that many studies focus either on aggregate consumption or on broad categories of expenditure. Less attention is given to the experimental analysis of how individuals redistribute a reduced budget across several consumption categories after a negative income shock.

2.3 Behavioural Frictions and Incomplete Adjustment

The gap between the theoretical prediction of re-optimisation and observed consumption behaviour can be explained by behavioural frictions. Households may not immediately adjust to a new budget constraint because consumption decisions are shaped by habits, routines, limited attention, and resistance to reducing established standards of living. This is especially relevant after negative shocks, when individuals are required to cut expenditure rather than simply allocate additional income.

One explanation is related to sticky expectations. If consumers update information slowly, their spending decisions may continue to reflect previous income conditions even after their financial situation has changed (Carroll, 2020). Social and psychological factors may also matter. For example, status concerns and perceptions of inequality can influence the desire to maintain visible forms of consumption (Velandia-Morales, 2022). In this sense, some categories of expenditure may be difficult to reduce not because they are strictly essential, but because they are linked to identity, social comparison, or previous lifestyle patterns.

Financial constraints can further limit the ability of households to smooth or adjust consumption. Credit constraints and financial frictions affect how households respond to shocks, particularly in markets for durable goods (Gavazza, 2021). The sensitivity of consumption to interest rates may also vary over time (Nordström, 2020). In addition, broader structural factors such as inequality and wealth distribution can influence aggregate consumption

patterns ([Cuaresma, 2018](#); [Rhee, 2018](#)).

These studies help explain why adjustment may be incomplete. However, they do not fully answer the question addressed in this paper: if individuals fail to adjust efficiently after a negative income shock, can a simple form of spending guidance move their choices closer to a benchmark allocation?

2.4 Guidance and Decision Support

The idea of spending guidance is related to a broader literature on decision aids, nudges, and simplified rules in economic decision-making. When choices are complex, individuals may benefit from information or rules that reduce the cognitive cost of making a decision. This is particularly relevant in household budgeting, where individuals must allocate limited resources across several competing needs.

Experimental studies show that individuals often deviate from the predictions of the standard rational model when facing income or expense shocks ([Wang-Ly, 2024](#); [Larsen, 2023](#)). These deviations do not necessarily mean that individuals are irrational. They may instead reflect limited attention, uncertainty, or difficulty in translating a new budget constraint into a new consumption plan. In this context, guidance may work as a decision aid by making the adjustment problem simpler.

Other contributions suggest that rules, algorithms, or allocation procedures can help individuals make decisions in complex environments ([Abebe, 2020](#)). Macroeconomic conditions may also affect the relevance of such tools, since periods of instability can make household decisions more uncertain and more difficult ([Dubé, 2018](#)). Evidence from economic psychology further suggests that preferences, social comparison, and inequality perceptions can shape consumption choices ([Velandia-Morales, 2022](#)).

The present paper uses this logic in a specific way. Spending guidance is not treated as general financial advice, but as a simplified signal derived from a benchmark optimisation model. The question is whether this signal helps participants reallocate expenditure after a negative income shock, especially by reducing discretionary spending more than essential spending.

2.5 Position of the Present Study

The literature provides three main insights for this paper. First, consumer theory offers a clear benchmark: after an income shock, individuals should revise their consumption allocation. Second, empirical and experimental evidence shows that actual adjustment is often incomplete, heterogeneous, and affected by expectations, uncertainty, and financial

constraints. Third, behavioural research suggests that simple decision aids may improve choices when individuals face complex or unfamiliar decisions.

The contribution of this study is to bring these three elements together. The paper develops a benchmark model of expenditure allocation across heterogeneous goods and uses it to design spending guidance in an experimental setting. This allows the analysis to move beyond the question of whether consumption falls after income declines. The focus is instead on how individuals redistribute expenditure, whether their choices move closer to the benchmark allocation, and whether guidance improves this adjustment.

This approach is especially relevant because negative income shocks require households to make difficult downward adjustments. In practice, individuals may attempt to preserve previous consumption patterns even when income falls. By studying the distance between observed allocations and the model-implied allocation, the paper provides a more direct way to evaluate incomplete adjustment and the possible role of spending guidance.

3 Conceptual Framework

The conceptual framework starts from the standard consumer problem. Individuals allocate expenditure across several goods subject to a budget constraint. In its simplest form, the consumer chooses a consumption bundle that maximises utility given prices and disposable income:

$$\max U(c_1, c_2, \dots, c_n) \tag{1}$$

subject to

$$\sum_{i=1}^n p_i c_i \leq Y \tag{2}$$

where c_i denotes consumption of good i , p_i is the corresponding price, and Y is disposable income. In this framework, a change in income should lead the consumer to revise the consumption bundle and move towards a new optimal allocation.

After a negative income shock, disposable income falls from Y to Y' , with:

$$Y' < Y \tag{3}$$

The standard prediction is that the consumer should re-optimize under the new budget constraint. However, this prediction may not fully describe actual household behaviour. In practice, individuals may continue to follow previous spending habits, especially when

adjustment requires reducing categories of expenditure that are linked to routines, comfort, or perceived living standards.

This paper therefore distinguishes between the benchmark allocation predicted by the optimisation model and the allocation actually chosen by individuals. The difference between the two captures incomplete adjustment. Spending guidance is introduced as a simple decision aid that may reduce this difference.

To represent expenditure choices more directly, consider a set of agents indexed by:

$$a = 1, \dots, A \quad (4)$$

Each agent allocates expenditure across goods indexed by:

$$i = 1, \dots, N \quad (5)$$

The expenditure vector of agent a is:

$$x^a = (x_1^a, \dots, x_N^a) \quad (6)$$

where x_i^a denotes expenditure on good i . Agents differ in their budgets, preferences, and feasible expenditure bounds. Preferences are represented by a satiation utility function:

$$U^a(x^a) = \sum_{i=1}^N w_i^a \exp \left[-\frac{m_i^a}{d_i^a} \left(\frac{x_i^a - d_i^a}{d_i^a} \right)^2 \right] \quad (7)$$

The model uses a non-linear satiation utility function, allowing utility losses to depend on deviations from good-specific bliss points.

where d_i^a is the bliss point for good i , $w_i^a > 0$ captures the relative importance of each good, and $\alpha_i^a > 0$ measures the sensitivity of utility to deviations from the bliss point.

Each agent faces an exact budget constraint:

$$\sum_{i=1}^N x_i^a = B^a \quad (8)$$

together with lower and upper bounds:

$$m_i^a \leq x_i^a \leq M_i^a \quad (9)$$

The optimisation problem is therefore:

$$\max_{x^a} U^a(x^a) \quad (10)$$

subject to:

$$\sum_{i=1}^N x_i^a \leq B^a, \quad m_i^a \leq x_i^a \leq M_i^a \quad (11)$$

The Lagrangian is:

$$\mathcal{L} = \sum_{i=1}^N w_i^a \exp \left[-\frac{m_i^a}{d_i^a} \left(\frac{x_i^a - d_i^a}{d_i^a} \right)^2 \right] + \lambda \left(B^a - \sum_{i=1}^N x_i^a \right) \quad (12)$$

Taking first-order conditions:

$$\frac{\partial \mathcal{L}}{\partial x_i^a} = -\frac{2m_i^a}{(d_i^a)^3} w_i^a (x_i^a - d_i^a) \exp \left[-\frac{m_i^a}{d_i^a} \left(\frac{x_i^a - d_i^a}{d_i^a} \right)^2 \right] - \lambda = 0 \quad (13)$$

The optimal expenditure allocation is:

$$x^{a*} = (x_1^{a*}, x_2^{a*}, \dots, x_N^{a*}) \quad (14)$$

which serves as the reference allocation in the experiment.

The benchmark allocation is obtained numerically in MATLAB by solving:

$$x^{a*} = \arg \max_{x^a} U^a(x^a) \quad (15)$$

The solution of this problem provides a benchmark allocation, denoted by x^{a*} . Since the utility function is based on satiation points, the problem is solved numerically under the imposed budget and expenditure constraints. The benchmark allocation should therefore be interpreted as the model-implied reference allocation for a given calibration, rather than as a universal prediction of behaviour.

When a negative income shock occurs, the budget changes from B^a to $B^{a'}$, with:

$$B^{a'} < B^a \quad (16)$$

This generates a new benchmark allocation, denoted by $x^{a'*}$. The key behavioural question is whether individuals move from their initial allocation towards this new benchmark after the shock. If adjustment is incomplete, observed choices may remain closer to the pre-shock allocation than to the new benchmark allocation.

Spending guidance enters the framework as a simplified signal based on the benchmark allocation. Instead of requiring participants to solve the optimisation problem themselves, the experiment provides guidance about how expenditure should be reorganised after the

income loss. The expected mechanism is therefore:

negative income shock $\rightarrow$ incomplete adjustment $\rightarrow$ spending guidance $\rightarrow$ revised allocation

The central idea is not that guidance eliminates all behavioural frictions, but that it may reduce the distance between observed consumption choices and the benchmark allocation after a negative income shock.

4 Hypotheses

The hypotheses follow from the distinction between the model-implied benchmark allocation and the allocation actually chosen by participants.

H1: Incomplete Adjustment After a Negative Income Shock

After a negative income shock, participants adjust their expenditure, but their new allocation remains closer to the baseline allocation than to the benchmark post-shock allocation.

This hypothesis reflects the idea that downward consumption adjustment is difficult. Participants may reduce expenditure, but they may not immediately reorganise their budget in the way predicted by the optimisation model.

H2: Effect of Spending Guidance

Spending guidance reduces the distance between observed post-shock allocations and the benchmark allocation.

This hypothesis tests whether guidance helps participants move closer to the allocation implied by the model. The expected effect is not simply a larger reduction in total spending, since total spending is constrained by the available budget. The relevant outcome is whether participants redistribute expenditure more efficiently across categories.

H3: Differential Adjustment Across Types of Goods

Spending guidance leads to stronger reductions in discretionary expenditure than in essential expenditure after a negative income shock.

This hypothesis reflects the idea that not all expenditure categories should adjust in the same way. Categories such as housing, food, health, and basic transport may be harder to

reduce, while leisure and other discretionary categories may provide more room for adjustment.

5 Proposed Experimental Design

The study proposes a controlled laboratory experiment in which participants make simulated household budgeting decisions. The experiment will be implemented in oTree, which allows the allocation task, randomisation, treatment conditions, and data collection to be programmed in a consistent way.

Participants will allocate a fixed budget across several expenditure categories. The task is designed to resemble a simplified household budgeting problem. Although the experimental environment cannot fully reproduce real financial pressure, it allows the study to isolate how individuals adjust expenditure after a negative income shock and whether guidance affects this adjustment.

The experiment has three main stages.

Stage 1: Baseline Allocation

In the first stage, participants receive an initial disposable income and allocate it across expenditure categories. The categories may include:

- housing;
- food;
- transport;
- health;
- leisure;
- other expenditures.

This stage captures the participant’s baseline allocation before any income shock. It also provides a reference point for measuring how much the participant changes spending after income falls.

Stage 2: Negative Income Shock

In the second stage, participants face a reduction in disposable income. They are informed that their available budget is now lower and are asked to make a new allocation under the reduced budget constraint.

This stage measures spontaneous adjustment. Participants must decide how to distribute the income loss across expenditure categories without receiving any guidance. The comparison between the baseline allocation and the post-shock allocation shows how participants initially respond to the negative income shock.

Stage 3: Spending Guidance

In the third stage, participants receive a spending suggestion based on the benchmark optimisation framework. The guidance does not require participants to understand or solve the mathematical model. Instead, it translates the logic of the model into an affordability rule that can be applied either to a single good or to several expenditure categories.

For a single good, the guidance is based on the maximum recommended expenditure that an individual should allocate to a purchase, given current disposable income. The purpose of this rule is to indicate whether a desired purchase is compatible with the individual's financial capacity.

Let p_i^{min} denote a reference minimum price, or minimum necessary expenditure, for good i . Let Y^a denote the current disposable income of individual a , and let Y^{ref} denote a reference income level, such as the minimum wage. The maximum recommended expenditure for good i is defined as:

$$\bar{p}_i^a = p_i^{min} \left(\frac{Y^a}{Y^{ref}} \right) \quad (17)$$

where $\bar{p}_i^a$ is the affordability threshold suggested by the guidance. This threshold increases with disposable income and decreases when the individual's income is closer to, or below, the reference income level.

For example, suppose an individual has monthly disposable income of EUR 1,500 and the reference income is EUR 950. If the reference minimum price for a pair of trousers is EUR 10, the maximum recommended expenditure is:

$$\bar{p}_i^a = 10 \left(\frac{1500}{950} \right)$$

which gives:

$$\bar{p}_i^a \approx 15.79$$

In this case, the guidance would suggest that the individual should buy trousers costing no more than approximately EUR 15.79, or choose a payment plan whose monthly instalment does not exceed this value. If the desired item costs EUR 200, the guidance would indicate that the purchase is above the recommended affordability threshold under the current income constraint.

When the decision involves several goods, the guidance is extended to a vector of recommended maximum values:

$$\bar{p}^a = (\bar{p}_1^a, \dots, \bar{p}_N^a) \quad (18)$$

These values can be interpreted as guidance-based upper bounds in the allocation problem:

$$x_i^a \leq \bar{p}_i^a \quad (19)$$

In the multi-good case, the model searches for the feasible allocation that provides the highest attainable utility while respecting the individual's budget constraint, lower expenditure bounds, and recommended upper expenditure limits. This corresponds to the constrained optimisation problem implemented in the MATLAB code presented in the Appendix ⁰.

For participants, the guidance is presented in a simplified way. For a single good, participants may receive a message such as:

Given your current disposable income, the recommended maximum amount for this purchase is EUR 15.79. If the good costs more than this amount, you should consider a cheaper alternative, postpone the purchase, or choose a payment plan whose monthly instalment does not exceed this threshold.

For several goods, the guidance may take the form of a recommended allocation across expenditure categories, indicating which categories should be protected and which categories should absorb a larger share of the adjustment after the income shock.

After receiving this guidance, participants make a final allocation under the same reduced budget. This makes it possible to compare two post-shock decisions: one made without guidance and one made after guidance.

The design therefore allows three comparisons. First, it compares the baseline allocation with the spontaneous post-shock allocation. Second, it compares the spontaneous post-shock

⁰See the MATLAB code in the Appendix for the numerical implementation.

allocation with the guided allocation. Third, it compares both post-shock allocations with the benchmark allocation generated by the optimisation model.

A limitation of this design is that participants make decisions in a simplified setting. Real households face more complex constraints, emotional pressure, debt obligations, and uncertainty about the future. However, the simplified experimental environment is useful because it isolates the allocation problem and allows the role of guidance to be tested directly.

6 Measurement Strategy

The main empirical objective is to measure whether spending guidance changes the way participants reallocate expenditure after a negative income shock. Since the experimental task imposes a budget constraint, total expenditure is mechanically linked to available income. For this reason, the analysis focuses mainly on category-specific adjustment and on the distance between observed allocations and the benchmark allocation.

For each expenditure category i , the category-specific income elasticity of expenditure is defined as:

$$\eta_i = \frac{\% \Delta x_i}{\% \Delta Y} \quad (20)$$

where x_i is expenditure in category i and Y is disposable income. This measure shows how strongly each category responds to the income shock.

The analysis can compare elasticities across essential and discretionary categories. Essential categories are expected to be less responsive to the shock, while discretionary categories are expected to absorb a larger share of the adjustment.

A second outcome variable is the distance between the observed allocation and the benchmark allocation. For participant j in decision stage t , this distance can be written as:

$$D_{jt} = \|x_{jt} - x_{jt}^*\| \quad (21)$$

where x_{jt} is the observed allocation and x_{jt}^* is the benchmark allocation predicted by the optimisation model. A lower value of D_{jt} indicates that the participant's decision is closer to the model-implied allocation.

The effect of spending guidance can then be evaluated by comparing the distance before and after guidance:

$$\Delta D_j = D_{j, \text{after guidance}} - D_{j, \text{before guidance}} \quad (22)$$

If spending guidance improves adjustment, this difference should be negative:

$$\Delta D_j < 0 \tag{23}$$

This would mean that participants move closer to the benchmark allocation after receiving guidance.

The measurement strategy therefore focuses on three outcomes:

- changes in expenditure by category;
- differences between essential and discretionary categories;
- the distance between observed allocations and the benchmark allocation.

This approach is more informative than analysing total expenditure alone, because the main question is not only whether participants spend less after an income shock, but how they reorganise their spending under the new constraint.

7 Discussion

This section discusses the main interpretations of the proposed framework. First, the analysis focuses on the individual level, examining consumption adjustment after a negative income shock and the potential role of spending guidance in this process. Second, an aggregate interpretation is presented based on heterogeneity in income and expenditure patterns, establishing a conceptual bridge between the microeconomic analysis developed in the paper and broader macroeconomic implications.

7.1 Individual Interpretation

The proposed framework is built around a distinction between mechanical adjustment and compositional adjustment. Mechanical adjustment occurs when disposable income falls and total expenditure must decrease accordingly. Compositional adjustment concerns how individuals distribute this reduction across different expenditure categories. The second margin is the main focus of this paper.

This distinction is important because, in the experimental task, total expenditure is constrained by the available budget. If participants are required to allocate the full budget, total expenditure will necessarily move with income. The more informative question is therefore not whether expenditure falls, but whether participants reorganise expenditure in a way that is closer to the benchmark allocation implied by the model.

The guidance mechanism introduced in the experiment is designed to simplify this reallocation problem. For a single good, the guidance provides an affordability threshold that indicates the maximum recommended expenditure given the individual’s disposable income. For several goods, the guidance is extended to a constrained allocation problem in which expenditure must be distributed across categories while respecting the budget and category-specific bounds.

This approach is useful because negative income shocks create a particular behavioural difficulty. When income rises, individuals can expand consumption without abandoning previous habits. When income falls, they must reduce or reorganise existing expenditure patterns. This makes downward adjustment more likely to be affected by habits, routines, limited attention, and resistance to reducing established consumption levels.

The paper therefore does not treat spending guidance as a substitute for individual preferences. Instead, guidance is interpreted as a decision aid that translates the benchmark optimisation logic into a simpler rule. The central question is whether this rule helps participants move closer to the model-implied allocation after a negative income shock.

The framework also provides a way to measure incomplete adjustment directly. Rather than focusing only on total consumption, the analysis compares observed allocations with benchmark allocations. This makes it possible to evaluate whether guidance affects the composition of spending and whether it reduces the distance between actual choices and the model-implied reference allocation.

7.2 Aggregate Interpretation and Population Heterogeneity

Although the proposed framework is developed at the individual level, it can also be interpreted from a broader population perspective. The experiment and optimisation model focus on individual expenditure decisions, where each participant allocates a budget across multiple consumption categories after a negative income shock. For individual a , total expenditure can be written as:

$$C^a = \sum_{i=1}^N x_i^a \quad (24)$$

where x_i^a denotes expenditure in category i .

A central feature of the framework is that individuals differ in their disposable income. Rather than assuming a representative consumer, the population is characterised by a distribution of incomes:

$$Y^a \sim F(Y) \quad (25)$$

where $F(Y)$ denotes the income distribution in the population.

The spending guidance rule introduced in the experiment depends directly on disposable income. For expenditure category i , the affordability threshold of individual a is given by:

$$\bar{p}_i^a = p_i^{\min} \left(\frac{Y^a}{Y^{ref}} \right) \quad (26)$$

where $p_i^{\min}$ is a reference minimum expenditure level and Y^{ref} is a reference income level.

Since individuals differ in disposable income, the affordability threshold is not a single value but a distribution of recommended expenditure levels:

$$\{\bar{p}_i^1, \bar{p}_i^2, \dots, \bar{p}_i^A\} \quad (27)$$

Equivalently, the set of affordability thresholds can be described by a distribution $F(\bar{p}_i)$, which is induced by the underlying income distribution $F(Y)$.

Consequently, the same spending guidance rule may generate different expenditure recommendations across households. Changes in wage growth, income inequality, or labour market conditions may therefore alter the distribution of affordability thresholds even when the underlying guidance rule remains unchanged.

From an aggregate perspective, total consumption and disposable income can be written as:

$$C = \sum_{a=1}^A C^a \quad (28)$$

and

$$Y = \sum_{a=1}^A Y^a \quad (29)$$

respectively.

The present study does not attempt to estimate aggregate consumption directly, since the proposed experiment focuses on individual decision-making. However, if implemented using a representative sample of the target population, statistical inference could be used to characterise the distribution of consumption adjustment within the broader population. In this sense, the proposed approach offers a natural bridge between individual consumption decisions and broader macroeconomic questions concerning heterogeneous household behaviour and aggregate demand.

8 Limitations and Future Work

The proposed design has some limitations. The first limitation is that the experiment uses a simulated budgeting task. Real households face uncertainty, debt obligations, family responsibilities, emotional pressure, and institutional constraints that are difficult to reproduce in a laboratory setting. Participants in the experiment may therefore behave differently from households facing actual financial stress.

A second limitation is the simplified structure of expenditure categories. The experiment uses a limited number of categories, such as housing, food, transport, health, leisure, and other expenditures. This makes the task easier to understand and easier to analyse, but it does not capture the full complexity of real household budgets.

A third limitation concerns the distinction between essential and discretionary expenditure. Some categories are naturally more essential than others, but the distinction is not always fixed. For example, transport may be essential for one participant and more flexible for another. Future versions of the experiment could allow participants to classify categories according to their own circumstances.

Future work should implement the experiment and estimate whether spending guidance reduces the distance between observed post-shock allocations and the benchmark allocation. It would also be useful to examine whether the effect of guidance differs by income level, age, employment status, household size, or financial literacy.

Another possible extension would be to compare different types of guidance. One treatment could provide model-based guidance, while another could provide general financial advice or social-norm information. This would make it possible to identify whether the effect comes from the benchmark allocation itself or simply from receiving any form of advice.

A further extension would be to introduce repeated decisions. In real life, households rarely adjust consumption only once. They revise their decisions over time as they receive new information about income, prices, and future uncertainty. A repeated version of the experiment could therefore examine whether participants learn over time and whether guidance has persistent effects.

Future versions of the study could also vary the size of the income shock. Small income losses may be easier to absorb, while large shocks may require more substantial reallocation. Comparing different shock sizes would help identify whether guidance is more useful when the adjustment problem becomes more severe.

A more ambitious extension would be to analyse the aggregate implications of the proposed guidance mechanism. If spending guidance affects individual consumption decisions, it may also influence aggregate consumption and saving behaviour when adopted by a suffi-

ciently large number of households. Future work could explore this possibility by embedding the guidance rule into a heterogeneous-agent macroeconomic framework. This would allow simulations of how negative income shocks affect consumption, saving, and adjustment dynamics when households respond not only to prices and income, but also to model-based spending recommendations.

9 Concluding Remarks

This paper has proposed a framework for analysing how individuals may adjust consumption after negative disposable income shocks and how simple spending guidance could support this adjustment. The central argument is that downward consumption adjustment is not only a mechanical response to a tighter budget constraint. It may also be affected by habits, routines, limited attention, and resistance to reducing previously established consumption patterns.

The paper develops a benchmark optimisation model in which individuals allocate expenditure across heterogeneous goods subject to a budget constraint and category-specific lower and upper bounds. After a negative income shock, the model generates a new benchmark allocation. This benchmark is then used to design spending guidance that can be tested in an experimental economics setting.

The proposed experimental design compares three decisions: a baseline allocation before the income shock, a spontaneous allocation after the shock, and a guided allocation after participants receive spending guidance. This structure allows the study to examine whether participants move closer to the model-implied benchmark allocation after receiving guidance.

Since the experiment has not yet been conducted, the paper does not claim empirical results. Instead, it outlines a testable framework and identifies the main outcomes to be measured, including category-specific expenditure changes and the distance between observed allocations and the benchmark allocation.

The study has some limitations. A simulated budgeting task cannot fully reproduce the complexity of real household financial stress, where individuals may face debt obligations, uncertainty, social commitments, and emotional pressure. Nevertheless, the proposed design provides a controlled environment for studying downward consumption adjustment and the potential role of model-based spending guidance.

Future work should implement the experiment, estimate the effect of guidance on post-shock allocations, and examine whether this effect differs across expenditure categories and participant characteristics. In this sense, the paper should be understood as a theoretical and experimental proposal rather than as evidence of an already observed behavioural effect.

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A Illustrative MATLAB Implementation

A.1 Model Setup

```
%% =====  
% High-Dimensional Consumer Expenditure Optimisation  
% =====  
  
clear; clc;  
  
nGoods = 10;  
nAgents = 5;  
alpha = 0.001 * ones(1, nGoods);  
  
% ----- Agent 1 -----  
agents(1) = struct('B', 1000, ...  
    'm', [30 50 100 20 40 10 15 25 60 80], ...  
    'M', [200 150 700 100 120 50 60 80 150 300], ...  
    'd', [300 170 800 150 130 60 70 90 160 400], ...  
    'w', [1 1 1 1 1 1 1 1 1 1]);
```

A.2 Agents Specification

```
% ----- Agent 2 -----  
agents(2) = struct('B', 1500, ...  
    'm', [20 40 80 10 30 5 10 20 50 70], ...  
    'M', [250 180 750 120 140 60 70 90 160 320], ...  
    'd', [280 150 700 60 120 35 45 55 130 210], ...  
    'w', [1 1 1 1 1 1 1 1 1 1]);  
  
% ----- Agent 3 -----  
agents(3) = struct('B', 800, ...  
    'm', [25 45 90 15 35 8 12 22 55 75], ...  
    'M', [180 140 650 90 110 45 55 75 140 280], ...  
    'd', [250 110 650 40 90 30 40 50 110 180], ...  
    'w', [0.9 1 1.1 0.8 1 0.6 0.7 0.9 1 1]);  
  
% ----- Agent 4 -----
```

```

agents(4) = struct('B', 1200, ...
    'm', [35 55 110 25 45 12 18 28 65 85], ...
    'M', [220 160 720 110 130 55 65 85 155 310], ...
    'd', [310 130 780 55 110 45 55 65 125 205], ...
    'w', [1 1.1 1 0.9 0.95 0.55 0.65 0.75 1 1]);

% ----- Agent 5 -----
agents(5) = struct('B', 900, ...
    'm', [28 48 95 18 38 9 14 24 58 78], ...
    'M', [190 145 680 95 115 48 58 78 145 290], ...
    'd', [270 115 700 45 95 38 48 58 115 190], ...
    'w', [0.95 1 1 0.85 0.9 0.5 0.6 0.7 0.95 1]);

```

A.3 Optimisation Procedure

```

%% ----- Optimisation settings -----
options = optimoptions('fmincon', ...
    'Display', 'off', ...
    'Algorithm', 'sqp');

for a = 1:nAgents
    ag = agents(a);

    %% Initial point
    x0 = ag.d;
    x0 = max(min(x0, ag.M), ag.m);
    x0 = x0 * (ag.B / sum(x0));

    %% Equality constraint
    Aeq = ones(1, nGoods);
    beq = ag.B;

    %% Objective function
    % The objective is multiplied by -1 because fmincon minimises.
    obj = @(x) -sum(ag.w .* exp(-alpha .* (x - ag.d).^2));

```

A.4 Solution and Output

```
%% Solution
[x_opt, fval] = fmincon(obj, x0, [], [], Aeq, beq, ...
    ag.m, ag.M, [], options);

%% Output
U = -fval;
U_norm = U / sum(ag.w);

agents(a).x_opt = x_opt;
agents(a).U = U;
agents(a).U_norm = U_norm;

fprintf('\n--- Agent %d ---\n', a);
fprintf('Budget: %.0f\n', ag.B);
disp(x_opt);
fprintf('Total utility: %.4f\n', U);
fprintf('Normalised utility: %.3f\n', U_norm);
end
```

Data availability

Data sharing is not applicable to this research as no data were generated or analyzed.

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This article does not contain any studies with human participants performed by any of the authors.