

# **Short-term changes in financial situation have immediate mental health consequences: The Changing Cost of Living Study**

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## Abstract

Poverty is associated with mental health outcomes such as anxiety and depression, as well as other psychological variables such as steeper time discounting and greater risk aversion. However, less is known about whether short-term changes in financial circumstances are coupled to immediate psychological responses. We studied panels of adults in France (n = 232) and the UK (n = 240), who completed financial and psychological surveys every month for a year at a time of rapid change in the cost of living (September 2022-August 2023). We found the expected overall socioeconomic gradients in anxiety, depression and time discounting. In addition, monthly fluctuations in financial situation were associated with fluctuations in depression, anxiety and risk preference. Increases in essential costs, considered separately from fluctuations in income, had an immediate impact on depression. Social support, the instrumental and emotional assistance derivable from one's social network, buffered the effects of short-term financial fluctuations on depression and time discounting, but did not mitigate the overall gradients. We conclude that declines in income or increases in the cost of living have immediate and measurable mental health impacts, which must be borne in mind in the formulation and evaluation of public policy.

## Introduction

Poverty is associated with a number of important psychological variables. These include greater anxious and depressed mood (Gallo & Matthews, 1999; Kessler et al., 1994; Lorant et al., 2003; McMillan et al., 2010); steeper time discounting (the relative preference for smaller, sooner over larger, later rewards) (Green et al., 1996; Guillou et al., 2022; Haushofer & Fehr, 2014; Reimers et al., 2009); and reduced risk preference (the relative preference for actions whose payoff is more variable compared to less) (Donkers et al., 2001; Haushofer & Fehr, 2014). These associations have been documented for decades. The main difficulty has been disentangling three possible causal pathways. First, poverty may cause changes in the psychological variables (*causation*); second, the psychological variables may cause poverty (*reverse causation*); and finally, both poverty and the psychological variables may be influenced by some shared third variable, such as genetic predisposition, personality, or an early-life exposure (*third variable*). These pathways are not mutually exclusive and all may operate to different extents and over different timescales.

Since cross-sectional evidence is inconclusive, attention has recently turned to longitudinal studies, natural experiments such as policy changes and windfalls, and, especially, randomised control trials (Akanni et al., 2022; Boon-Falleur et al., 2022; Ridley et al., 2020; Thomson et al., 2022). The consensus from this newer evidence is that the causation pathway is important. For anxiety and depression, longitudinal studies suggest a dynamic relationship between income and symptoms (Akanni et al., 2022; Parra-Mujica et al., 2023), and randomised control trials show that exogenous improvements in income produce moderate and sustained improvements in symptoms (Ridley et al., 2020). Likewise, natural experimental evidence from wars, disasters, economic shocks and the pandemic shows that changes in circumstances can change time discounting and risk preference, though the direction of effects is inconsistent across studies (Boon-Falleur et al., 2022; Callen, 2015; Cassar et al., 2017; Hanaoka et al., 2018; Page et al., 2014).

As emphasized by Ridley et al. (Ridley et al., 2020), there are several mechanisms that could explain the causal effects of poverty and life circumstances on psychological variables. Most obviously, there are acute effects. For example, the immediate worry and uncertainty that comes from having to try, with difficulty, to make ends meet in a given month will contribute to anxious and depressive symptoms. Other effects may require a long-term accumulation of experience, possibly including experience in early life. More indirect mechanisms may also be important: for example, those with low incomes may have to live in areas with worse air pollution and more noise, or be more exposed to crime and violence, which in turn affect anxiety and depression. The time course of the change in psychological variables when one's financial situation changes is an indicator of which mechanisms are important. If the change is immediate, the acute worry and uncertainty likely dominates. If

the change only develops over many months or years, more indirect pathways, or long-term accumulation of experience, are likely to be critical.

This paper presents a novel approach to the psychological impact of poverty, in which we longitudinally studied short-term (i.e. month-to-month) fluctuations in both financial situation and psychological variables, in panels of adults from the UK and France. In particular, we repeatedly ascertained the ratio of people's monthly incomes to their essential monthly costs. The study was conducted in a period (September 2022 to August 2023) of high cost-of-living inflation, particularly in the price of energy. In September 2022, UK consumer price inflation stood at 10.1% (<https://www.statista.com/statistics/306648/inflation-rate-consumer-price-index-cpi-united-kingdom-uk/>), whilst the cap on household energy bills was due to rise by 80% in October 2022 <https://commonslibrary.parliament.uk/research-briefings/cbp-9491/>, albeit that this was in the event substantially mitigated by government action. France's inflation rate in 2022 was 5.9%. The impact of these cost of living challenges affected households differentially, and also in a way that was desynchronized over time, for example because mortgages or energy agreements had to be renewed in different months for different households.

We reasoned that if psychological variables such as anxiety and depression changed in real time as people's financial situations fluctuated, this must predominantly reflect the causation pathway. Reverse causation (poor mental health leading to reduced job market performance) is a long-term, cumulative process; people's career situation is unlikely to change much with a single month of worse mental health or greater impatience. Likewise, if the third variable pathway is dominant, we would not expect fluctuations in poverty to be coupled with psychological fluctuations.

A possible objection is that coupling of short-term fluctuations in financial situation to short-term fluctuations in psychological variables does not entirely rule out reverse causation. For example, an acute depressive episode could cause zero income for someone who is self-employed. We were able to address this limitation by separately examining monthly fluctuations in income from monthly fluctuations in essential costs. Whilst variations in income could plausibly be consequences of mental health status, variations in essential costs are driven by wider economic forces and are effectively exogenous shocks as far as psychological variables are concerned.

As well as zeroing in on the causation component of the poverty-psychology covariance, examining short-term fluctuations allows us to identify the part that is due to the acute challenge of making ends meet in the short term. The cumulative or indirect psychological benefits of greater affluence, such as being able to move to an area with less noise or air pollution, or change career, will not materialize with a single month of financial improvement. Thus, the response of psychological variables to a single month of improved financial situation provides a lower-bound estimate of the immediate psychological impact of trying to manage to get through that month.

A secondary research question for the present study concerned social support. Social support refers to actual or expected instrumental and emotional assistance coming from one's social network (Kocalevent et al., 2018). Social support is an independent predictor of health outcomes (House et al., 1988), including psychological health (Kawachi & Berkman, 2001). In many studies, it has also been found to help people buffer the impact of financial difficulties (Cohen & Wills, 1985; Domínguez & Watkins, 2003; Richards, 2016; Zangger, 2023). If social support plays a buffering role, we would expect the impact of fluctuations in financial situation to be moderated by the level of social support available.

Our research questions were, then, as follows. First, what is relationship between people's financial situations and their anxiety, depression, time discounting and risk preference? Using within-between modelling (Pol & Wright, 2009) on our longitudinal dataset, we disaggregated the cross-sectional association (are people whose financial situations are better overall also less depressed and more patient overall?) from the fluctuation question (do people become less depressed and more patient than they usually are, after a month where their financial situation was better than usual?). Second, can we find evidence that psychological variables fluctuate in response to fluctuations in income *and* fluctuations in essential costs, when these two components of financial situation are separated out? Third, does social support moderate the effects of fluctuations in financial situation, buffering people psychologically from bad months?

## Methods

### Ethics statement

The Changing Cost of Living study was approved by the Faculty of Medical Sciences Research Ethics committee, Newcastle University (application 2413/24908/2021).

### Panel

We recruited panels in France (n = 232) and the UK (n = 240) via online research participation platforms (France: crowpanel.io; UK: prolific.co). From September 2022, participants completed a survey at the beginning of each month reporting financial information relating to the previous month, plus current psychological measures. Participants completed an average of 10.07 of the 12 surveys each (sd 2.96). By the final month (August 2023), 216 and 156 of the original participants responded.

The panels were not nationally representative, and were somewhat skewed towards the low end of their respective national income distributions, especially in France. For the UK, we can compare our sample's distribution of monthly household incomes to data from the Institute for Fiscal Studies for the country as a whole ([https://ifs.org.uk/tools\\_and\\_resources/where\\_do\\_you\\_fit\\_in#tool-results-section](https://ifs.org.uk/tools_and_resources/where_do_you_fit_in#tool-results-section)). We applied the Institute for Fiscal Studies household-size equivalization formula to our panel for comparability. On this basis, the 25th percentile of our panel was at the 17th percentile nationally; our median was at the 38th percentile nationally; and our 75th percentile was at

62nd percentile nationally. For France, the available data necessitates comparing in a different way, using net income per adult in the household and comparing to figures for the 10th percentile, median and 90th percentile for 2019, from the Centre de l'Observation de la Societe (<https://www.observationsociete.fr/revenus/niveaux-salaires/>). Our 10th percentile was €719, compared to €1319 nationally; our median was €1549 compared to €1940 nationally; and our 90th percentile was €2185 compared to €3844 nationally.

## Measures

The full set of measures is described in the preregistered initial (<https://osf.io/x26mf>) and supplementary (<https://osf.io/rj683>) protocols of the study. Not all measures are analysed here.

*Demographic variables.* At the first time point, participants completed a number of demographic and socioeconomic variables. As well as age and sex, these included MacArthur ladder of subjective socioeconomic status (Adler et al., 2000). This measure asks participants to place their perceived status on a ladder of ten rungs representing the people in their society. They also completed a measure of subjective financial strain (overall, were they financially: living comfortably; doing alright; just about getting by; finding it quite difficult; or finding it very difficult).

*Income and costs.* Participants reported the amount of income received into their household in the reference month (i.e. net of taxes and including benefits). For costs, participants reported, for the reference month, the amounts paid out for rent/mortgage, water, residence-based taxes, and energy. We summed these to produce an estimate of unavoidable living costs. UK figures were converted to euros at a purchasing-power parity rate.

Income and cost variables were base-2 logged (adding €1 because of zeroes) to reduce positive skew. As well as examining income and costs separately, we computed the difference between logged income and logged costs. Since the difference in logs is the log of the ratio, this variable, which we henceforth refer to as the income-to-costs ratio (ITC), represents the proportional relationship of household income and unavoidable costs. Thus, an ITC of zero indicates that income just covered unavoidable costs; a value of 1 that income was twice unavoidable costs; and a value of 2 that income was four times unavoidable costs. Negative values (1.6% of cases) indicate failure of income to even cover unavoidable costs.

*Psychological variables.* We measured four psychological variables that have been related to socioeconomic position. For *anxiety* and *depression*, we employed widely used, clinically validated scales, the GAD-7 (Spitzer et al., 2006), and PHQ-8 (Kroenke et al., 2009). Cut-offs on these scales can be used to establish the presence of clinical disorder, but we here treat them as continuous variables. We measured *time preference* by a series of seven choices between hypothetical increasingly large, delayed cash amounts and a smaller, immediate amount. The variable is the number of immediate choices (0-7). For *risk preference*, participants made choices between a 50% chance of €800/£800, and a series of

increasingly large ‘for sure’ amounts. The variable is the number of choices for the gamble (0-7). These measures were adapted by Pepper et al. (Pepper et al., 2017) from Griskevicius et al. (Griskevicius et al., 2011).

*Social support.* From December 2022, we added the Oslo Social Support Scale (Kocalevent et al., 2018) to the monthly survey. The three items of the scale cover the number of social network members who can be turned to; the concern for the respondent that those network members show; and how easy it is to obtain practical assistance from those network members. The scale score (higher score equals higher support) can range from 3 to 14.

## **Analysis strategy**

Data were analysed using linear mixed models in R. We included random effects of participant, to account for the repeated responses of the same participants, and of country, to capture any country or translation differences in responses to the psychological variables. The variance attributed to country was negligible in all analyses. All models included age and gender as control variables, though these are not reported. GAD and PHQ scores were positively skewed and were square-root transformed for analysis, but are plotted on their original scales. Continuous variables were zero-centred to aid interpretation of coefficients in models including interaction terms, but retained un-centred for plotting.

For the main analyses, we decomposed the financial variables into their between-participant and within-participant components (Pol & Wright, 2009). The between-participant component is the person’s average value over the course of the study; we henceforth refer to this as their ‘overall’ income, cost, or ITC. The within-participant component is the deviation of the person’s income or cost from their own average in a given month; we henceforth refer to this as ‘income fluctuation’, ‘cost fluctuation’ or ‘ITC fluctuation’ (see Supporting Materials S1 for more information on the models). Thus, the decomposition allowed us to establish, for example, whether people who are worse off overall have more anxiety overall, separately from whether their anxiety goes up after a month when they have been worse off than usual. We first examined the ITC, which combines income and costs; and then income and costs separately. Since we reasoned that a loss of a given proportion of one’s incomes might have a stronger effect when one’s income is lower, we initially included an interaction term between overall ITC and ITC fluctuation. We subsequently examined possible moderation by social support. Since social support was only measured in eight months of the study, all analyses including social support are on the subset of the data starting with the reference month December 2022.

## **Data and code availability**

Data from the Changing Cost of Living study are available at: <https://osf.io/d9qb6/>. The R code underlying the analyses reported in this paper is available at: <https://osf.io/d3ryg/>.

## Results

### Demographics and descriptive statistics

Participant demographics are shown in table 1, and descriptive statistics of the main measures are shown in table 2.

Table 1. Demographic descriptives of sample

	France (N=232)	UK (N=240)	Overall (N=472)
Gender			
Woman	118 (50.9%)	123 (51.3%)	241 (51.1%)
Man	113 (48.7%)	116 (48.3%)	229 (48.5%)
Prefer not to say	1 (0.4%)	1 (0.4%)	2 (0.4%)
Age			
Mean (SD)	41.2 (8.45)	42.2 (12.3)	41.7 (10.6)
Missing	3 (1.3%)	0 (0%)	3 (0.6%)
Subjective SES (MacArthur ladder)			
Mean (SD)	5.92 (1.73)	5.33 (1.90)	5.62 (1.84)
Financial strain			
Finding it very difficult	12 (5.2%)	10 (4.2%)	22 (4.7%)
Finding it quite difficult	26 (11.2%)	22 (9.2%)	48 (10.2%)
Just about getting by	75 (32.3%)	51 (21.3%)	126 (26.7%)
Doing alright	97 (41.8%)	112 (46.7%)	209 (44.3%)
Living comfortably	22 (9.5%)	40 (16.7%)	62 (13.1%)
Missing	0 (0%)	5 (2.1%)	5 (1.1%)

Ns in this table represent numbers of participants. Variables are as reported in the first month of the study.

Table 2. Descriptive statistics of main study measures.

	France (N=2238)	UK (N=2644)	Overall (N=4882)
Income (€)			
Mean (SD)	3220 (2010)	3620 (2300)	3440 (2180)
Missing	5 (0.2%)	3 (0.1%)	8 (0.2%)
Costs (€)			
Mean (SD)	1170 (884)	1080 (639)	1120 (762)
Missing	26 (1.2%)	15 (0.6%)	41 (0.8%)
Income-to-costs (ITC)			
Mean (SD)	1.55 (1.05)	1.73 (1.12)	1.65 (1.09)
Missing	31 (1.4%)	18 (0.7%)	49 (1.0%)
Anxiety (GAD)			
Mean (SD)	5.72 (4.86)	5.33 (5.76)	5.50 (5.37)
Missing	27 (1.2%)	9 (0.3%)	36 (0.7%)
Depression (PHQ)			
Mean (SD)	6.25 (4.81)	5.81 (6.13)	6.01 (5.57)
Missing	18 (0.8%)	11 (0.4%)	29 (0.6%)
Time discounting			
Mean (SD)	3.30 (2.26)	3.05 (2.20)	3.17 (2.23)
Missing	29 (1.3%)	16 (0.6%)	45 (0.9%)
Risk preference			
Mean (SD)	2.44 (1.68)	2.20 (1.52)	2.31 (1.60)
Missing	30 (1.3%)	17 (0.6%)	47 (1.0%)

Ns in this table represent number of reports (i.e. up to 12 per participant).

We also calculated repeatabilities (Intra-Class Correlation Coefficients or ICCs). The ICC is a measure of the extent to which the values of individual participants are consistent from month to month. An ICC of 1 would indicate that a given participant had the same value in every month, whilst an ICC of 0 would indicate that individuals varied from month to month as much as they differed from one another in a given month. For the financial variables, ICC were moderate (values and 95% CI: income: 0.59 (0.55 - 0.63); costs: 0.79 (0.77 - 0.81); ITC: 0.57 (0.53 - 0.6)). For the psychological variables, the ICCs were somewhat higher, with the exception of risk preference (anxiety: 0.79 (0.77 - 0.81); depression: 0.8 (0.78 - 0.82); time discounting: 0.73 (0.7 - 0.75); risk preference: 0.49 (0.45 - 0.52). The ICC for social support was 0.81 (0.79 - 0.83).

### **Income-to-costs and psychological variables**

For anxiety and depression, we found significant and negative associations both with overall ITC, and ITC fluctuation (table 3). That is, people who on average had worse ITCs were on average more anxious and depressed, and in months where people had worse ITCs than usual, they were more depressed and anxious than usual. The interaction terms were not significant: that is, the models did not support the hypothesis that a proportionate fluctuation in ITC would have a stronger effect on people with a lower overall ITC. The within-participant associations were around one quarter the strength of the between-participant associations. That is, taking a population of people all of whom had the median ITC, and subjecting them to an income shock where they moved to the average ITC positions of our participants for a single month, would produce a gradient in anxiety and depression, but a substantially weaker one than the between-participant gradient we observed.

For time discounting, there was only an overall association: people who on average had worse ITCs were more on average present-oriented; but their present-orientation did not significantly increase in months when their ITC was worse than usual. For risk preferences, there was an interaction between overall ITC and ITC fluctuation: worse than usual months made people more risk averse, and better than usual months made them more risk prone, but this was only true of people with lower overall ITCs.

Figure 1 visualizes the associations by showing the predicted values of the psychological variables for individuals whose overall incomes were different multiples of their overall essential costs, in a typical month, a month where the situation was twice as bad as usual, and a month where the situation was half as bad as usual.

Table 3. Output of models predicting the four psychological variables from overall income-to-costs ratio, income-to-costs ratio fluctuation, and their interaction.

Predictor	Anxiety	Depression	Time discounting	Risk preference
Overall ITC	-0.21 (0.07)**	-0.23 (0.07)***	-0.58 (0.12)***	0.08 (0.07)
ITC fluctuation	-0.06 (0.01)***	-0.06 (0.01)***	-0.03 (0.03)	0.05 (0.02)*
Interaction	0.012 (0.011)	0.018 (0.011)	-0.0017 (0.022)	-0.045 (0.022)*

Values are coefficients with their standard errors in parenthesis. +  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

## Decomposing variation in income and variation in costs

In a subsequent round of models, rather than computing the ITC, we entered the person's (logged) income and their (logged) costs as separate predictors, each separated into its overall level and its fluctuations. We did not include interactions between the components, as the interactions were not significant in the ITC analysis. Note that since both income and costs are entered as predictors into this model, the coefficients are to be interpreted as the marginal impact of one of the variables whilst controlling for the other. For example, the cost fluctuation coefficient is the marginal impact of one's household costs going up without household income changing, and the income fluctuation coefficient is the marginal effect of one's income going up without any increase in costs.

Table 4 shows the results. For depression and anxiety, there were significant negative associations with income (higher incomes associated with lower scores), both for the overall income and the fluctuation. For costs, there were positive associations between overall costs and the variables (significant for both outcomes), and also between costs fluctuations and the outcomes (significant for anxiety, marginally non-significant for depression). For time preference, the overall coefficients of both income and costs were significantly different from zero, but the fluctuation coefficients were not. For risk preference, the decomposition revealed a significant but weak overall gradient for income (higher income, higher risk preference), and a negative fluctuation association for costs (lower risk preference in months where costs were higher).

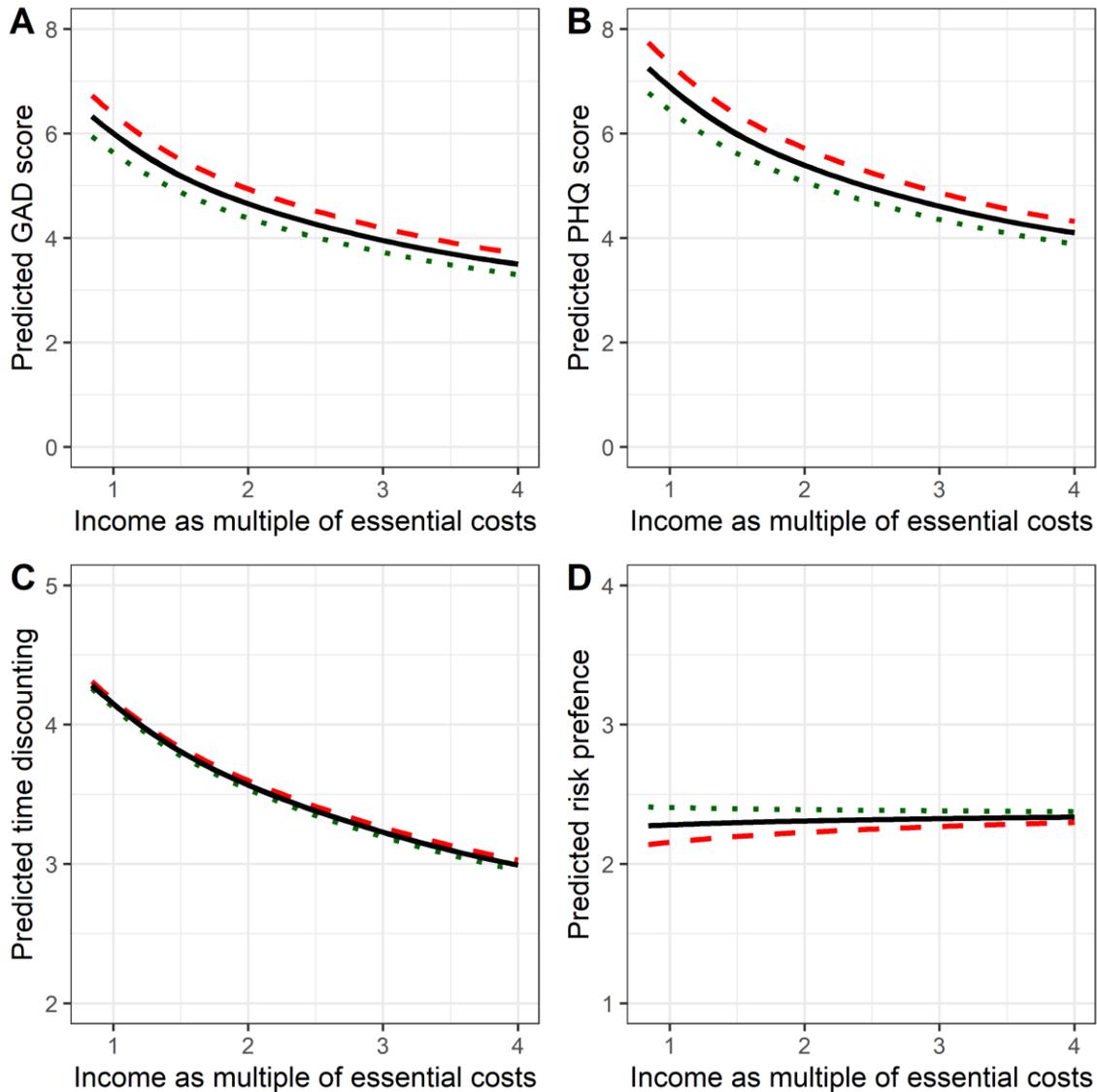


Figure 1. Predicted values of psychological variables for people with different multiples of overall income to overall essential costs, in a typical month (black solid line), a line where the multiple was twice its usual value (dotted green line), and a month where the multiple was half its usual value (red dashed line). A. Anxiety (GAD). B. Depression (PHQ). C. Time discounting. D. Risk preference.

Table 4. Output of models predicting the four psychological variables from income and costs (overall and fluctuation) separately.

Predictor	Anxiety	Depression	Time discounting	Risk preference
Overall income	-0.28 (0.08)***	-0.33 (0.08)***	-0.73 (0.14)***	0.2 (0.09)*
Income fluctuation	-0.06 (0.02)***	-0.07 (0.02)***	-0.04 (0.03)	0.02 (0.03)
Overall costs	0.17 (0.08)*	0.17 (0.07)*	0.48 (0.13)***	0 (0.08)
Costs fluctuation	0.05 (0.02)*	0.03 (0.02)+	0.01 (0.04)	-0.08 (0.04)*

Values are coefficients with their standard errors in parenthesis. +  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

### The moderating role of social support

To investigate whether social support could moderate the impacts of financial insufficiency and fluctuations on psychological variables, we used the subset of data for which social support values were available. To constrain model complexity, we used the ITC variable for these analyses rather than the separate income and costs variables. We added social support in interaction with overall ITC, and ITC fluctuation, to models predicting each of the four psychological variables. Results are shown in table 5.

Table 5. Output of models predicting the four psychological variables from income-to-cost ratio (overall and fluctuation) and social support. Models use only the final eight months of data.

Predictor	Anxiety	Depression	Time discounting	Risk preference
Overall ITC	-0.2 (0.07)**	-0.22 (0.07)**	-0.45 (0.12)***	0.11 (0.08)
ITC fluctuation	-0.03 (0.02)	-0.01 (0.02)	-0.04 (0.03)	0.04 (0.04)
Social support	-0.07 (0.01)***	-0.07 (0.01)***	-0.07 (0.02)***	0.01 (0.02)
Social support * Overall	0 (0.01)	0 (0.01)	0.02 (0.02)	-0.01 (0.02)
Social support * Fluctuation	0.01 (0.01)+	0.02 (0.01)**	0.02 (0.01)*	0 (0.01)

Values are coefficients with their standard errors in parenthesis. +  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

Social support had independent main effects on anxiety, depression and time discounting (higher social support associated with lower anxiety, depression and discounting). In addition, for depression and time discounting, there was a significant interaction between social support and ITC fluctuations. There were no significant interactions between social support and overall ITC. Figure 2 visualizes the interaction between social support and ITC fluctuations for depression and time discounting. As the figure shows, increasing depression and time discounting in financially worse than usual months were restricted to the low social support group; in those with moderate or strong social support, these effects were completely abolished. Overall social support (people’s average social support over the eight months of responses) was weakly positively correlated with their overall ITC ( $r = 0.19$ ,  $p < 0.001$ ).

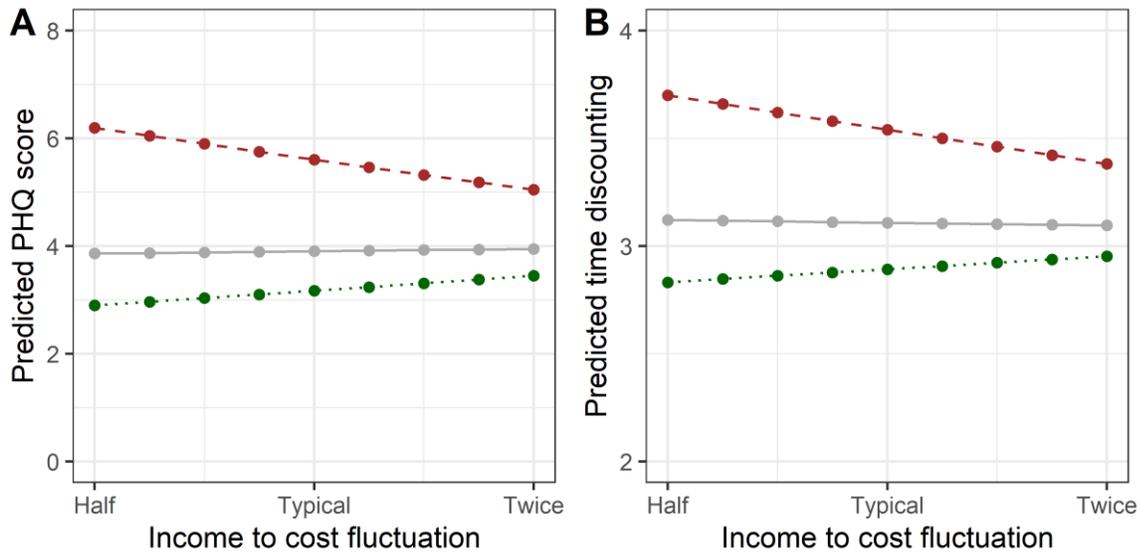


Figure 2. A. Predicted depression (PHQ score) as ITC fluctuates from worse than average (half the value of a typical month), to better than average (twice the value of a typical month), for individuals with strong (dotted green line), moderate (solid grey line) and poor (dashed brown line) social support, as defined by the Oslo Social Support scale. B. As panel A, but for time discounting.

## Discussion

In panels of adults from the UK and France, during a year where the cost of living was changing rapidly, we measured people's financial situation every month, along with their anxiety, depression, time discounting and risk preference. For anxiety, depression and time discounting, we found very clear socioeconomic gradients: people whose average financial situations over the year were worse were more anxious, depressed and impatient. We also found that fluctuations in anxiety and depression were coupled with fluctuations in financial situation: after a month with a worse-than-usual income-to-cost ratio, people were measurably more anxious and depressed than usual. Decomposing the income-to-cost ratio, we found, for anxiety at least, that it responded not just to changes in monthly income, but also to changes in monthly essential outgoings (housing, local taxation, water and energy). Finally, we found evidence that, for depression and time discounting, social support can buffer individuals from the immediate consequences of fluctuations in their financial position.

The findings lend support to the consensus that the associations between poverty and anxiety and depression are at least partly causal, rather than due to reverse causality or shared third variables (Akanni et al., 2022; Parra-Mujica et al., 2023; Ridley et al., 2020; Thomson et al., 2022). If shared determinants were fully responsible, the financial and psychological variables would not be coupled over short timescales. Reverse causality would predict a coupling in the long term, but downward income drift due to psychological illness is likely to be a slow process, and so there would not necessarily be coupling from month to month. The essential costs analysis in particular is hard to square with reverse causality: whilst variation in monthly income could, in some cases, be driven by variation in psychological state, variation in the cost of living is much less likely to be.

The impacts of fluctuations in financial situation were weaker than the overall gradients. Comparing coefficients, the predicted effect of a given within-person fluctuation in income-to-cost ratio is around one quarter the predicted effect of having had always that income-to-cost ratio. In other words, if we took a sample of people all of whom had the median income-to-cost ratio and shocked them, for a single month, to the average financial positions of our panels, we would generate a socioeconomic gradient, but only around one quarter as steep as the one we actually observed. There are several plausible reasons for this. First, the between-participant socioeconomic gradient reflects the sum of all three pathways (causation, reverse causation, and third variables), whereas the short-term coupling reflects predominantly the first of these. Second, the causation pathway itself is mediated by multiple mechanisms over multiple timescales, from immediate worry and stress to long-term exposure to bad air quality, noise or housing through lack of financial choice (Ridley et al., 2020). After a single month of worse-than-usual finances, we are probably picking up only the acute change in worry and stress, and not any longer term psychological costs of poverty. Third, the challenges of acute poverty are cumulative: people may well be able to cope with an exceptionally bad month (especially with help from social partners), but not an exceptionally bad year. In the light of all this, it is perhaps

striking that the association between monthly variation in finances and monthly variation in anxiety and depression is even one quarter of the strength of the overall socioeconomic gradient.

The effect of social support in buffering the impact of financial fluctuations on depression was in line with previous findings (Richards, 2016), though in our case it was not significant for anxiety. Interestingly, social support did not buffer the effects of overall financial hardship on depression and time discounting, only the fluctuations. In other words, even strong social support cannot mitigate the psychological effects of long-term poverty, though it can protect from bad individual months. Social support also had strong independent main effects on anxiety, depression and time preference. Moreover, it was itself socioeconomically distributed, with higher support amongst those who were better off overall. Thus, people in poverty in these populations face a double disadvantage: not only do they endure the direct effects of poverty on their psychological states, but they are also likely to enjoy less social support, which in turn has psychological consequences.

Socioeconomic gradients in risk preference were weak. In the analysis separating income from cost, we found that people with higher incomes preferred slightly more risk, which is consistent with previous findings (Donkers et al., 2001), and also that people became somewhat more risk averse after a month in which their costs had been higher than usual. Both theoretical models (Courson & Nettle, 2021) and some empirical evidence (Barsky et al., 1997) suggest that there might be U-shaped relationships between financial situation and risk preference, with greater risk-taking at the low extremes of financial situation. Such non-linearities would not have been detected by our linear models. We plan to explore non-linear effects in future work.

The novelty of our study is three-fold. First, though there has been extensive previous longitudinal research on financial situation and anxiety and depression, it has typically measured the outcomes less often, for example yearly (see (Thomson et al., 2022) for review). Though the overall conclusions are similar (that there are within-person effects, typically weaker than the between-person gradient), our study uniquely shows that financial variables and anxiety and depression are coupled over short time scales, to an extent that is likely to be important at the level of population health, for example in times of inflation or recession. Demonstrating short-term coupling, uniquely, identifies the immediate acute effect of stress and worry over making ends meet, as distinct from other, more gradual mechanisms by which a worse financial situation can affect psychological health (Ridley et al., 2020). Second, our study was unusual in including measures of time preference and risk taking. Although socioeconomic gradients in those variables have often been documented (Donkers et al., 2001; Green et al., 1996; Guillou et al., 2022; Reimers et al., 2009), the studies have generally been cross-sectional, or before-after studies of one-off shocks (Boon-Falleur et al., 2022; Callen, 2015; Cassar et al., 2017; Hanaoka et al., 2018; Page et al., 2014), rather than examining ongoing fluctuations over time. Finally, our study was unusual in being able to disaggregate the component of financial hardship which is due to changes in incomes from that which is due to changes in costs. Since the psychologically

important variable is 'liveability' (having the resources to do valued activities) (Calafati et al., 2023), both of these two components should be important. Our analysis confirms that, at least for depression, they are.

Our study also had important limitations. The panels from the two countries were not nationally representative. In both cases, the panels predominantly consisted of 25-45s, with no representation of younger adults and little representation of people of retirement age. The panels were concentrated towards the lower end of the income distribution, especially in France. They contained sufficient socioeconomic variation, both between people and over time, to find significant associations with psychological variables. Given that our main substantive conclusions concern the within-person fluctuations, the non-representativeness is not a serious methodological issue, but these data should not be used to estimate likely population health effects of changes in incomes or the cost of living.

For the financial variables, we relied on online survey-completion. Moreover, our measurement of essential costs did not include food. Thus, it differs from the way Calafati et al. (Calafati et al., 2023) measure residual income, which they define to be the leftover after housing, energy, water, local taxes and food. As food price inflation was high over the study period, food expenditures would have been useful to include, but we did not include them to minimize participant burden.

We also treated the anxiety (GAD) and depression (PHQ) scores as continuous variables. These scales show considerable variation within the non-clinical population, and an increase of 1 or 2 points does not necessarily qualify as a change in clinical state. However, both scales are widely employed with cut-offs (a score of 10 in both cases) to establish likely clinical illness. A score of 10+ on the PHQ is considered equivalent to a categorical diagnosis of Major Depressive Disorder (Kroenke et al., 2009). Although the associations with economic fluctuations are modest in size, any change in the distribution of the continuous scores is bound to push some people into the zone of clinical illness. For example, the difference in predicted PHQ score between a 'worse than usual' month and a 'better than usual' month as shown in figure 1 is around one point. Adding one point to the first-month PHQ scores of everyone in the sample would send the implied rate of Major Depressive Disorder in the cohort from 22.7% to 27.3%. This is a substantial change, and makes our evidence for economic influences very similar to the evidence used to argue for the effectiveness of anti-depressant medications. These too produce rather small advantages over placebo on change in continuous symptom rating scales, that only constitute a change in categorical diagnostic status for a small sub-group of individuals (Moncrieff & Kirsch, 2015).

Despite these limitations, our findings strongly suggest that people's financial situations have not only chronic but acute psychological effects. They bolster the view that anxiety and depression, rather than being best viewed as decontextualised brain disorders, represent, to a considerable degree, comprehensible responses to life circumstances (Read & Moncrieff, 2022). The critical life circumstances are in turn influenced by the socioeconomic

environment, and hence fall within the scope of public policy. For policymakers, it is important to understand that economic changes such as inflation and downward pressure on incomes will have immediate psychological and behavioural consequences. This is an argument for policies that protect people from such shocks. Policies that undermine people's non-committed income, such as welfare state retrenchment, will have measurable impacts on expenditure elsewhere, for example in the cost of treating mental illness and distress. The UK's universal credit system, for example, by introducing retrospective payment and an initial lead time, produced measurable increases in anxiety and depression (Wickham et al., 2020). The costs of mitigating such negative consequences are not routinely factored into projections of financial savings from such policies. Conversely, interventions such as minimum income guarantee and Universal Basic Income, which would protect people from even short term inadequacies in their financial position, can be justified and evaluated not just on the basis of fairness or economic efficiency, but also on the grounds of their positive effects on population mental health (Chen et al., 2023; Johnson et al., 2020; Parra-Mujica et al., 2023).

### **Conflict of interests statement**

The authors have no conflicting interests to declare.

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# Within-between regression models for the longitudinal cost of living study

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## 1 Income to cost ratio

We define the income to cost ratio of individual  $p$  in month  $m$  as:

$$ITC_{p,m} = \log_2(i_{p,m} + 1) - \log_2(c_{p,m} + 1) \quad (1)$$

- where  $i$  is their income and  $c$  is their outgoings on essential costs.

To create a within-between model in which the participant's overall ITC over the study is measured orthogonally to their ITC fluctuation in a given month, we defined the between-person component of ITC as:

$$ITCB_p = \log_2(\bar{i}_p + 1) - \log_2(\bar{c}_p + 1) \quad (2)$$

- where  $\bar{i}_p$  and  $\bar{c}_p$  represent the each participant's mean income and costs respectively over the 12 months of the study.

The within-person component for each month is then defined as:

$$ITCW_{p,m} = \log_2(i_{p,m} + 1) - \log_2(c_{p,m} + 1) - [\log_2(\bar{i}_p + 1) - \log_2(\bar{c}_p + 1)] \quad (3)$$

For the main analyses,  $ITCB$  and  $ITCW$ , whose inter-correlation is approximately zero, are entered as independent predictors of the psychological variables along with age, sex, and random intercepts for participant and country.

## 2 Decomposing income and costs

In the analyses in which income and costs were decomposed rather than treated as a single ratio, we defined the between-person averages for income and costs:

$$ib_p = \log_2(\bar{i}_p + 1) \quad (4)$$

$$cb_p = \log_2(\bar{c}_p + 1) \quad (5)$$

And the within-person components:

$$iw_{p,m} = \log_2(i_{p,m} + 1) - \log_2(\bar{i}_p + 1) \quad (6)$$

$$cw_{p,m} = \log_2(c_{p,m} + 1) - \log_2(\bar{c}_p + 1) \quad (7)$$

The predictors in the models are thus  $ib$ ,  $iw$ ,  $cb$ ,  $cw$ , plus age, sex, and random intercepts for participant and country.