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The well-being cost of inflation inequalities

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Abstract
In terms of well-being, how costly is inflation? To answer this question, empirical evaluations have typically studied average inflation rates at the national level, thus disregarding the role of inflation inequalities within a country. In this paper, we relax the assumptions that heterogeneous consumers face homogeneous inflation rates, and study the correlation between price changes and self-reported satisfaction with living standards. We use newly available data from France, and adopt two approaches. First, we focus on in-dividually perceived inflation and use the internationally harmonized Opinion Price Index as a proxy for experienced inflation. Variations in perceived inflation help predict well-being differences among consumers, even when controlling for relevant socio-demographic factors, personality traits and common method variance. We estimate their marginal impact to be higher than equivalent variations in nominal income. Second, we compare groups of consumers over time, and find that changes in the price of a good disproportionately affect the relative well-being of those who consume it. The study shows that the well-being cost of the inflation crisis would be underestimated if looking at aggregate figures only.

Key words: inflation inequality, heterogeneous inflation, subjective well-being, standard of living, perceived inflation, opinion price index
JEL: E31; I31; D63

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1. Introduction

The importance that consumers attach to price variations cannot be overstated. For a long time, inflation has been one of the main social concerns in Western countries (Shiller, 1997). In a large 1996 survey by the International Social Survey Program, over 40% of the 30,000 respondents declared that they prefer the government keeps inflation down rather than unemployment (Jayadev, 2006). Today, this fear is back. In 2022, the Euro area, which has never experienced major inflationary periods since its creation, registered record levels of inflation: in June 2022, consumer prices have increased by 8.6% over one year. A year earlier, the rate was below 2% (Eurostat, 2022).

In this context, it is crucial for public authorities to understand the degree to which inflation harms citizens' well-being. Typically, previous empirical evaluations have relied on average inflation rates at the national level, measured via the the Consumer Price Index (CPI).[1] Despite its merits, the CPI is an aggregate macroeconomic index, which disregards to what extent different consumers experience different inflation rates within that same country. These differences can be important. Indeed, the composition of the basket of goods varies from one consumer to the other and so do product price indexes, which depend on the geographical location, on purchasing platforms (internet, superstore, local shops, etc.) and on several other factors that are generally uncorrelated with observables (Kaplan and Schulhofer-Wohl, 2017). By way of illustration, in France in September 2019, a €1,400 monthly earner who smokes three packs of cigarettes per week has faced an annual inflation rate double that of a non-smoker, all other things being equal.[2] Whether a consumer owns a car (or not) or rents their apartment (or not) can generate situations with even greater contrast.

In a nutshell, over the same period and in the same country, different people experience different inflation rates. Here, we study how this heterogeneity helps explain the distribution of well-being in France between 2016 and 2022. For the empirical analysis, we exploit some newly available survey data, representative of the French population. The data set is a longitudinal cross-section from more than 40,000 individuals, collected by the National Statistical Office (INSEE) and the CEPREMAP Well-Being Observatory.

In order to measure well-being, we use *material satisfaction*, intended as self-reported satisfaction with personal living standards. In spite of being declarative measures, data on subjective well-being have been shown to be statistically reliable (OECD, 2013, chap. 1) and to correlate with both physiological (Sandvik et al., 2009) and neurological body responses (Urry et al., 2004).

In order to measure heterogeneous inflation (i.e., inflation inequalities) we adopt two approaches. First,

[1] This index allows the average prices that the representative consumer faces to be estimated for a given period. Year-to-year changes of the index thus reflect year-to-year changes in the average prices. In its simplest form, it is calculated as a weighted sum of the inflation rates of a representative basket of items, where the weights represent the relative importance of each item with respect to the overall consumption expenditure.

[2] Computed via the INSEE inflation simulator at <https://www.insee.fr/fr/statistiques/2418131> [11/09/19].

we use the individual level of inflation reported by consumers themselves. Second, we infer the inflation rates experienced by different groups of consumers, based on their consumption habits and the price index of a specific good. The two approaches are complementary in their strengths and weaknesses.

The first approach uses the Opinion Price Index (OPI), an internationally harmonised monthly index that is built from surveys asking people by how much prices have changed over the last twelve months. The OPI measures what is known as *perceived inflation*. Perceived inflation has been shown to be based on actual individual differences in experienced price changes (Brachinger, 2008; Jungermann et al., 2007), and can thus provide a useful indicator of inflation heterogeneity. The reason for using self-reported information rather than observed information is purely operational: the monthly OPI is available at the individual level, while the CPI is not. Evolutions of aggregate OPI correlate at 78% with the CPI in France (see tab.2a) and above 0.6 in every European country (Arioli et al., 2017). Opinions on inflation predict observable consumption behaviors both in the lab (Armantier et al., 2015) and in the field (Allcott, 2013; Shaffer, 2018). Some people experience higher inflation rates than others, and asking them how much prices have changed seems a natural way to learn about these differences.

However, perceived inflation is also a noisy measure. Inflation is a complex construct, and we would expect perceived inflation to be only an approximation of the actual inflation rate people experienced. The level of accuracy can vary greatly, and data requires a specific treatment for outliers. For this, we follow the recommendations of Arioli et al. (2017)'s European Central Bank report. Moreover, both material satisfaction and perceived inflation are self-reported variables, thus raising obvious concerns of omitted variable bias and reverse causality. We address the first by introducing a rich set of subjective variables in our regressions, which control for declarative biases in subjective well-being reports and idiosyncratic personality traits (optimism / pessimism). The set of controls is intended to capture the time-invariant component of the error term and single out the relationship between individual inflation and well-being. To address concerns of reverse causality, we move on to the second approach.

The second approach uses differences in the consumption baskets of groups of consumers to infer differences in the inflation they experience. Price variations of some goods can significantly affect some consumers, while they do not affect those who do not consume such goods. Thus, if we categorize people according to their consumption habits, we can infer the relative difference in inflation rates between the two groups. We investigate different reactions to variations in the gasoline price index and in the housing price index, which disproportionately affected the part of the population that regularly commutes by motor vehicles and that rent their accommodation, respectively. This estimation has the advantage of being based on reliable information about prices, that are tracked accurately by the French National Statistical Office (INSEE).

This second approach has its own limit though. The estimation is conducted under the simplifying assumption that all consumers in a certain group have the same consumption basket and face the same price

changes, thus neglecting within-group heterogeneity. Moreover, at this aggregate level, the small amount of data points do not allow a sharp identification of the effect size.

Overall, we document three results. First, perceived inflation is a robust predictor of material satisfaction, beyond aggregate time effects and net of general optimism and common method variance. Second, the net effect of variations in perceived inflation is higher than equivalent variations in nominal income. Third, following accelerations in the gasoline price index in 2018, material satisfaction appears to be significantly lower among people who are affected by the shock, despite a context of general price stability. Similarly, tenants' satisfaction deteriorates when housing price accelerates, but the gap does not reach conventional significance levels. These findings show that inflation inequalities matter, and information on non-aggregate measures of inflation can improve the understanding of the economic determinants of well-being within a population.

This study is the first attempt to empirically evaluate the relationship between disaggregate inflation rates and citizens' well-being within the same country. Most well-being evaluations from longitudinal data have used the CPI as a deflator, but this procedure assumes that all consumers face the same level of inflation, thus ignoring asymmetric non-aggregate effects. In the early 2000s, a few studies used between-countries and between-time variations to estimate the average effect of aggregate inflation on life satisfaction (see Dolan et al., 2008, chap. 3.7.3, for a short review). However, this small strand of literature is silent about the effect of heterogeneous inflation rates within the same country. The sole exception is Boes et al. (2007), which exploits regional price variations in Germany, and documents the marginal effect of inflation on financial satisfaction to be statistically relevant, and its point estimate to be over and above the marginal effect of nominal income. Our results are consistent with theirs.

Until recently, the present study would have not been possible. Among the wide national and international surveys asking people to report on their satisfaction, none ask respondents about their estimate of inflation. In the internationally-harmonized consumer surveys, subjective well-being is not measured. A fortunate new exception is France. Since June 2016, the French monthly Consumer Confidence Survey includes a quarterly Well-being module, which measures subjective well-being in its various aspects. The module offers a unique opportunity for monitoring the population's well-being regularly, and paves the way for further empirical analysis of its economic determinants. This study takes that path.

This study focuses on material satisfaction, i.e. satisfaction with living standards, while much of the happiness literature focuses on life satisfaction, i.e. an overarching measure of satisfaction with life. There is an ongoing debate on whether life satisfaction should (Frijters et al., 2020) or should not (Singh and Alexandrova, 2020) be a single subjective indicator of well-being for policy making. Yet, there seems to be some consensus that measures of satisfaction with a particular aspect of life can be more adapted to some policy and research questions (Dolan and White, 2007; OECD, 2013, p.168). We think that the relationship

between inflation and subjective well-being is one of these questions. First, because material satisfaction has a lot to do with public policies, especially in the context of inflation, while life satisfaction is more exposed to personal factors which are beyond the government's reach. Second, because, in practice, most policy indexes for quality-of-life measurement are multidimensional, and material well-being (objective and/or subjective) is systematically included among these domains (e.g. the Italian BES, the OECD Better Life Index). Herein, we will use the terms "material satisfaction" or, simply, "well-being" interchangeably.

We organize the paper as follows. In Section 2, we start by discussing methods and results from the previous literature, and we justify the use of subjective well-being and perceived inflation as meaningful constructs to answer our research question. In Sections 3 and 4, we move on to describing the main data set, the summary statistics and the results from the regression analysis. Section 5 builds two new data sets to study how the well-being of car commuters and tenants reacted to trends in gasoline and housing prices. Section 6 discusses the set of assumptions which would allow the mapping of perceived inflation effects into actual inflation effects. Section 7 concludes.

2. Related literature

2.1. Official inflation and subjective well-being

Economists evaluate the desirability and effectiveness of public policies according to their impact on the well-being of the population. This welfarist approach is built on the premise that well-being can be measured quantitatively, but leaves the question of *how* to measure it unanswered. Over the last two decades, academics and policy makers have paid increasing attention to some declarative measures of well-being, known as subjective well-being (for an overview, see Clark 2018; for the most recent United Nations report, see Helliwell et al. 2022). Subjective well-being measures rely mostly on interviews where respondents answer some simple intuitive questions, and report their answers on an ordered scale. In a typical regression analysis, researchers study how variations in economic variables predict variations in subjective well-being.

Starting from the seminal study by Richard Easterlin (1974), the relationship between income and subjective well-being has sparked much interest among economists. Such interest is not surprising, as income is considered the typical argument of the utility function and, insofar as subjective well-being reports are assumed to correspond to a utility metric, income should be its central economic determinant. Nevertheless, the canonical utility function contains a second argument which has received less attention in the well-being literature: price level.

Most papers take inflation into account *implicitly*, by deflating income measures or using time dummies. These solutions assume that every consumer faces the same inflation rate. This is a reasonable simplification when estimating income effects, but it prevents studying inflation effects as a source of inequality. The papers that have included inflation *explicitly* in the subjective well-being equation are relatively few and limited

to a macroeconomic perspective. Di Tella et al. (2001) are the first to document a negative relationship between inflation and life satisfaction across countries and over time. They adopt a two-step estimation strategy, where they estimate residual satisfaction conditional on individual characteristics and then use national aggregate unexplained satisfaction as the dependent variable of their macroeconomic model. The negative effect of inflation has been confirmed using Eurobarometer data in Europe (Di Tella et al., 2001, 2003; Wolfers, 2003; Alesina et al., 2004; Becchetti et al., 2010; Blanchflower et al., 2014), Latinobarometro data in Latin America (Graham and Pettinato, 2001) and the General Social Survey in the US (Di Tella et al., 2001, 2003; Alesina et al., 2004). To the best of our knowledge, the only study that investigates the effect of inflation on well-being within the same country is Boes et al. (2007), based on German data. The paper exploits regional price variations to show that people's satisfaction with their financial situation responds differently to different changes in the price level, thus rejecting the money illusion hypothesis (i.e., the hypothesis that consumers tend to overlook inflation).

The main obstacle to studying inflation effects on well-being is the lack of individual variability. In their review on the determinants of subjective well-being, Dolan et al. (2008, p.109) express it clearly: "Investigating the impact of inflation is limited to comparisons across countries over time. Within the same country it would be impossible to isolate an inflation effect from any other time effects". However, the quote is only valid insofar as inflation is assumed to be a macroeconomic phenomenon that impacts every consumer equally within a country. This is unlikely to be the case. Price increases affect consumers differently, according to their heterogeneous baskets of goods, credit/debit balance, and propensities to consume. As soon as we adopt the consumer perspective, inflation ceases to be a purely macroeconomic phenomenon and can be examined at a more granular level.

2.2. Official inflation and perceived inflation

Even though the importance of studying inflation inequality is acknowledged, measuring its well-being cost poses some serious methodological challenges. The most natural approach would be to construct an objective heterogeneous inflation rate, based on individual consumption weights and individual price indexes, and then combine it with individual-level material satisfaction. To the best of our knowledge, no existing dataset allows for this, for a simple reason: consumption datasets do not monitor the material satisfaction of respondents.

Typically, two types of consumption data sets are used to estimate the level of inflation inequalities: micro-expenditure surveys and scanner data. Both approaches have abundantly shown important levels of inflation inequality (Jaravel, 2021). Based on American scanner data, Kaplan and Schulhofer-Wohl (2017) document "massive heterogeneity in inflation rates at the household level" (ibid, p. 36) and show that lower-income households have experienced higher inflation rates over the period of study (2004 to 2013). Recent data suggest that inflation inequalities have been widening since the beginning of the inflation crisis (Orchard,

2022; Avtar et al., 2022). These estimates should be interpreted as lower-bounds. Micro-expenditure datasets contain no information on individual price indexes, so that consumers living, say, in the capital or in a rural area are assumed to face the same price index, thus attenuating the dispersion of the inflation rates.[3] Scanner data monitor price variations for shopping items, but not for other goods that can significantly contribute to inflation inequalities (e.g., energy prices and rent prices).

Beyond consumption data, a growing literature is interested in the study of the Opinion Price Index (OPI) as an alternative measure of inflation (Ranyard et al., 2008, for a review). The OPI, which is commonly referred to as a measure of *perceived inflation*, has the fundamental advantage of capturing individual heterogeneity. OPI trends are approximately in line with CPI trends, but levels are not: consumers' estimates of inflation are constantly higher than estimates by national statistical offices.[4] This discrepancy cannot be explained solely by aggregation effects of the CPI, and it would be naive to consider the OPI as an accurate measure of actual experienced inflation. However, several pieces of empirical evidence establish that consumers form their inflation judgments in accordance with their actual experience.

In a seminal study, using survey data, Brachinger (2006, 2008) shows that once frequency bias (i.e., consumers' tendency to overweight products which are more frequently purchased) and loss aversion (i.e., consumers' tendency to overweight price raises with respect to price losses) are taken into account, aggregate perceived inflation closely mirrors the CPI. Subsequent experimental studies support this claim. Jungermann et al. (2007) ask participants the perceived price changes for several goods, and show that people overestimate price raises compared to price declines, according to a loss-aversion coefficient that authors estimate to be around 2. In a laboratory experiment, Georganas et al. (2014) shows that aggregate perceived inflation is systematically biased toward the perceived inflation rates of the frequently purchased items.

Therefore, albeit there is no agreement yet on the exact functional form that links experienced inflation and perceived inflation,[5] there is convergent evidence that people form their beliefs about inflation based on a reduced basket of goods that they frequently consume, and where price raises are overestimated (see also Huber, 2011; de Bruin et al., 2011). Since price fluctuations of this reduced basket contribute substantially to changes in actual inflation (Nam and Go, 2018), it should not be surprising that OPI trends are approximately

[3] In France, the National Statistical Office does not collect data on regional price indexes. It calculates consumer price index for: the whole of France, French European territories and some French Extra-European territories (Reunion, Guadeloupe, Martinique and Guyana).

[4] For an extensive discussion on this discrepancy in the French data, see Accardo et al. (2011).

[5] Psychophysical laws suggest a monotonic but nonlinear relation between the actual change in prices and the perceived change (Brachinger, 2008; Antonides, 2008). For instance, the Weber-Fechner law implies that the perception of prices is logarithmic. The role of memory biases can play a role too (Kemp, 1984, 1987, 1991).

in line with CPI trends.[6]

Based on this body of evidence, in the remainder of the analysis, we exploit variations in inflation perceptions to study variations in individually experienced inflation. The use of perceived information is much more common than it may seem at first glance. Let us take, for example, a comparison with income. The vast majority of survey-based empirical studies use self-reported income as an explanatory variable in their models, despite declared income being known to systematically differ from the "true" income measured in the fiscal registers (Bakker and Daas, 2012; Jäntti et al., 2013). Insofar as variations in self-reported information are a reasonable approximation of variations in the unobserved information that is targeted, the analysis of the former can offer useful insights about the latter.[7]

3. The data

For our empirical analysis we use quarterly data drawn from the *Enquête de conjoncture auprès des ménages* (CAMME), the French version of the monthly Consumer Confidence Survey, run by the National Institute of Statistics and of Economic Studies (INSEE). Consumer Confidence Surveys have been harmonized according to Eurostat recommendations, so that questions are comparable at the European level. Interviews take place by phone on a representative sample of about 1,700-1,800 individuals per wave. CAMME is a monthly survey with partially overlapping sub-samples: one third of the sample is renewed every month, so that each person is interviewed three times over three consecutive months (perceived inflation is asked every month). The question on material satisfaction is part of a "Well-being Module" which is fielded every three months. Therefore, each person reports their material satisfaction exactly once. This restricts the frequency of usable data to quarterly.

In the first part of the paper, we use the data set provided by the CEPREMAP Well-being Observatory. It is a longitudinal cross-section made of 24 quarterly waves, from June 2016 to March 2022. The data set contains quarterly information from the waves where the Well-being Module is fielded (March, June, September and December each year).[8]

In the second part of the paper, we construct two new data sets based on the data provided by the National Statistical Institute. We link the Well-being Module with two other survey modules that contain some additional information about respondents' consumption habits. Despite offering richer information per

[6]Incidentally, these empirical results reject the idea that consumers report information from the media when answering the question on perceived inflation. This is suggested not only from the systematic difference between aggregate levels of OPI and CPI, but also from the relationship between perception of individual prices and aggregate inflation perception (see Jungermann et al., 2007, for a discussion).

[7]Section 6 discusses the assumptions that are needed to map perceived inflation effects into actual inflation effects.

[8]The dataset is available upon request to the CEPREMAP Well-being Observatory.

respondent, the new datasets contain only a subsample of the individuals and only up to December 2018. More details are provided in section 5.[9]

We use the following definitions:

Material satisfaction = the answer, on a scale from 0 to 10, to the following question: "To what extent are you satisfied with your standard of living?" [0 = not satisfied at all, 10 = completely satisfied].[10]

Perceived inflation = inflation as measured by the Opinion Price Index (OPI). Perceived inflation is elicited from the preliminary question "Would you say that over the last twelve months prices have i) risen a lot; ii) risen moderately; iii) risen slightly; iv) stayed about the same; v) fallen" and the subsequent question on the value of the increase / decrease of prices (in percentage, rounded to the first decimal).[11] It varies both across individuals and over time.

Official inflation = inflation as measured by annual variations in the Consumer Price Index (CPI). It varies over time.

3.1. Data treatment

Data on perceived inflation entail some practical challenges. A first issue concerns the treatment of outliers, that is many individuals report unrealistic levels of inflation. For the purpose of enhancing data quality, we follow the recommendations by Arioli et al. (2017, section 4.2) and apply a certain degree of trimming to eliminate outliers. We apply a symmetric trimming procedure: we remove the top and bottom 10% of the distribution of answers in each survey wave, i.e., 2,067 answers overall. By applying a trimming threshold that is specific to each quarter, we account for differences between low and high inflation periods. Features become more realistic, yet preserving ordered differences in the OPI between socio-demographic groups. Average perceived inflation goes from 5.9% down to 3.9%, while the leptokurtic (i.e., "fat tail") feature of the distribution mitigates: kurtosis falls from 22 down to 8 (as a benchmark, the kurtosis of a univariate normal distribution is 3).

In the remainder of the paper, we will systematically run our estimations on the trimmed sample. In the appendix, table A1 reports summary statistics of the untrimmed sample, while table A2 reports robustness checks, where we replicate our analysis under alternative trimming strategies and winsorization.

A second issue is related to missing data. The high non-response rate (38%) to the question on quantitative inflation requires specific treatment. In the linear estimations, we replace missing data in the OPI vector

[9] The original data files (lil-1309, lil-1373, lil-1176) are publicly available upon request to the French Data Archive for Social Science. Additional methodological information is available here: <https://www.insee.fr/fr/metadonnees/source/serie/s1208/presentation>. [Accessed on 09/09/21]

[10] *Dans quelle mesure êtes-vous satisfait de votre niveau de vie ?*

[11] The original question is: *Trouvez-vous que, au cours des douze derniers mois, les prix ont i) fortement augmenté; ii) modérément augmenté; iii) un peu augmenté; iv) stagné; v) diminué.*

with its mean value, and add a binary variable which takes value 1 when the observation is missing. In the appendix, we replicate the analysis using three different imputation strategies: listwise deletion, conditional mean imputation and multiple imputations. They all lead to very similar results as those obtained in our baseline estimation (see table A3).

3.2. Cross-sectional statistics

The left panel in table 1 displays average perceived inflation, by population subgroup. In line with previous evidence, people perceive inflation to be higher than the official statistics: 3.9% instead than about 1.2%. The table shows that women estimate inflation to be higher than men, and young adults higher than older ones (consistently with Arioli et al., 2017, p.30). People with lower incomes are particularly prone to perceive high inflation, as already noticed 40 years ago in the UK (Bates and Gabor, 1986), and consistently with recent evidence on experienced inflation from American scanner data (Jaravel, 2019). Income is especially likely to affect inflation, because people at different points of the income distribution are likely to have different consumption baskets and to face different prices. The right panel in table 1 displays average material satisfaction on a scale from 0 to 10. Material satisfaction increases with the level of income and education, and has a trough in midlife.

Figure 1 shows the distribution of answers about perceived inflation in the trimmed sample. 28% of the respondents report null inflation, while 5% report levels of inflation higher than 10%. Figure A2, in the appendix, shows the distribution of the OPI by quarter.

3.3. Longitudinal statistics

Figure 2a displays the evolution of official and perceived inflation over the period of interest: the measures evolve according to a positive but imperfect correlation ($r = 78\%$, p-value < 0.001). In figure 2b, we can observe that in periods where inflation accelerated (2018 and, especially, 2021), material satisfaction tended to decline. The satisfaction low-point in 2018 happened in conjunction with an escalation of the price of gasoline and with the subsequent protests of the Yellow Vests movement[12] (we discuss this specific period more in detail in Section 5). The negative satisfaction trend in 2021 happened during the second year of the COVID-19 pandemic, when the year-to-year inflation level escalated up to levels which were unseen since the 80s in the country.

To illustrate the importance of heterogeneity in consumption baskets, figure 3 plots the inflation index of four product categories. Prices of these products evolved in substantially different ways: tobacco and spirits prices have expanded because of fiscal inflation, health services prices have been mostly flat, transportation prices showed a spectacular increase in 2020-21, and telecommunications prices have been driven downward

[12]For a discussion on the relationship between subjective well-being and this event, see Perona (2019).

by enhanced market competition. These differences illustrate how experienced inflation differs from one consumer to the other: smoking habits, health status, commuting and phone use can explain large differences in individual inflation, all other things being equal. Inflation heterogeneity can neither be captured by a representative basket of goods, nor can it be assessed easily for a particular population group without additional information on its consumption habits.

Figure 1: Distribution of the OPI

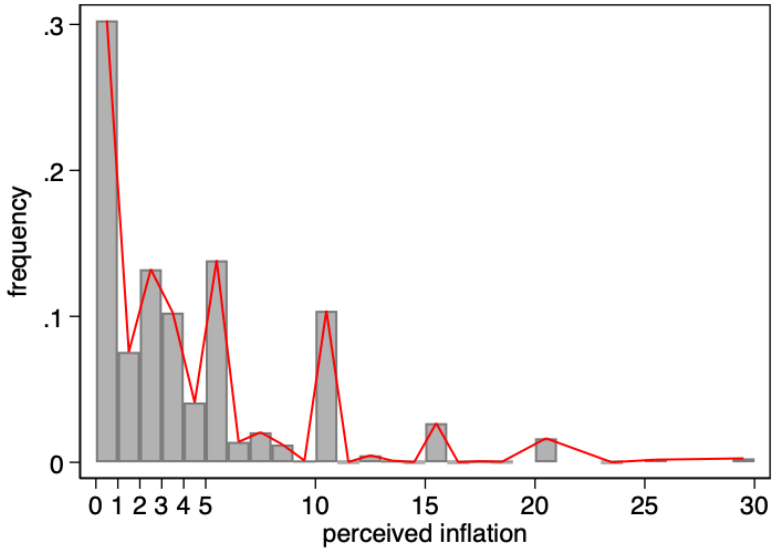
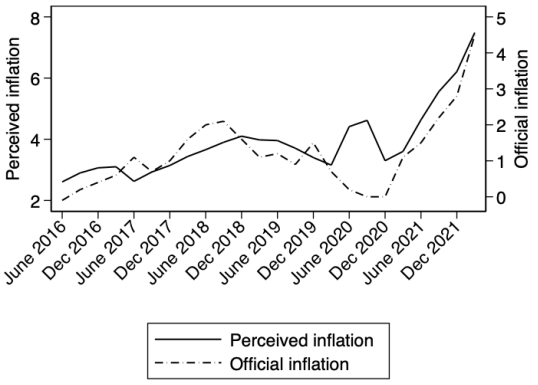
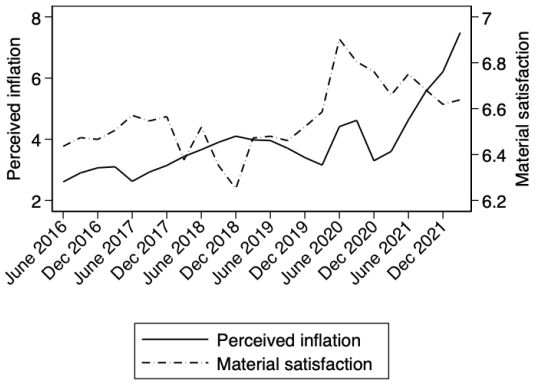


Figure 2: Evolution of the OPI

(a) Evolution of the OPI and the CPI

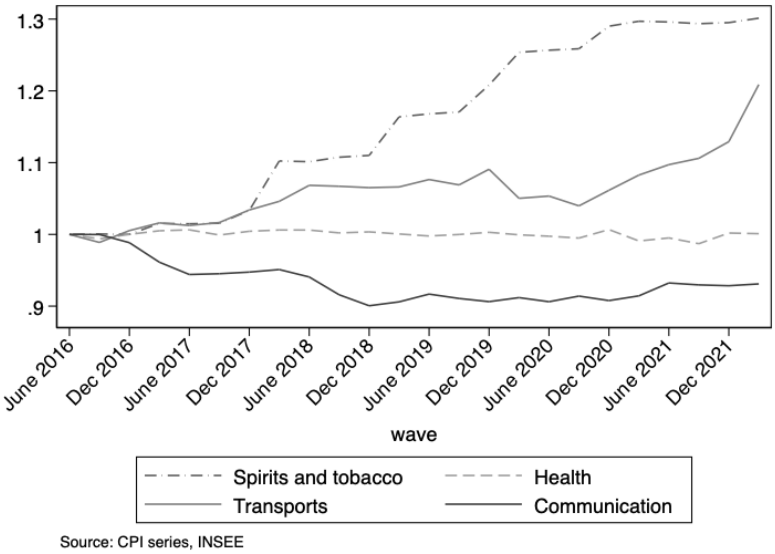


(b) Evolution of the OPI and Material Satisfaction



Note: Each graph plots the evolution of two variables, by quarter, from June 2016 to March 2022. It should be noted that variables refer to two different y axes, which do not have the same scale. Source: Well-being Module, Consumer Confidence Survey and INSEE.

Figure 3: Evolution of Aggregate Price Indexes (four categories)



Reading note: This figure displays the evolution of the product price index of four good categories. For instance, in March 2022, the average price of goods from the tobacco and spirits category was 30% higher than in June 2016. Categories are defined according to the COICOP *(Classification of Individual COnsumption according to Purpose)* international standard. Source: INSEE.

Table 1: Summary statistics of perceived inflation and material satisfaction

	Perceived inflation			**Material sat.**		
	mean	st.dev.	N	mean	st.dev.	N
Overall	3.88	4.59	23,142	6.56	1.82	40,225
Sex:						
Female	4.32	4.94	10,087	6.45	1.86	20,456
Male	3.54	4.27	13,055	6.67	1.77	19,769
Age:						
< 40	4.42	5.20	4,424	6.62	1.77	7,154
40-60	4.07	4.78	8,813	6.45	1.86	14,664
> 60	3.46	4.07	9,905	6.62	1.80	18,407
Income:						
1st quartile	4.54	5.08	3,820	5.76	2.05	8,487
2nd quartile	4.04	4.61	4,853	6.38	1.76	8,571
3rd quartile	4.03	4.55	5,320	6.71	1.59	8,585
4th quartile	3.42	4.29	5,965	7.27	1.48	8,596
Highest diploma:						
No diploma	3.91	4.30	2,578	6.13	2.04	6,108
High school (*bac*)	4.23	4.85	4,075	6.51	1.77	6,782
Graduate (*bac+5*)	3.12	4.19	3,388	7.14	1.62	4,772

Reading note: Estimated conditional means, standard deviations and number of observations of OPI and material satisfaction. The statistics are computed on the original data set, without any imputation.

4. Heterogeneous perceived inflation

To explore the relationship between inflation inequalities and material satisfaction, we start with a simple cross-section analysis of the first wave of CAMME. All people are interviewed during the same quarter (June 2016). Insofar as we assume inflation to be approximately stable during that month, the dispersion of material satisfaction among respondents is explained only by differences within the same period. A linear regression of material satisfaction on the OPI estimates a coefficient of -0.08 (p-value < 0.001, N= 1,725), regardless of controlling or not for socio-demographic characteristics (see tab. A4). This estimation tells us that, in June 2016, a consumer reporting a one percentage-point higher inflation than another consumer endured a (statistically significant) satisfaction gap. This gap is an order of magnitude larger than the one associated with a 1% difference in *income*.[13] Importantly, the estimated effect is due only to inequalities *within* the same period. This is a first empirical hint that previous macroeconomic analysis based on time effects might have overlooked an important aspect of the well-being cost of inflation.

We now move to the longitudinal dimension, and use the whole available dataset, from June 2016 to March 2022. We also consider the threat of omitted variable bias, and introduce a richer set of explanatory variables. We study a regression of the form:

$$h_{it} = \alpha \text{OPI}_{it} + \beta log\text{income}_{it} + X'_{it}\gamma + Z'_{it}\delta + \text{T}'_t\tau + \epsilon_{it} \tag{1}$$

where h_{it} is the level of current satisfaction with the standard of living reported by individual i at quarter t; OPI_{it} is the level of perceived inflation he or she reports; $log\text{income}_{it}$ is his/her adjusted household monthly income in the standard log form; X'_{it} is a set of socio-demographic variables that includes a dummy variable for imputed OPI, age, age^2, sex, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers); Z'_{it} is a set of subjective variables. $T'_t\delta$ captures time fixed-effects, including changes in aggregate official inflation; ϵ_{it} is the error term, which we assume to be normally distributed. A Breusch-Pagan test strongly rejects the null hypothesis of homoskedasticity ($p < 0.001$), therefore we correct standard errors across specifications.

The content of matrix Z_{it} is pivotal for our identification. Since both our regressand (h_{it}) and main regressor (OPI_{it}) are self-reported variables, and the data do not allow to apply a fixed-effects estimator, our main challenge is to rule out spurious correlations with omitted subjective variables. To this end, we gradually introduce two sets of measures intended to control for, respectively, declarative biases in subjective well-being reports and idiosyncratic personality traits (optimism / pessimism).

[13] The coefficient associated with log(income) is 0.8. Thus, if we decrease income by one percent, we expect material satisfaction to decrease by about (0.8/100)=0.008 scale units.

Other satisfaction variables. On top of material satisfaction, the Consumer Confidence Survey measures satisfaction with a few domains which are mostly independent from inflation: satisfaction with health, satisfaction with social relationships and satisfaction with free time.[14] They are elicited through the following questions: "To what extent are you satisfied with your health?" [0 = not satisfied at all, 10 = completely satisfied]; "To what extent are you satisfied with your relationships with your family and friends?" [0 = not satisfied at all, 10 = completely satisfied]; "To what extent are you satisfied with your free time, the time that you can use as you wish?" [0 = not satisfied at all, 10 = completely satisfied].[15] These measures have the advantage of being orthogonal to h_{it} if not for the common method variance (*viz.* they are elicited the same way) and some cross-domain spillovers.

Optimism and pessimism. Optimism and pessimism are known to importantly affect survey measures. They can introduce some artifactual covariance due to respondents' propensity to view the world around them in generally positive or negative terms (Podsakoff et al., 2003, p. 882).[16] They have also been proposed as a major biasing factor for inflation perceptions (Abildgren and Kuchler, 2021). Although neither the Consumer Confidence Survey nor its Well-being module include a psychometric test of optimism, they both contain several questions which can help to construct a valid measure. Psychological optimism and pessimism are two polar opposites of the same spectrum that refer to the general tendency to anticipate positive vs negative outcomes.[17] In our survey, respondents express their view of the future on several levels: unemployment, the overall economy over the next year in France, the respondent's future situation, that of the next generation in France and that of the next generation in Europe; saving conditions and favorite time period to live in (past, present or future). We conduct a Principal Component Analysis on these seven dimensions and extract two orthogonal components that we can readily interpret as optimism and pessimism. We provide details of the Principal Component Analysis and related statistical tests in the appendix, Section A1.

[14] Respondents are also interviewed about their perceived satisfaction with respect to others, job satisfaction, satisfaction with professional relationships and work-life balance. However, we omit these variables from our analysis because the former is unlikely to be orthogonal to heterogeneous effects on material satisfaction, while the other ones are missing for inactive, unemployed and retired people.

[15] The original questions are: "*Dans quelle mesure êtes-vous satisfait de votre santé ?*"; "*Dans quelle mesure êtes-vous satisfait de vos relations avec vos proches ?*"; "*Dans quelle mesure êtes-vous satisfait de votre temps libre, du temps que vous pouvez utiliser comme bon vous semble ?*".

[16] Sharot (2012), offers a useful overview of the associations between happiness and optimism (Chapter 5) and autobiographical retrieval and optimism (Chapter 6).

[17] See the American Psychological Association's definition: `<https://dictionary.apa.org/optimism>` [Accessed on 28/04/20].

4.1. Impact of perceived inflation

We focus on a cardinal interpretation of material satisfaction and estimate the model by OLS (table 2). When we use nonlinear estimators under more flexible assumptions, results are very similar. See the appendix, Table A5 for ordered probit and Table A6 for median quantile regressions.

The dependent variable is the individual material satisfaction score and the main regressor of interest is the individual OPI. In columns (2) to (5), we progressively add various sets of controls. Column (2) controls for socio-demographic variables and confirms that between-group heterogeneity cannot solely explain variations in material satisfaction. In addition to socio-demographic variables, the specification in column (3) controls for three other dimensions of satisfaction. All three have a positive coefficient, consistently with some inter-domain correlation of the latent constructs and with some common method biases. Column (4) controls for the levels of optimism and pessimism. While the first trait is a strong predictor of high reported material satisfaction, the estimated coefficient for the second trait is not statistically different from zero. Column (5) displays results for the model where all sets of controls are included. At the risk of some overfitting, this model offers a good bet for avoiding omitted subjective variables. In this full specification, variations of the regressors explain over one third of variations of material satisfaction.

What about our main variable of interest, the OPI? The effect of perceived inflation is significant and negative across the specifications, suggesting that the lower perceived inflation is, the higher material satisfaction is. From the initial specification (column (1)) to the full specification (column (5)), the estimated coefficient associated with the OPI more than halves its magnitude, confirming the importance of spurious correlations, now captured by the rich set of controls. Yet, it maintains a non-negligible size: according to our more conservative estimates (column (5)), on average, a person who perceives inflation to be low (OPI=1%), reports material satisfaction to be 6.72; a person who perceives a relatively high level of inflation (OPI=5%) reports 0.08 less points material satisfaction, 6.64. This loss corresponds to an effect size of about 4% of a standard deviation of the dependent variable. To give a better idea of the effect size, we make a comparison with the effect of income heterogeneity.

4.2. Impact of perceived inflation relative to income

In most Western countries, the average nominal income and the price indexes tend to both increase over time, and they affect material satisfaction in opposite directions. Over a given period of time, the net effect of a raise in nominal income and an equivalent raise in prices is not trivial. On the one hand, the *money illusion* phenomenon suggests that individuals tend to overlook inflation, while nominal income is what really matters. On the other hand, the *loss aversion* phenomenon predicts inflation to outweigh equivalent income raises, since a factor implying a loss of purchasing power should matter more than a

factor implying an equivalent gain.[18] Using regional variations of the CPI in Germany, Boes et al. (2007) estimate the marginal effect of a raise in the price index to be higher, in absolute value, than the effect of an equivalent nominal income raise - as predicted by loss aversion, and contrary to money illusion. In our dataset, although income is measured as the monthly level for the household, while prices are measured by individuals as growth rates over a year, a comparison between their estimated marginal effects can offer some interesting insights. Our results are along the same lines of Boes et al. (2007). According to our linear regressions, the effect of perceived inflation is about twice as high as under nominal equivalence (this is in line with previous measures of loss aversion using satisfaction data, see Boyce et al. 2013). For instance, for a household earning €2,000 monthly, the well-being cost of a 1-percentage-point increase in perceived inflation (i.e. a €20 loss in purchasing power) equals the loss brought about by a €52 loss in monthly income.

Overall, these results show a non-negligible impact of perceived inflation rates on material satisfaction. According to linear estimations, a 1-percentage-point increase in perceived inflation shifts about 2% of the population downward from one satisfaction category to another, *ceteris paribus*. This effect is not small, in particular when we consider that it is in addition to the effect of average inflation, which is captured by the time dummies.

Indeed, these microeconomic effects are estimated on top of the macroeconomic aggregate variations, captured by the CPI: it is in this sense that the OPI captures heterogeneous inflation. The coefficient 0.02 is estimated from differences between individuals and not from differences over time (which are captured by the time dummies instead). For instance, in September 2016, average material satisfaction was 0.03 points lower than in the previous quarter (June 2016, i.e., the reference period). Although people reporting OPI = 1% typically declare 0.02 lower material satisfaction than those reporting OPI = 0%, what we observe in the raw data is that people reporting OPI = 1% in September 2016 are 0.05 less satisfied than those reporting OPI = 0% in the previous quarter. Rescaling by exactly 0.03 fixes the problem of comparing people interviewed at different times, but it also omits effects associated with aggregate inflation.

Regardless of average inflation being high or low, in the hypothetical situation of homogeneous inflation (*ceteris paribus*), the coefficient associated with OPI should be close to zero; in the hypothetical situation of heterogeneous inflation (*ceteris paribus*), the coefficient should be statistically negative. This analysis clearly points toward the second scenario.

[18] This prediction assumes the value function to be separable in income and prices. That is, it assumes people to display loss aversion when price increases, regardless of any compensatory effect due to an increase in their nominal income.

Table 2: Linear estimations of the impact of perceived inflation on material satisfaction

	(1)	(2)	(3)	(4)	(5)
perceived inflation	-0.046***	-0.040***	-0.030***	-0.021***	-0.018***
	(-16.76)	(-14.47)	(-11.93)	(-7.32)	(-6.93)
log(income)	0.965***	0.854***	0.733***	0.755***	0.687***
	(53.64)	(36.92)	(35.82)	(30.44)	(30.35)
age		-0.028***	-0.036***	-0.026***	-0.032***
		(-7.41)	(-11.03)	(-6.29)	(-8.67)
age^2/100		0.026***	0.037***	0.025***	0.033***
		(7.77)	(12.49)	(6.55)	(9.52)
1 if male		-0.062***	-0.063***	-0.121***	-0.108***
		(-3.27)	(-3.71)	(-5.99)	(-5.81)
sat. with health			0.161***		0.127***
			(34.62)		(24.50)
sat. with free time			0.246***		0.213***
			(52.22)		(40.85)
sat. with social rel.			0.125***		0.113***
			(19.82)		(15.98)
optimism				0.378***	0.261***
				(52.42)	(37.64)
pessimism				0.014	-0.011
				(1.38)	(-1.22)
time dummies	yes	yes	yes	yes	yes
socio-dem controls	no	yes	yes	yes	yes
N	38161	38161	36975	28932	28382
Adjusted R^2	0.108	0.126	0.314	0.226	0.353

Reading note: Linear regressions of material satisfaction. t-statistics are in parentheses. Standard errors are computed by White formula. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Socio-dem. controls: education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers).

5. Heterogeneous inflation between groups of consumers

In this section, we further investigate price-related well-being inequalities between groups of consumers. More specifically, we test the prediction that groups of consumers who are exposed to higher-than-average inflation report both higher perceived inflation and lower material satisfaction.

We construct two new data sets, containing some additional information about respondents' consumption habits. We obtain it from the linkage of the responses in the Well-being module with the responses in two other modules of the Consumer Confidence Survey. The first module is on "Environmental habits and opinions", and has been fielded in November each year. In this module, people are asked "Among the following means of transport, which one do you usually take to go to work/school?", thus allowing to elicit respondents' commuting habits. The mode of transport is reported on a list of several options, which we dichotomize as "car / motorbike" (=1) or not (=0). The second module is on "Difficulties in lodging-related payments", and was fielded once in 2016 and twice in 2017. In this module, respondents report whether they are owners or tenants of their house. Table 3 gives an overview of the timing of the different modules.

5.1. The data

The CAMME survey is a longitudinal cross-section with partially overlapping sub-samples: one third of the sample is renewed every month, so that each person is interviewed three times over three consecutive months (see Figure 4). Therefore, all of those interviewed about their commuting habits also report their material satisfaction either two months before (1/3 of them) or one month later (2/3); all of those interviewed about housing also report material satisfaction either one month before (2/3 of them) or two months later (1/3). This particular structure requires moving the temporal unit of analysis from quarters to semesters, to ensure a representative sample. In other words, we consider that the interviews done in March, April and June belong to the same time unit (S1), and so we do with the interviews done in September, October, November and December (S2). Section A7, in the appendix, gives more details.

The official year-to-year variations of the CPI and of the goods price indexes are displayed in the first two rows of tables 4 and 5. The gasoline price index increased very steeply between 2017 and 2018 and recorded a contraction in 2019, so that car commuters saw their average price index decrease that year, compared to non-car commuters and all other things being equal. The year-to-year variation of the housing price index accelerated in 2017, doubling over 12 months. Although the variations are an order of magnitude smaller than the ones of gasoline, their impact can be consequential given the large role of rents in tenants' expenditure.

5.2. Car commuters

Commuting habits provide invaluable information for studying the differential impact of variations in the gasoline price, which is typically unforeseeable, volatile and salient in the consumers' basket. The 2016-19

Figure 4: Consumer Confidence Survey Timeline

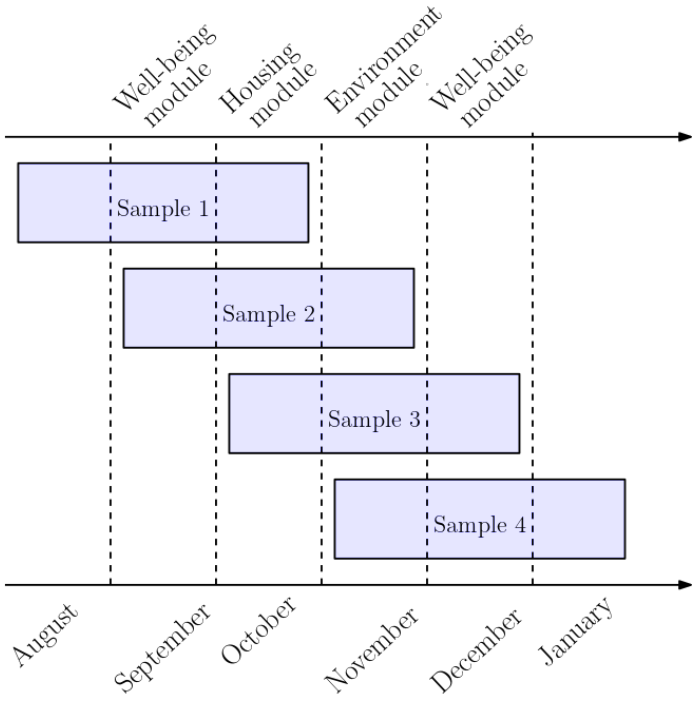


Table 3: Module Dates

Date	Module
October 2016	Housing
November 2016	Environment
April 2017	Housing
October 2017	Housing
November 2017	Environment
November 2018	Environment
November 2019	Environment

Reading note: The Well-being module is fielded each year in March, June, September and December.

period of study is especially interesting. In France, in the second semester 2018, the average price per liter of gasoline was almost 20% higher than in the same period of the previous year, due to a combination of enhanced fiscal burden and increasing oil price in the international market. A shock of this magnitude can importantly and immediately affect the overall expenditure for daily users of cars and motorbikes. On the

contrary, users of public and other transport (mostly cyclists) were not directly affected by the shock, at least on the short term.

Herein, we compare the difference in perceived inflation and material satisfaction between commuters who did and did not use a motor-vehicle at different time periods. We use the interaction between whether someone is a car commuter and the gasoline price as as an instrument for asymmetric inflation. For material satisfaction, we compare mean values conditional on socio-demographic characteristics. Table A7, in the appendix, reports the whole regression table, baseline 2018. The second panel of Table 4 summarizes the results.

On the one hand, the observed differences in the OPI carry the expected sign: the coefficient associated with the interaction term is positive (+0.015, p-value = 0.001), meaning that a 1-percentage point increase in the gasoline price is associated with a 0.015 higher perceived inflation among car commuters (tab.A7, column (1)). On the other hand, OPI variations between periods are small and, in particular, car commuters seem to under-react to important price changes in 2017 and 2018.

As for material satisfaction, the two groups display similar levels in the second semesters of 2016 and 2019 (*ceteris paribus*), but not in the second semesters of 2017 and 2018, when gasoline price spikes and car users report a substantial drop in material satisfaction relative to the other group of commuters. When the gasoline price increases by 1 percentage point, car commuters endure a 0.01-scale-points drop in their material satisfaction, compared to non-car commuters (p-value = 0.009; tab.A7, column (2)).

5.3. Tenants

The difference between tenants and owners is perhaps the most obvious example of how the composition of consumption baskets can affect individual inflation. In France, four out of ten households are tenants, while the rest own their house.[19] For the former, rent represents 20% of consumption expenditures on average, while rent is (by definition) null for the owner. The CPI, as a macroeconomic measure, does not take into consideration this asymmetry and has been criticized recently on these grounds (Todd, 2020). Trends in housing prices are quite stable and therefore more predictable than gasoline. However, this was arguably not the case in 2016-17. The housing index reversed its trend in mid-2016: after five years of decline, it started increasing and progressively accelerating. Five years later, in 2021, the index is 20% higher than it was in June 2016. Admittedly, the increase involved only a subset of the group of tenants, and to a very different extent according to the affordability ratio (i.e., the ratio between a household's expenditure on housing and its income).

We adopt a similar regression analysis as for the gasoline price. The instrument is now the interaction between a dummy for being a tenant and the housing price index. The lower panel of Table 5, below, sum-

[19] https://www.insee.fr/fr/statistiques/2415555

marizes the estimated differences. For material satisfaction, we control for socio-demographic characteristics. Table A8, in the appendix, reports the whole regression table, baseline 2017 (S2).

In 2017, the housing price index recorded an acceleration that is reflected in the OPI: a gap appears between owners' and tenants' OPI, and is maintained in the following semester. The interaction term in the regression analysis predicts that a 1-percentage point increase in the housing index is associated with 0.31 points higher OPI for tenants than for owners (p-value < 0.001; tab.A8, column (1)).

As expected, differences in material satisfaction move in the opposite direction than differences in the OPI: tenants report less satisfaction scale points than owners and the gap widens as housing price accelerates. Despite carrying the expected negative sign, the interaction term in the regression analysis is not significant (-0.04, p-value = 0.392; tab.A8, column (2)). The test is under-powered (it is essentially based on four observations), but this null coefficient invites caution in the interpretation of the asymmetric effect of housing prices on material satisfaction. Overall, there is no sufficiently strong evidence that housing prices affect the material satisfaction of owners and tenants differently.

Are changes in the OPI plausible reactions to changes in expenditure patterns? Based on the observed evolution of the gasoline (resp. housing) price and its average weight in the basket of car commuters (resp. tenants), we can calculate the expected difference in group-specific inflation. This is a back-of-the envelope calculation, but it can help give an idea of the between-group differences in aggregate OPI that we would predict from macroeconomic data. Details of the calculation can be found in the appendix, Section A7. Figures A3 and A4 summarize the exercise. For commuters, the pattern of the predicted differences in OPI highly correlates (r=97%) with the observed pattern, although we would have expected a much larger variation of the OPI in 2018 (+1.7 instaed of +0.8). For tenants and owners, patterns over time correlate well (r=80%), but the predicted gap is systematically higher than the figures we observe in the survey. Overall, differences in perceived inflation levels between groups of consumers are compatible with changes in the expenditure patterns of these same groups. People's feelings about their material situation seem to be influenced by these price changes, too. Relative material satisfaction significantly drops when group-specific inflation rises, as it happened in 2017 for tenants and in 2018 for car commuters.

A word of caution is needed as to the causal interpretation of these figures. The observed discrepancies in material satisfaction are likely to be due to a combination of factors and cannot be explained by asymmetric inflation solely. In 2018, the material satisfaction of car commuters was 0.24 scale-point lower than the other group, while the difference in well-being due to differences in the OPI should be much smaller. Even though the change in prices are plausibly exogenous, social amplifications and social comparisons can play an important role, adding to the individually-experienced inflation. A commuter who sees the price of gasoline spiking might be concerned about his future financial situation, disappointed by the new burden

and frustrated by the unequal treatment of his social group (car users), above and beyond the pure inflation effect. The precise estimation of the *causal* impact of inflation asymmetries is an important future step, which will require longer time series and richer expenditure data.

6. Discussion and extension

This section discusses under which assumptions the quantitative considerations on the effect of perceived inflation can be extended to the effect of actual experienced inflation. In section 2.2, we reported some cognitive biases that predict the discrepancy between perceived and experienced inflation. Once these cognitive biases are accounted for, the Opinion Price Index (OPI) can be cleaned out of systematic mis-perceptions so as to reflect experienced individual inflation Π. You can think of mis-perception as a function f: $\Pi \rightarrow OPI$, so that $f^{-1}(OPI) = \Pi$.

In order to assess that heterogeneous inflation has a negative effect on well-being, we require only weak assumptions on the functional form of f. We simply need to assume f to be invertible and monotonic, so that differences in perceived inflation represent an ordered mapping of actual differences in individual inflation. In other words, we should assume that a person who perceives inflation to be 1% actually faces lower individual inflation than a person who perceives it to be 5%. Even so, we can remain agnostic about the size of the difference in their experienced inflation rates. Under this weak condition, perceived inflation already represents a meaningful construct for the empirical investigation of inflation heterogeneity.

The exercise of inferring the actual *level* of individual inflation from perceived inflation data is an exciting extension, but it requires much more restrictive assumptions. In what follows, we offer a set of assumptions, which are simple and manageable but which cannot be validated on our data at the individual level. We count on the growing empirical research for the empirical validation of the relationship between OPI and CPI. In the appendix, Section A7, we calculate the predictions of the model at the aggregate level, considering only two groups of consumers.

Let us denote by p_g^t the average price of good g at time t, by p_g^{t+1} the price of good g at time $t+1$ and by q_g the weight associated with each good g in the consumption basket of the representative agent; $g \in \{1, 2, \ldots, G\}$ is a good of the representative basket. In its most simple form, you can think of the variation of the CPI as:

$$CPI = \sum_{g=1}^{G} \frac{p_g^{t+1} - p_g^t}{p_g^t} q_g. \tag{2}$$

If we denote Π_i the actual experienced level of inflation, Π_i will depend on q_{gi}, the actual weight of good g in the consumption basket of consumer i, so that $\forall i \ \sum_{g=1}^{G} q_{gi} = 1$:

$$\Pi_i = \sum_{g=1}^{G} \frac{p_g^{t+1} - p_g^t}{p_g^t} q_{gi}. \tag{3}$$

Table 4: First difference between people who commute with vs without a car

	2016	2017	2018	2019
Consumer PI	0.5	1.1	1.9	1.2
Gasoline PI	1.4	7.6	19.3	-1.9
Δ OPI	0.6	0.7	0.8	0.5
	(0.02)	(0.01)	(0.01)	(0.02)
Δ Mat. Sat.	-0.05	-0.11	-0.24	-0.02
	(0.03)	(0.03)	(0.05)	(0.03)

Reading note: Line 1: Annual variation of the CPI, average over the semester, source: INSEE. Line 2: Annual variation of the gasoline price index, average over the semester, source: INSEE. Line 3: Average mean difference in the OPI reported by car commuters and non-car commuters, st.error in parentheses. Line 4: Average mean difference in material satisfaction reported by car commuters and non-car commuters, conditional on socio-demographic characteristics, st.error in parentheses. Data refers to the second semester of each year.

Table 5: First difference between house tenants and owners

	2016	2017 (s1)	2017 (s2)
Consumer PI	0.5	0.9	1.1
Housing PI	1.5	3.0	3.3
Δ OPI	-0.1	0.4	0.5
	(0.01)	(0.01)	(0.02)
Δ Mat. Satisfaction	-0.16	-0.23	-0.24
	(0.04)	(0.08)	(0.09)

Reading note: Line 1: Annual variation of the CPI, average over the semester, source: INSEE. Line 2: Annual variation of the housing price index, average over the semester, source: INSEE. Line 3: Average mean difference in the OPI reported by tenants and owners, st.error in parentheses. Line 4: Average mean difference in material satisfaction reported by tenants and owners, conditional on socio-demographic characteristics, st.error in parentheses. Data refers to the second semester of 2016, and to both semesters of 2017.

Now, let us assume that both prices and consumption shares change from one consumer to the other. Specifically, given an average price p for good g at time t, consumer i faces a price $(1+\omega_i)p_g^t$, where ω_i is a random draw from a centered distribution. ω_i is individual-specific but approximately constant over two subsequent periods: you can think of it as an unpredictable determinant of the different prices people face, according to their geographical location, their favorite retail store and the purchasing platform they adopt.

We assume prices to be increasing, so that $p_g^{t+1} \geq p_g^t$, for each good. According to the Weber-Fechner's law, perceived absolute price changes are a linear function of the logarithm of relative price changes so that $OPI = \theta ln\frac{p_{t+1}}{p_t}$.[20] In line with Brachinger (2008), we interpret parameter θ to capture loss aversion, so that consumers perceive a price increase to be θ times higher than the actual variation, and $\theta > 1$. A random variable v_i, $v_i \sim N(0, \sigma_v^2)$ captures the noisy component of the OPI, where σ_v is arbitrarily small. The random parameter v_i can be interpreted as a measure either of declarative error or of objective unpredictable inflation heterogeneity (as documented by Kaplan and Schulhofer-Wohl, 2017, inflation heterogeneity is mostly uncorrelated with observables). The constant parameter θ and the idiosyncratic parameters q_{gi} and v_i explain the discrepancy between the CPI and the average OPI. q_{gi} and v_i explain the dispersion of the OPI across consumers.

If we call OPI_i the perceived individual-specific level of inflation, we can express it as follows:

$$OPI_i = \sum_{g=1}^{G} \frac{(1+\omega_i)p_g^{t+1} - (1+\omega_i)p_g^t}{(1+\omega_i)p_g^t} q_{gi}\theta + v_i = \sum_{g=1}^{G} \frac{p_g^{t+1} - p_g^t}{p_g^t} q_{gi}\theta + v_i = \theta\Pi_i + v_i. \tag{4}$$

In this model, although prices are imperfectly perceived and the level of perceived inflation is upward biased, its variation across individuals is meaningful, but scaled up by a factor θ and blurred by some noise v_i. For instance, a consumer facing an individual specific-level of inflation of 2% perceives it to be between $\theta\times$ 2% - $2\sigma_v$ and $\theta\times$ 2% + $2\sigma_v$ in 95% of the cases. Under this set of assumptions, we can account for the noisy component v and the behavioral parameter θ, so as to infer the effect of actual heterogeneous inflation on well-being. Both factors play against the estimated effect, so that the actual impact of heterogeneous inflation should be higher than the one estimated using OPI data.

When we account for the fact that OPI measures true experienced inflation Π noisily, the estimated conditional correlation between material satisfaction and experienced inflation is biased, due to a measurement error.[21] Under the standard assumption of classical measurement error, where the noise component has a zero-mean and it is independent from the true value of the mis-measured variable, the estimated coefficient $\widehat{\alpha}$ is biased toward zero. In other words, if we account for the noisy component v, the actual effect of inflation on well-being would be even stronger than the one estimated from our regression model. Hence, $\widehat{\alpha}$ represents

[20] Note that: $ln\frac{p_1}{p_0} = ln(\frac{p_1-p_0}{p_0}+1) \approx \frac{p_1-p_0}{p_0}$

[21] It is worth highlighting that measurement error affects the relationship between material satisfaction and unobserved experienced inflation, not between material satisfaction and perceived inflation.

a lower bound (in absolute terms) of the actual effect of heterogeneous inflation.

As for θ, we can draw a plausible value of the parameter from the experimental literature on loss aversion, where estimates converge on a value around 2 (Tversky and Kahneman, 1991; Novemsky and Kahneman, 2005). This number has been confirmed by estimations on life satisfaction data (Boyce et al., 2013) and already adopted in previous inflation perception models (Brachinger, 2008). If we set $\theta = 2$, the actual effect of a 1% increase in experienced inflation is thus double the one estimated using OPI data. The amplification is due to consumers' over-response to inflation, so that a 1% price increase is actually perceived as a 2% increase.

7. Conclusion

This study shows that inflation is an economic determinant of psychological well-being not only because of its variations over time, but also because of its variations among citizens. While income differences within a population have been shown to affect the distribution of well-being (with richer people being more satisfied), inflation differences were overlooked so far. By studying the inflation inequalities within a population, we showed that inflation differences matter to an extent that is at least as important as equivalent nominal income differences.

Our analysis has some limits, that future research should address. Firstly, our estimations are based either on self-reported measures of individual inflation or on indirect measures of inflation that were inferred from aggregate consumption habits. The first area to explore would be to study timely microdata on observed individual inflation and subjective well-being. Although this data set does not yet exist, we hope that our paper will encourage exploring this path.[22] Secondly, we cannot identify the precise psychological mechanism that links the OPI to material satisfaction. For instance, we are unable to disentangle the role of social comparisons (which are known to be a key factor for the well-being effects of heterogeneous nominal income, see Clark and Senik 2010). We attribute the stronger effect of inflation relative to nominal income to loss aversion, but current perceived inflation can also create anxiety and fear about future inflation, thus amplifying negative feelings - incidentally, experienced inflation is highly correlated with inflation expectations (see Weber et al., 2022). Thirdly, our study focuses on a specific country of the Euro Area. Future research might want to explore the generalizability of our results to other regions.

Our work embraces the empirical challenge of investigating individual-level inflation using parsimonious information from consumers. It follows the path pointed by Kaplan and Schulhofer-Wohl (2017), who conclude that "we have little ability to forecast household-level deviations from aggregate inflation [...]. Whether households can use their much larger information sets to make better forecasts of their idiosyncratic inflation rates is an important question that we leave for further research" (*ibid*, p.37).

Inflation has been mostly stable in Western nations for four decades, and inflation inequalities have not been an institutional priority. Yet, recent research reveals that inflation inequalities have been widening since the beginning of the inflation crisis (Avtar et al., 2022), as predicted by the positive relationship between aggregate inflation and inflation dispersion (Orchard, 2020). Our dataset corroborates this concern: the standard deviation of the OPI distribution moved from 2.7 in March 2020 to 9.7 in March 2022. In

[22]The daunting task of matching subjective survey answers with detailed micro-data about consumption bundles and item-level prices has already been undertaken before. In a terrific project, the *Chicago Booth Expectations and Attitudes Survey* interviewed over 90,000 households of the *Kilts Nielsen Consumer Panel*, that allows to construct a household CPI for non-durable consumption basket (D'Acunto et al., 2019). A promising avenue is the inclusion of questions about subjective well-being in the future waves of this or similar surveys.

other words, the average inflation gap reported by consumers widened by 7 percentage points. If inflation inequalities increase, their wellbeing cost will increase too.

In the ongoing context of a cost-of-living crisis, this study is a warning toward considering not only the average level of inflation, but also its dispersion among citizens. Its results support the need for a transition to more individual-specific measures of inflation. It echoes one of the core recommendations made by the French Economic Analysis Council already fifteen years ago (Moati and Rochefort, 2008) and responds to the recent appeal by the European Central Bank president about reforming how we conceive and measure inflation.[23] The well-being cost of the inflation crisis would be underestimated if looking at aggregate figures only.

[23]During the first year of her office, the ECB president, Christine Lagarde, stated that "We need to keep track of broad concepts of inflation that capture the costs people face in their everyday lives [...]. This is not about moving the goalposts for monetary policy. It is about future-proofing how we measure inflation." (30/09/20, "ECB and Its Watchers XXI" conference) <https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200930~169abb1202.en.html> [Accessed on 23/08/21].

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Appendix

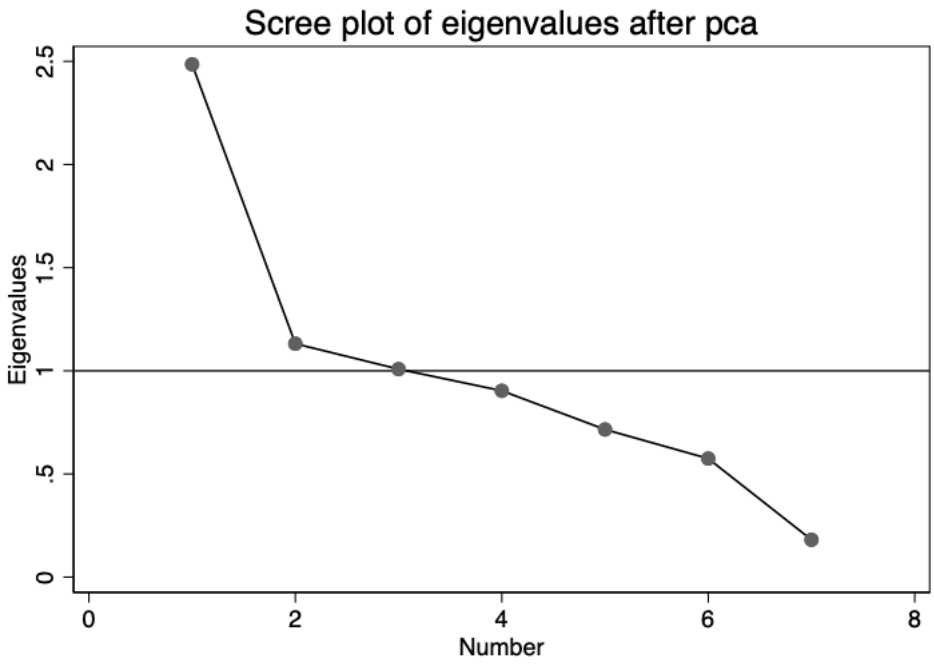
A1. Principal Component Analysis

For our Principal Component Analysis, we use the answers to the following seven questions:

- In the next twelve months, do you think that the number of unemployed people will... [1=strongly increase; 5=strongly decrease]
- In France, in the next twelve months, do you think that the general economic situation will... [1=clearly improve; 5=clearly deteriorate]
- In the current economic situation, do you think that it is a good moment for saving? [1=absolutely yes; 4=absolutely no]
- When you think about what you will live in the next years, to what extent are you satisfied with this perspective? [0=not satisfied at all; 10=completely satisfied]
- How do you think life will be for the next generation, in France? [0=much better than today; 10=much worse than today]
- How do you think life will be for the next generation, in the other European countries? [0=much better than today; 10=much worse than today]
- Some people would like to live in another epoch, in France. If you could choose, which one would you pick? [1=in the past, in the 50s; 8=in the future]

As a preliminary step, we check that this sample offers the statistical conditions for a Principal Component Analysis. Bartlett's test is highly significant ($p < 0.001$), meaning that there is sufficient intercorrelation among items to conduct factor analysis. The Kaiser-Meyer-Olkin Measure is 0.6, suggesting a good amount of variance overlapping. Figure A1 offers a visual illustration of the eigenvalues associated to each orthogonal component. The first two components have an eigenvalue statistically higher than 1 and, when combined, they explain 52% of the variations.

Figure A1: Screeplot of Principal Component Analysis



Note: The Principal Component Analysis of the replies to the seven questions about future outcomes singles out two components with an eigenvalue greater than 1, corresponding to the orthogonal traits of optimism and pessimism.

A2. Outliers

The present study deals with outliers by applying a symmetric trimming procedure: we remove all answers below the 10th percentile and above the 90th percentile in each survey wave. Figure A2 displays the distribution of answers on perceived inflation, for each survey wave. The upper trimming threshold changes at every wave, depending on the distribution of the answers. It can easily be noted that the threshold is higher in recent waves, when the distribution of the OPI shifts to the right, in line with higher average inflation. Table A1 compares the OPI in the trimmed (left panel) and untrimmed (right panel) sample. Although the trimmed sample has lower average OPI, between-group differences are qualitatively similar.

As a robustness check, we replicate our analyses while considering different strategies to deal with outliers. As a first solution, we trim the left and right 25% of the distribution of answers in each survey wave (25% distr. trim). As a second solution, we remove answers which estimate inflation to be beyond ±10% (10% level trim). The last strategy consists in winsorizing the top and bottom 10% of the distribution of answers in each survey wave, that is, setting all values below the 10th percentile to the 10th percentile, and all values above the 90th percentile to the 90th percentile (10% winsor).

Regression results are displayed in Table A2. Perceived inflation is a significant (at 99% level) predictor of material satisfaction, regardless of the data treatment, thus showing that results are not driven by the tails of the OPI distribution. On the contrary, the more extensive the trimming, the larger the size of the estimated coefficient associated with the OPI (up to 50% than in the baseline model, see upper panel). This pattern suggests that some level of trimming is indeed recommendable, since the data in the tails of the distribution are likely to be noisy and therefore to attenuate the regression coefficients.

Figure A2: Distribution of answers per wave.

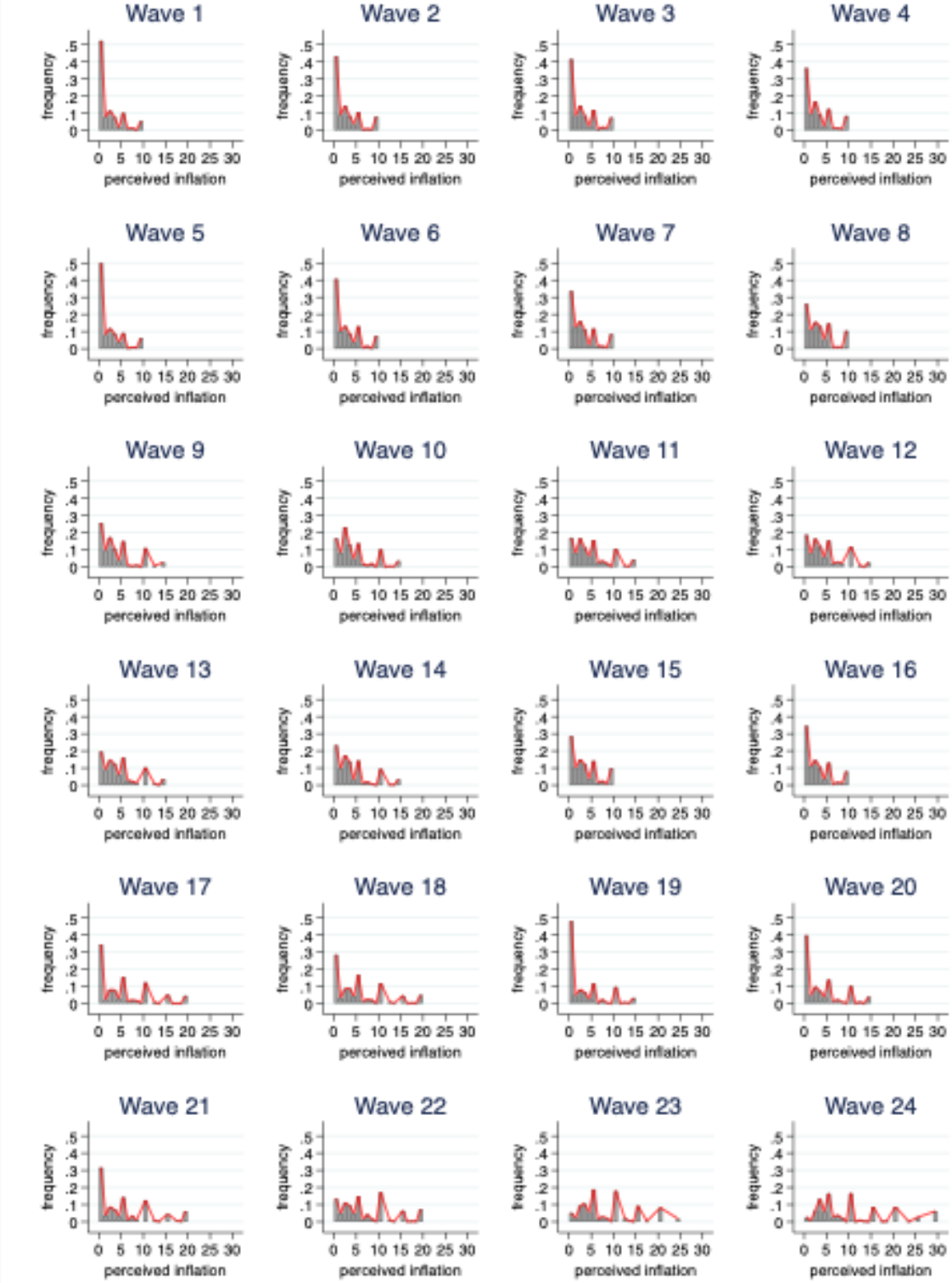


Table A1: Summary statistics of trimmed and untrimmed OPI.

	OPI (trimmed)			**OPI (untrimmed)**		
	mean	st.dev.	N	mean	st.dev.	N
Overall	3.88	4.59	23,142	5.92	9.50	25,209
Sex:						
Female	4.32	4.94	10,087	7.29	10.91	11,419
Male	3.54	4.27	13,055	4.80	7.98	13,790
Age:						
< 40	4.42	5.20	4,424	7.04	10.61	4,939
40-60	4.07	4.78	8,813	6.31	9.90	9,707
> 60	3.46	4.07	9,905	5.04	8.44	10,563
Income:						
1st quartile	4.54	5.08	3,820	8.32	12.67	4,428
2nd quartile	4.04	4.61	4,853	6.20	9.58	5,332
3rd quartile	4.03	4.55	5,320	5.83	8.68	5,757
4th quartile	3.42	4.29	5,965	4.48	7.12	6,263
Highest diploma:						
No diploma	3.91	4.30	2,578	7.27	12.27	2,927
High school (*bac*)	4.23	4.85	4,075	6.20	9.20	4,454
Graduate (*bac+5*)	3.12	4.19	3,388	3.86	6.39	3,517

Reading note: Estimated conditional means and standard deviations of trimmed and untrimmed OPI. Although the trimmed sample displays lower average perceived inflation, between-group differences are qualitatively similar.

Table A2: Results from different strategies to deal with outliers.

	(1)	(2)	(3)	(4)	(5)
time dummies	yes	yes	yes	yes	yes
socio-dem controls	no	yes	yes	yes	yes
other satisfaction	no	no	yes	no	yes
optimism/pessimism	no	no	no	yes	yes
(25% distr. trim)					
perceived inflation	-0.065***	-0.057***	-0.044***	-0.030***	-0.027***
	(-14.36)	(-12.52)	(-10.77)	(-6.29)	(-6.13)
log(income)	0.963***	0.842***	0.720***	0.735***	0.667***
	(51.74)	(35.19)	(34.09)	(28.50)	(28.30)
N	34799	34799	33685	26108	25607
Adjusted R^2	0.110	0.129	0.318	0.221	0.352
(10% level trim)					
perceived inflation	-0.064***	-0.057***	-0.044***	-0.031***	-0.027***
	(-17.09)	(-15.12)	(-13.13)	(-8.06)	(-7.75)
log(income)	0.957***	0.843***	0.723***	0.739***	0.672***
	(52.50)	(36.02)	(34.90)	(29.45)	(29.31)
N	36950	36950	35789	27900	27363
Adjusted R^2	0.110	0.128	0.317	0.226	0.355
(10% winsor)					
perceived inflation	-0.046***	-0.039***	-0.029***	-0.019***	-0.016***
	(-19.92)	(-16.82)	(-13.61)	(-7.85)	(-7.31)
log(income)	0.958***	0.852***	0.729***	0.750***	0.679***
	(54.43)	(37.46)	(36.19)	(30.67)	(30.42)
N	40225	40225	38992	30614	30038
Adjusted R^2	0.109	0.126	0.315	0.226	0.355

Reading note: Multivariate regressions of material satisfaction. t-statistics are in parentheses. Standard errors are computed by White formula. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Socio-dem. controls: age^2, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers). Other satisfaction: satisfaction with health, with social relationships and with free time. 25% distr. trimming = the distribution is truncated at the 25$^{\text{th}}$ and 75$^{\text{th}}$ percentiles, OPI $\in$ [0%;15%]. 10% level trimming = the distribution is truncated at levels below -10 and above +10, OPI $\in$ [-10%;10%]. 10% winsor = the distribution is wisorized at the 10th and at the 90$^{\text{th}}$ percentiles, OPI $\in$ [0%;30%].

A3. Non-response

The limited familiarity of French people on how percentages are calculated may explain the relatively high non-response rate to the quantitative question on inflation in this country (Accardo et al., 2011). Non-response may undermine the representativeness of our sample, whether the distribution of characteristics in respondents and non-respondents are different. We start by checking that the relationship between material satisfaction and non-response. The distributions of material satisfaction conditional on the individual reporting the OPI or not are virtually identical at the first, second and third moment. A Kolmogorov-Smirnov test fails to reject the null hypothesis that distributions are equal ($p < 0.001$).

In a further step, we replicate the analysis using three different imputation strategies: conditional mean imputation, multiple imputation and listwise deletion.

In the thorough ECB report on perceived inflation by Arioli et al (2015), the authors state that, in their graphs, "missing data have been calculated on the basis of the replies to the qualitative questions" (p. 17). The authors are referring to the following question: "Would you say that prices over the last 12 months prices have i) risen a lot; ii) risen moderately; iii) risen slightly; iv) stayed about the same; v) fallen", which is asked in the French Consumer Survey as well. Let us call this variable "qualitative index".

In the *conditional mean imputation*, we estimate the conditional first and second moment of perceived inflation for each response to the qualitative index, on the sample of respondents. We impute the conditional mean to non-respondents and add some white noise centered at zero and with standard deviation equivalent to the one estimated.[24] The advantage of the conditional mean is its robustness to mis-specification issues, and the advantage of the white noise component is to avoid artificially decreasing the variance of the explanatory variable.

For the *multiple imputation* strategy, we simulate 10 imputed datasets, where the missing values are generated as a linear prediction based on the qualitative index and time fixed-effects. The analysis is conducted over the 10 datasets separately and pooled according to Rubin's rules (Rubin, 1987). The advantage of this strategy is that it considers the uncertainty both in the estimation and in the imputation.

Finally, we also apply *listwise deletion*, that is, we exclude the entire record of an individual if the quantitative response on perceived inflation is missing.

Results are summarized in Table (A3). Across the three panels, estimations on the imputed samples show similar results to the ones from our baseline specification, both in terms of direction and magnitude of the estimated effects.

[24] Formally: $OPI_{nr}|q5 = (\bar{OPI}_r|q5) + u$, $u \sim N(0, \sigma_r|q5)$; where $q5$ is the qualitative opinion inflation, indexes r and nr refer respectively to respondents and non-respondents.

Table A3: Results from different imputation strategies.

	(1)	(2)	(3)	(4)	(5)
time dummies	yes	yes	yes	yes	yes
socio-dem controls	no	yes	yes	yes	yes
other satisfaction	no	no	yes	no	yes
optimism/pessimism	no	no	no	yes	yes
(conditional mean imputation)					
perceived inflation	-0.038***	-0.032***	-0.024***	-0.018***	-0.015***
	(-15.68)	(-13.51)	(-11.05)	(-7.18)	(-6.67)
log(income)	0.962***	0.851***	0.735***	0.754***	0.687***
	(51.72)	(35.68)	(34.69)	(29.72)	(29.60)
N	35258	35258	34250	27197	26705
Adjusted R^2	0.107	0.126	0.312	0.226	0.352
(multiple imputation)					
perceived inflation	-0.042***	-0.037***	-0.028***	-0.018***	-0.016***
	(-18.00)	(-15.81)	(-13.76)	(-6.99)	(-6.88)
log(income)	0.979***	0.857***	0.735***	0.756***	0.689***
	(54.65)	(36.78)	(35.65)	(30.35)	(30.27)
N	37616	37616	36487	28712	28172
(listwise deletion)					
perceived inflation	-0.048***	-0.042***	-0.032***	-0.023***	-0.020***
	(-16.97)	(-14.57)	(-12.21)	(-8.01)	(-7.53)
log(income)	0.964***	0.859***	0.750***	0.784***	0.717***
	(42.61)	(30.09)	(29.45)	(27.19)	(27.07)
N	23027	23027	22551	19168	18887
Adjusted R^2	0.111	0.128	0.303	0.227	0.348

Reading note: Multivariate regressions of material satisfaction. t-statistics are in parentheses. Standard errors are computed by White formula. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Socio-dem. controls: age^2, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers). Other satisfaction: satisfaction with health, with social relationships and with free time.

A4. Linear estimation from cross-section, first wave

Table A4: Linear esimations of the impact of perceived inflation on material satisfaction. Cross-section, June 2016 only.

	(1)	(2)
perceived inflation	-0.084***	-0.077***
	(-4.05)	(-3.71)
log(income)	0.939***	0.805***
	(9.90)	(7.00)
socio-dem. controls	no	yes
N	1725	1725
Adjusted R^2	0.092	0.134

Reading note: Multivariate regressions of material satisfaction. t-statistics are in parentheses. Standard errors are computed by White formula. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Controls: age, gender, couple, age^2, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers).

A5. Nonlinear estimation strategies

Although OLS offer easy-to-interpret results, they are valid under the simplifying assumption that responses correspond to a cardinal ranking of individuals' satisfaction. In a second step, we relax this assumption and move to an ordinal interpretation. When we estimate the model by Ordered Probit, results (Table A5) are qualitatively similar. The marginal effect of perceived inflation is significant and negative along the satisfaction scale, consistently with OLS. We can also estimate the predicted probabilities from the whole sample, conditional on some values of the OPI: a person who perceives inflation to be 1% has 2-percentage-points higher chance to report a level of satisfaction equal or higher than 8 ($P(\widehat{h} \geq 8) = 29\%$) than a person who perceives inflation to be 5% ($P(\widehat{h} \geq 8) = 27\%$).

In spite of Ordered Probit being a standard approach for subjective well-being practitioners, recent criticisms (Schroeder and Yitzhaki, 2017; Bond and Lang, 2019) point out that its underlying assumptions are stronger than they seem at first sight.[25] To account for this criticism, we focus on a measure of central tendency which respects subjective well-being properties under much weaker conditions: the median. In doing so, we follow the recommendation by Chen et al. (2019) and estimate the model by quantile regression, with bootstrapped standard errors. Although the estimation is computationally intensive, results (presented in Table A6) are relatively easy to interpret. The coefficient associated to the OPI is significantly different from zero and maintains a negative sign. Its magnitude tells us that a 1-point increase in perceived inflation is associated with a decrease in the conditional *median* of material satisfaction by 0.017-0.041 (columns (5)-(1)) scale points.

[25] It requires that under the cardinalization hypothesized by the satisfaction scale (drawn from an infinite number of possible cardinalizations) the variance of satisfaction is equal for all groups. Bond and Lang (2019) reject this assumption for nine well-known studies in the happiness literature and show that simple log-normal transformations (which preserve the ranking order) can reverse the published results. Kaiser and Vendrik (2019) offers an elegant counter-criticism where they show that reversals can happen only under highly implausible hypotheses about the report function.

Table A5: Ordered Probit estimations of the impact of perceived inflation on material satisfaction.

	(1)	(2)	(3)	(4)	(5)
perceived inflation	-0.028***	-0.024***	-0.020***	-0.013***	-0.013***
	(-16.96)	(-14.57)	(-11.97)	(-7.30)	(-6.88)
log(income)	0.566***	0.512***	0.503***	0.496***	0.499***
	(52.09)	(36.46)	(35.36)	(30.13)	(30.08)
age		-0.016***	-0.024***	-0.016***	-0.022***
		(-7.02)	(-10.53)	(-5.82)	(-8.16)
age^2/100		0.015***	0.025***	0.015***	0.023***
		(7.42)	(11.98)	(6.10)	(9.00)
1 if male		-0.037***	-0.041***	-0.077***	-0.074***
		(-3.16)	(-3.47)	(-5.76)	(-5.44)
sat. with health			0.110***		0.092***
			(34.87)		(24.86)
sat. with free time			0.170***		0.155***
			(52.07)		(41.19)
sat. with social rel.			0.091***		0.088***
			(21.58)		(17.65)
optimism				0.244***	0.184***
				(50.14)	(36.51)
pessimism				0.008	-0.010
				(1.15)	(-1.44)
time dummies	yes	yes	yes	yes	yes
socio-dem controls	no	yes	yes	yes	yes
N	38161	38161	36975	28932	28382
Pseudo R^2	0.029	0.034	0.097	0.065	0.112

Reading note: Multivariate regressions of material satisfaction. z-statistics are in parentheses. Standard errors are computed by White formula. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Socio-dem. controls: age^2, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers).

Table A6: Median regression estimations of the impact of perceived inflation on material satisfaction.

	(1)	(2)	(3)	(4)	(5)
perceived inflation	-0.041***	-0.034***	-0.029***	-0.014***	-0.017***
	(-13.81)	(-11.06)	(-11.93)	(-4.27)	(-5.84)
log(income)	0.998***	0.899***	0.693***	0.749***	0.672***
	(46.77)	(36.64)	(28.61)	(27.13)	(24.87)
age		-0.023***	-0.030***	-0.018***	-0.026***
		(-5.26)	(-7.16)	(-4.21)	(-6.04)
age^2/100		0.022***	0.032***	0.019***	0.027***
		(5.34)	(8.38)	(4.54)	(6.77)
1 if male		-0.076***	-0.052***	-0.109***	-0.091***
		(-3.98)	(-2.67)	(-4.96)	(-4.35)
sat. with health			0.166***		0.131***
			(32.98)		(22.25)
sat. with free time			0.249***		0.212***
			(49.80)		(37.43)
sat. with social rel.			0.145***		0.133***
			(20.99)		(16.77)
optimism				0.373***	0.244***
				(48.27)	(32.93)
pessimism				0.028***	0.003
				(2.75)	(0.36)
time dummies	yes	yes	yes	yes	yes
socio-dem controls	no	yes	yes	yes	yes
N	38161	38161	36975	28932	28382
Pseudo R^2	0.039	0.050	0.163	0.100	0.179

Reading note: Multivariate regressions of material satisfaction. z-statistics are in parentheses. Standard errors are computed by bootstrapping (100 reps). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant and a dummy variable for imputed values. Socio-dem. controls: age^2, education level, marital status, region of residence, size of urban unit of residence, employment status (employed, inactive, unemployed, retired, student or civil servant), category of occupation (managers, intermediate, clerks, workers).

A6. Section 5 Appendix 5

Data

The matching process allows two samples to be created, which are at the same time augmented (in the sense that they contain more variables for each individual than the original sample) and reduced (in the sense that they contain less individuals than the original sample). The first sample contains information on commuting habits, perceived inflation and material satisfaction from over 5,000 individuals in the second semester of each of the following years: 2016, 2017, 2018 and 2019. Among them, 3,307 regularly commute either by car/motorbike (2,613) or not (694). To enhance comparability of the two groups of consumers, we restrict the sample to people who regularly commute (i.e., who are employed and do not work from home). The data set contains 3,295 individual reports of material satisfaction and 1,400 of perceived inflation. The second sample groups together 4,410 individuals, interviewed in the second semester of 2016 and in both semesters of 2017. For them, we know if they own (3,378 individuals) or rent (1,029 individuals) their home, their material satisfaction (4,372 answers) and the level of perceived inflation (1,628 answers). We exclude from the analysis three subjects who do not report if they are owners or tenants.

Regression tables

Tables A7 and A8 display the coefficients associated to the linear regressions of the OPI (column (1)) and material satisfaction (column (2)) on the treatment variable (being a car commuter and being a tenant, respectively), its interaction with the gasoline price, and time dummies. The coefficients reported in tables 4 and 5 can be retrieved from these two tables.

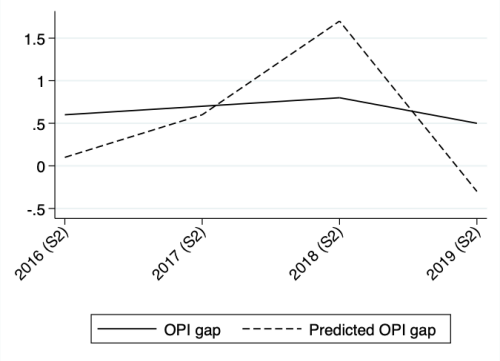
Predicted vs observed OPI

Herein, we calculate the differences in the OPI between groups of consumers which would be predicted by macroeconomic data. The calculation is done under the (simplified) assumption that the groups of people who do not consume a good g (non-car commuters, owners) experience a level of inflation (Π) equal to the average inflation rate (CPI). On the other hand, it assumes that the group of people consuming g (car commuters, tenants) experiences a level of inflation which is in line with the CPI except for the proportion of their consumption basket devoted to the good g. As for the mapping from experience to perceived inflation, we use Equation 4.

For the calculation, we use data on the average annual inflation (the CPI), the average annual change of gasoline price index (GPI) and of the housing price index (HPI) and the average share of the relevant good in the consumers' basket. As for the expenditure shares, we consider car commuters to devote 5% of

their expenditure to gasoline, and tenants to devote 20% of their expenditure to the rent.[26] We apply a loss aversion parameter of 2. We can calculate the predicted mean difference in the OPI reported by car commuters and non-car commuters as follows: $2 \times ((0.05 \times \text{GPI} + 0.95 \times \text{CPI}) - \text{CPI})$. As for housing, the predicted between-group differences in aggregate OPI is computed as: $2 \times ((0.20 \times \text{HPI} + 0.80 \times \text{CPI}) - \text{CPI})$. This is a back-of-the-envelope calculation and should be treated as such.

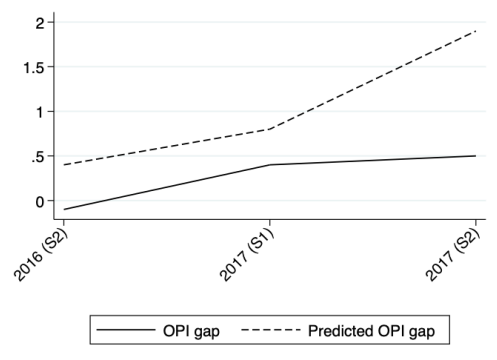
Figure A3: Predicted and observed OPI gap between people who commute with vs without a car



Reading note: Predicted OPI gap: Predicted mean difference in the OPI reported by car commuters and non-car commuters, computed as: $2 \times ((0.05 \times \text{GPI} + 0.95 \times \text{CPI}) - \text{CPI})$. OPI gap: Average mean difference in the OPI reported by car commuters and non-car commuters. Data are from the second semester of each year.

[26]Source: INSEE, TM207. Available at: <https://www.insee.fr/fr/statistiques/4648319?sommaire=4648339> [Accessed on 09/09/21]. For commuters, it corresponds to an average-income-earner (€27,700) who commutes 30km to work, for 230 days per year, with a car consuming 7 liters per 100 km. For tenants, it corresponds to on an average-income-earner (€27,700) who pays €460 in monthly rent.

Figure A4: Predicted and observed OPI gap between people who own vs rent their house



Reading note: Predicted OPI gap: Predicted mean difference in the OPI reported by tenants and owners, computed as: 2 × ((0.20×HPI + 0.80×CPI) - CPI). OPI gap: Average mean difference in the OPI reported by tenants and owners, st.error in parentheses. Data are from the second semester of 2016, and both semesters of 2017.

Table A7: Linear estimations of the impact of gasoline prices on heterogeneous groups of consumers

	(1)	(2)
	OPI	Mat.Satisfaction
commute by car × GPI	0.015***	-0.010***
	(9.75)	(-4.75)
commute by car	0.561***	-0.035
	(24.71)	(-1.11)
2016	-1.184***	0.020
	(-22.20)	(0.70)
2017	-0.983***	0.230*
	(-52.52)	(2.73)
2019	-0.413***	0.020
	(-19.50)	(0.71)
socio-dem controls	no	yes
N	2008	3296
Adjusted R^2	0.026	0.099

Reading note: Linear regressions with standard errors clustered at the "commute by car × GPI" level. Dependent variable: OPI (column (1)) and material satisfaction (column (2)). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant. Socio-demographic controls include a dummy variable for missing income values, which are imputed with the sample mean if missing. Baseline is "does not commute by car" and "2018".

Table A8: Linear estimations of the impact of housing prices on heterogeneous groups of consumers

	(1)	(2)
	OPI	Mat. satisfaction
tenant × HPI	0.314***	-0.044
	(29.36)	(-1.00)
tenant	-0.574***	-0.095
	(-32.61)	(-1.27)
2016(S2)	-0.061***	-0.101***
	(-12.99)	(-7.86)
2017(S1)	-0.195***	-0.055
	(-15.81)	(-1.06)
socio-dem controls	no	yes
N	2561	4372
Adjusted R^2	0.002	0.101

Reading note: Linear regressions with standard errors clustered at the "tenant × HPI" level. Dependent variable: OPI (column (1)) and material satisfaction (column (2)). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include a constant. Socio-demographic controls include a dummy variable for missing income values, which are imputed with the sample mean if missing. Baseline is "own their home" and "2017(s2)".

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