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ORIGINAL PAPER

# The Euro Changeover and the Factors Influencing Perceived Inflation

**Helmut Jungermann · Hans Wolfgang Brachinger · Julia Belting · Katarzyna Grinberg · Elisabeth Zacharias**

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**Abstract** The most flamboyant economic effect of the euro changeover on consumers was a dramatic increase in perceived inflation. To directly measure perceived inflation, Brachinger developed a new index of perceived inflation (IPI). This index is based on some hypotheses about factors influencing perceived inflation. An experimental study is presented which investigated the influence of two of these hypothesized factors, purchase frequency and loss aversion, on individual judgments of price changes. Furthermore, two additional factors have been included that are informative with respect to the IPI, product segment and price level. Judgments of inflation were assessed with three methods, yielding different results. Empirical evidence for the hypotheses was obtained.

**Keywords** Perceived inflation · Index of perceived inflation (IPI) · Loss aversion · Purchase frequency

**JEL classification** C43 · E31 · D81

H. Jungermann (✉) · J. Belting · E. Zacharias
Institute of Psychology and Ergonomics, Technical University of Berlin,
Franklinstrasse 28/29, 10587 Berlin, Germany
e-mail: jungermann@gp.tu-berlin.de

J. Belting
e-mail: belting@gp.tu-berlin.de

E. Zacharias
e-mail: bettyzacharias@yahoo.de

H. W. Brachinger · K. Grinberg
Department of Quantitative Economics, University of Fribourg,
Bd. de Pérolles 90, 1700 Fribourg, Switzerland

H. W. Brachinger
e-mail: HansWolfgang.Brachinger@unifr.ch

K. Grinberg
e-mail: Katarzyna.Grinberg@unifr.ch

In January 2002, the euro notes and coins were introduced in 12 member states of the European Union. The most flamboyant economic effect of the Euro changeover on consumers was a dramatic increase in perceived inflation. Already in the spring of 2002 the general public in the euro zone perceived exceptionally high inflation. This perception entailed an increased awareness of price changes and inflation. It resulted in widespread scepticism about the relevance of official statistics, since it stood in stark contrast to the official inflation rates. In May 2002, the European inflation rate, at 2.0%, exhibited the same level in the twelve months to May as had been recorded just prior to the introduction of euro notes and coins. In Germany, the official consumer price index (CPI) in May 2002 had risen by only 1.1% over the previous twelve months and was at its lowest level since November 1999 (1.0%). The results for the other member states were similar.

For practically all countries in the euro zone, the wide gap between perceived and officially measured inflation became evident by comparing the development of the official CPI with the development of the perceived inflation balance generated within the EU Consumer Survey. This survey is part of the Joint Harmonised EU Programme of Business and Consumer Surveys (EC 2003) set up by the European Commission to "provide essential information for economic surveillance, short-term forecasting and economic research." Among other questions this survey asks a Europe-wide sample of 21,000 consumers how, in their opinion, consumer prices have developed over the last 12 months.

On the basis of the distribution of the various answers, an *aggregate balance* is calculated which can oscillate between a minimum value of −100, when all respondents think that the prices have "fallen", and a maximum value of +100, when all respondents perceive that prices have "risen a lot." The development of the time series for this balance for Germany since 1995 is shown by the dotted line in Figure 1 (left scale).

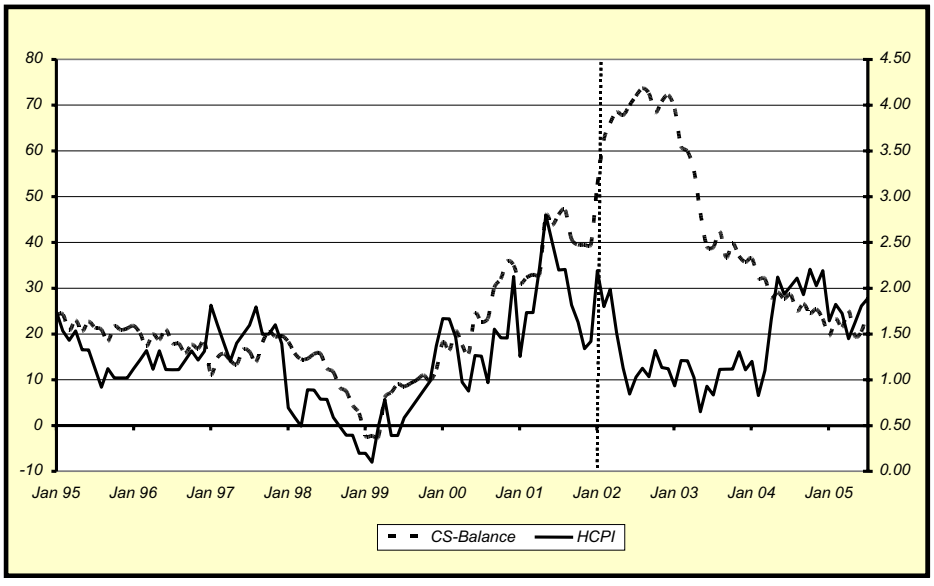


**Fig. 1** Harmonised consumer price index ("HCPI"; rescaled *right-hand scale*) and perceived inflation ("CS-Balance"; *left scale*) in Germany from 1/95 to 6/05

To provide a comparison between official inflation and inflation perceived by the general public, the harmonised consumer price index (HCPI) for Germany is shown next to the aggregate balance. It can be readily seen that the time series of the Consumer Survey balance on perceived inflation peaks markedly around the time of the introduction of euro notes and coins and that for 2004 it shows a clear decrease compared to 2002. It is evident that this time series parallels the CPI until 2002. Then a "gap" between the two time series opens until it closes down again already in 2004.

If the balance of the response categories is high, it suggests, in fact, that the proportion of those in the target population who perceive prices as having increased clearly surpasses that of the respondents who perceived the opposite. In this respect, this indicator shows something about the extension of higher perceived inflation. However, this indicator does not say anything regarding the change of the level of perceived inflation itself, measured in percent. Furthermore, this indicator does not reveal anything about the factors influencing perceived inflation.

In several papers, Brachinger developed a new index to measure perceived inflation (see Brachinger 2005, 2006, 2007). This *index of perceived inflation* (IPI) was constructed primarily as an instrument to assess perceived inflation rates comparable with official CPI rates. The index is based on hypotheses about inflation perception, which specify factors influencing perceived inflation. These hypotheses are derived from Kahneman and Tversky's (1979) prospect theory and their availability heuristic (Tversky and Kahneman 1973).

In the following, the key hypotheses of the IPI will first be introduced. Then an experimental study will be presented which investigated whether the influence of two of the factors hypothesized by Brachinger could be demonstrated in individual judgments of price changes. These factors are purchase frequency and loss aversion. Two additional factors were included that are also informative with respect to the IPI, product segment and price level.

## The IPI Hypotheses of Perceived Inflation

### Reference Prices

The first basic hypothesis about inflation perception assumes that in a preliminary perception phase the price of each good the buyer is confronted with is, isolated from other goods, encoded as *gain* or *loss* with respect to a *reference price* specific to that good. For instance, a 60-euro menu does not cost just 60 euros, but will be perceived as relatively expensive or relatively cheap depending on the reference point. If a patron at a restaurant expects a menu price of 60 euros (that would be his reference point) and is charged only 45 euros, he will consider the difference as a "gain." However, if he had expected a 30-euro menu and is confronted with a 45-euro check, he will rate this difference as a considerable "loss." The purpose of the IPI is a measurement of annual perceived inflation rates, which are comparable with the official German CPI rates. The CPI time series refers to prices of the base period. For temporal consistency with that series, also in the IPI, the prices of the base period are taken as reference prices.

However, there is overwhelming evidence that the majority of people in the euro zone, up to 2006, still converted actual euro prices into prices in the previous national currency and compared them with some base prices in national currencies (cf. EC 2006). If the goal is to model the inflation perception of those purchasers who, years after the introduction of euro notes and coins, still calculate in the previous currency, some other prices have to

serve as reference prices in the IPI. These reference prices have to be some function of prices in the previous currency and euro prices, for instance, some kind of moving weighted average of such prices. An approach to quantify inflation perception taking into account the purchasers' base price rigidity is developed in Brachinger (2006).

Loss Aversion

The second hypothesis of the IPI model assumes that price changes are evaluated according to a value function $V$, whereby price increases (losses) are evaluated higher than price reductions (gains). This means that the buyer reacts much more sensitively to price increases than to price reductions. This asymmetric evaluation, labelled loss aversion by Kahneman and Tversky (1979), is performed individually for every price change to which the consumer is confronted.

Formally, it is assumed that each current price $p_t(i)$ of a given good $i$ is not only encoded as gain or loss through the additive comparison with the corresponding good-specific reference price $p_0(i)$ but also evaluated according to the value function

$$V_i(p_t(i)) = \begin{cases} p_t(i) - p_0(i) & \text{for } p_t(i) \le p_0(i) \\ c_i(p_t(i) - p_0(i)) & \text{for } p_t(i) > p_0(i) \end{cases}. \quad (1)$$

In this value function it is assumed that the valuation of (small) price changes is linear and that the ratio between an evaluated price increase and (the absolute value of) an evaluated price decrease of the same extent equals $c_i$. The loss aversion assumption implies that this good-specific "loss aversion coefficient" is greater than unity, that is, $c_i > 1$.

The loss aversion assumption is central to the prospect theory developed by Kahneman and Tversky (1979) as a descriptive model for individual decision-making. It has been argued that the loss aversion phenomenon is restricted to decisions among monetary gambles (e.g., Hoffmann et al. 2006). However, there is ample evidence that loss aversion can be observed in a wide variety of economic domains. These range from labour economics, where downward-sloping of labour supply can be observed (Camerer et al. 2004), to consumer research, where asymmetric price elasticities have been found (Hardie et al. 1993) (for an overview, see Camerer 2004).

The decision-making literature also contains indications of how high to set the loss aversion of decision-makers in general. Tversky and Kahneman (1991) allude to a loss aversion coefficient "slightly greater than two" (p. 1053) resulting from an experiment on individuals' willingness to pay. They stress that from a series of experimental findings on individual decision-making under risk, a loss aversion coefficient of about 2 can be derived. In a lottery experiment with real payments, a loss aversion coefficient of 2.5 was found. In a more recent article, Kahneman (2003) points out once again that "estimates of the coefficient of loss aversion...converge on a value of about 2" (p. 164). Hardie et al. (1993) attempted to measure the loss aversion coefficient within the framework of an experimental study dealing with brand selection. They arrived at the conclusion that this coefficient, depending on the variable observed, lies in an interval between 1.5 and 2.5. This is the reason why for the calculation of the German IPI the loss aversion coefficient has been set to the value $c=2$.

Moreover, it is an interesting question whether loss aversion, in fact, can also be observed in the context of inflation perception and, if yes, whether the loss aversion coefficient, in fact, amounts to a value of around 2.

Psychophysical Law

There is a large body of evidence that the Weber–Fechner psychophysical law holds for various specific sensations like, for instance, weight or light. There is also evidence that it holds for price changes. For instance, Tversky and Kahneman (1981) have noted that a discount of $5 has a greater impact when the price is low than when the price is high. From the Weber–Fechner Law it follows that the perception of prices is logarithmic, which corresponds to the assumption of decreasing marginal returns widely employed in economics.

Accordingly, the third hypothesis of the IPI model assumes that the Weber–Fechner psychophysical law also holds for the perception of price changes, that is, that the perception of a price change is a linear function of the relative price change. Formally, it is assumed that for the perception $\Delta p_t$ of a price change $p_t(i)-p_0(i)$

$$\Delta p_t = c\left(\frac{p_t(i)-p_0(i)}{p_0(i)}\right) \tag{2}$$

where the linearity parameter $c$ is independent of the good $i$ (cf. Brachinger 2007, for details). Note that because

$$c\left(\frac{p_t(i)-p_0(i)}{p_0(i)}\right) = \frac{c(p_t(i)-p_0(i))}{p_0(i)} \tag{3}$$

the linearity parameter $c$ matches the loss aversion coefficient $c_i$ in Eq. 1, it follows that the loss aversion coefficient $c_i$ does not depend on the good, that is, $c_i = c$ for every good $i$. However, according to the loss aversion hypothesis, a difference is made between price increases and price decreases. The former are valued higher than the latter, that is, the constant $c$ should be higher for price increases than for price decreases.

Purchase Frequencies

A fourth hypothesis states that the average purchaser assesses inflation to be higher the easier it is for him or her to retrieve from memory examples of noticeable price increases. This frequency hypothesis is based on the idea that *availability* (Tversky and Kahneman 1973), that is, ease of memory retrieval, is a crucial factor in inflation perception. It is thus suggested that the ease with which examples of increased prices are retrieved from memory depends on personal experience in buying acts of the average purchaser. Accordingly, price reductions of goods purchased infrequently or of goods charged once a month such as rent on an apartment, have barely any effect at all on inflation perception.

Recall is strengthened by two forces: other incidents during which one is forced to recall some information, and the time one spends actively processing a piece of information (e.g., visualising it, spelling it forwards and backwards, etc). Both forces come into play in the context of inflation perception. In the case of a frequently bought good, the price change of that good is recalled more often than in the case of a good which is seldom purchased. The time spent actively processing a certain price change is clearly longer for frequently bought goods. So the frequency hypothesis seems sensible.

## Experimental Study

### Task

Participants of the study were asked to estimate price changes for specific goods and services. For each good, the participants were given its "actual" price twelve months ago as reference price. This reference price, in the sequel denoted by *rp04*, was the good's official average price the Statistical State Office Berlin had surveyed in October 2004 and delivered to the Federal Statistical Office for the calculation of the German CPI. Note that the participants were thus given fixed reference prices as it is assumed in the IPI. Then the participants were asked to estimate, in comparison with these reference prices, the corresponding present prices, denoted by *ep05*, or price changes. Three methods were used for eliciting participants' estimates (see Table 1). These methods were adapted from psychophysics, where such methods are applied in order to elicit subjective estimates of stimuli.

With method 1, participants were simply asked to estimate the present price of the product. For instance: "12 months ago, 500 g of coffee did cost 3.49. How much do 500 g of coffee cost now?" If a participant estimates that the present price is 3.99, he or she should enter 3.99 in the specified field (see Table 1). With method 2, participants were given a range of ten prices, five prices below and five prices above the reference price. The series of the five prices above (below) the reference price was generated by gradually increasing (decreasing) the reference price by a constant percentage (approximately 1%). Then the participants had to mark the price that they felt to be closest to the current price of the product. In the example in Table 1, the participant marked the price 0.93 as the price coming next to the actual price of 100 g of sausage. With method 3, participants estimated the price change in terms of euro or cents. For instance, if a participant knows that newspapers presently cost on average 0.80, he or she should enter the difference between the past price (0.56) and the present price (0.80), that is, 0.24 (see Table 1).

**Table 1** The three methods to elicit price estimates

<table>
<tr><th>Method 1</th><th>Method 2</th><th>Method 3</th></tr>
<tr>
<td>"12 months ago, 500 g of coffee cost 3.49 €. How much does 500 g of coffee cost presently?"<br>3.99€<br>----------</td>
<td>"12 months ago, 100 g of sausage cost 0.91 €. How much does 100 g of sausage cost presently?"
<table>
<tr><th>Price in 2005</th><th>Yes</th><th>No</th></tr>
<tr><td>0.96 €</td><td></td><td>X</td></tr>
<tr><td>0.95 €</td><td></td><td>X</td></tr>
<tr><td>0.94 €</td><td></td><td>X</td></tr>
<tr><td>0.93 €</td><td>X</td><td></td></tr>
<tr><td>0.92 €</td><td></td><td>X</td></tr>
<tr><td>0.91 €</td><td></td><td>X</td></tr>
<tr><td>0.90 €</td><td></td><td>X</td></tr>
<tr><td>0.89 €</td><td></td><td>X</td></tr>
<tr><td>0.88 €</td><td></td><td>X</td></tr>
<tr><td>0.87 €</td><td></td><td>X</td></tr>
<tr><td>0.86 €</td><td></td><td>X</td></tr>
</table>
</td>
<td>
<table>
<tr><th>Product</th><th>Price 10/2004</th><th>Price change</th></tr>
<tr><td>500 g of lentil</td><td>0.87 €</td><td>+ 0.50</td></tr>
<tr><td>100 g of sausage</td><td>0.91 €</td><td>+ 0.20</td></tr>
<tr><td>Newspaper</td><td>0.56 €</td><td>+ 0.24</td></tr>
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## Items

Thirty goods and services were selected from the official market basket of 620 goods and services for which the Statistical State Office Berlin surveys prices for the German CPI (Table 2). Items with high price fluctuations (e.g., due to seasonal availability) were excluded.

Items were chosen such that they differed on the following four factors: (1) *Price development* (from October 2003 to October 2004). Based on a comparison of the official average prices of October 2004 and October 2003, items were categorized in five groups with six items in each group: highly above average inflation (from +10.1 to +5.4%, e.g., razor blades), moderately above average (from +5.0 to +2.0%, e.g., newspapers), average (from +1.9 to −1.9%, e.g., hand cream), moderately below average (from −2 to −5%, e.g., scales), and highly below average (from −5.1 to −10.6%, e.g., blank CD). (2) *Product segment*. "Food" items (13 items, e.g., apple purée), "non-food" items (13 items, e.g., shoe polish), and "service" items (four items, e.g., haircut men) were selected, since perceived inflation was expected to be higher for food than for non-food or services. (3) *Price Level in October 2004*. Items that had a "high" price (two items, e.g., TV satellite set), a "medium" price (seven items, e.g., scales), or a "low" price (22 items, e.g., tooth paste) were selected assuming perceived inflation being higher for cheap than for expensive products and services. (4) *Purchase Frequency*. Since statistical data regarding the purchase frequencies of the selected goods in Berlin were not available, a pre-test was run in which 20 participants judged the frequency on a three-point scale as "low" (15 items, e.g., game collection), "medium" (five items, e.g., pack of biscuits), or "high" (eight items, e.g., sausage).

The 30 items were divided into three groups of ten with largely the same representation of factor levels. The reason for this partition is explained below together with the procedure description.

## Questionnaire and Procedure

The study was run in the fall of 2005 and was designed as a paper–pencil survey. Participants received a questionnaire which had general instructions followed by three sections (see Zacharias 2006, for details). In each section, one of the above-described three methods

**Table 2** The selected 30 goods and services

| Products and services | | |
|---|---|---|
| Sausage | Milk | Apple juice |
| Newspaper | Spinach | Potato chips |
| Beer | Colour cartridge | Potatoes |
| Chocolate | Fee P.M. gym | Tooth paste |
| Apple purée | Wallpaper | Fish sticks |
| Sparkling wine | Razor blades | TV satellite set |
| Per night/pension | Game collection | Scales |
| Shoe polish | Lentils | Hairbrush |
| Vitamin C pills | Packet of biscuits | Potted plant |
| Blank CD | Hand cream | Haircut men |

was used to elicit estimates for ten goods. In other words, each participant judged 30 items in total, 10 with each of the three methods. The sequence of the three methods was balanced among subjects. Likewise, every item of the 30 goods was measured with each method. The main section of the questionnaire was concluded by a question regarding the purchase frequency of each good ("never", "occasionally", "often").

Finally, two global questions concerning inflation were added. The first question was the EU consumer survey question on price development over the last 12 months mentioned in the introduction. The participants were accordingly asked: "How do you think that consumer prices have developed over the past 12 months: 1 = risen a lot, 2 = risen moderately, 3 = risen slightly, 4 = stayed about the same, 5 = fallen?" The second question was a direct question for a numerical inflation estimate: "What was the annual inflation rate in 2005 (Jan–Oct)? Please write down your estimate: __ %."

Seventy-nine participants were recruited to the study. Their mean age was 35 years (range 20–68 years) with 62% women. Students (35%) were approached in classes, the remaining participants came from a pool of people who volunteer to take part in studies. All filled in the questionnaire under supervision.

## Results

### Organization and Processing of Data

For each single estimated (mean) price *ep05* the corresponding perceived inflation rate *pi*05=*pi*(*ep*05; *rp*04) (in %) relative to the official reference price *rp04* was calculated as

$$pi = \frac{ep05 \times 100}{rp04} - 100.$$

The perceived inflation rates can be arranged in a (79×30)-matrix. Each row of that data matrix represents a participant and contains all perceived inflation rates of that subject over the set of the 30 goods and services considered. Ten of these rates are based on *method 1*, ten on *method 2*, and ten on *method 3*. The order of the three methods varies over the three groups of participants. Each column of the matrix represents a certain good or service and contains the perceived inflation rates retrieved for that good, about a third of which were each retrieved by one of the three methods outlined above.

For each column of the data matrix, that is, for each item, four average perceived inflation rates (*api*-rates) were calculated. First, for each column of the data matrix the average over all rows was calculated, that is, over all the perceived inflation rates (elicited by the different methods) in that column. The resulting 30 summary *api*-rates were used for the analysis of the effects of the four factors introduced before, independent of the elicitation method used.

Then, for each of the three methods separately, the arithmetic mean of the perceived inflation rates elicited by that method was calculated for each good or service. That is, for each column of the data matrix the average was taken for that third of the rows containing *pi*-values elicited by one and the same method. This leads, for each good or service, to three *api*-rates, each of which is specific for one of the three elicitation methods. These method-specific *api*-rates were used to examine the effect of the factors subject to the three elicitation methods and to compare the three methods with one another.

## Analysis of Summary Api-Rates

### *Frequency of Purchase*

For the analysis of the influence of purchase frequency on perceived inflation, the purchase frequencies employed by Brachinger (2005) for the IPI calculation (see Bechtold et al. 2005) were not used because they apply to Germany on the whole and might be different in Berlin. Therefore, the participants of the study were asked in the questionnaire to provide their personal judgment of the frequency with which they usually buy each good. This implies that the same good can be judged as being bought "occasionally" by one participant and as being bought "often" by another. Therefore, in an initial step for each individual participant, three *api*-rates were calculated: One for those goods which the participant judged as being bought "never", one for those being bought "occasionally", and one for those being bought "often". In the next step, an aggregate *api*-rate for each purchase frequency category was calculated by averaging, for each category, the *api*-rates over all participants.

An analysis of variance (ANOVA) with repeated measures showed a significant effect of subjective purchase frequency [$F_{(2,78)}$=23.03, $p$<.001; $\eta^2$=0.23]. Average perceived inflation is higher for often purchased goods (Mean *api*-rate=9.57, SD=12.89) than for occasionally (Mean *api*-rate=4.96, SD=12.41) or never (Mean *api*-rate=−0.96, SD=8.72) purchased goods. This finding clearly supports Brachinger's assumption concerning the relation between purchase frequency and perceived inflation.

### *Direction of Price Change*

Based on the official statistics, the 30 goods were classified as having had a price increase, a price decrease, or no price change between October 2004 and October 2005. The price of 18 goods had increased, the price of 12 goods had decreased (10) or remained stable (2). The *t*-test for repeated measures showed that perceived inflation is significantly higher for goods whose prices have increased (*api*-rate=4.72) than for items whose prices have decreased (*api*-rate=1.19; $t$=4.18, $df$=78, $p$<.01). This finding reflects a realistic perception of price changes.

### *Product Segment*

The data show the expected difference between *api*-rates for food items and non-food items. Perceived inflation is higher for food items (Mean *api*-rate=5.86, SD=15.69) than for non-food items (Mean *api*-rate=2.87, SD=9.53), although just missing statistical significance (*t*-test for repeated measures: $t$=1.83. $df$=78, $p$=.07). However, since food is more frequently purchased than non-food, the finding is in line with the finding reported above on the relation between purchase frequency and perceived inflation.

### *Level of Price*

An ANOVA with repeated measures showed a significant difference between *pi*-rates for the three price levels [$F_{(2,78)}$=17.48, $p$<.01; $\eta^2$=0.18]. Perceived inflation is highest for low price items (Mean *api*-rate=6.78, SD=13.01), lower for medium price items (Mean *api*-rate=−0.22, SD=6.88), and lowest for high price items (Mean *api*-rate=−4.64, SD=16.09).

These data, too, corroborate the relation between purchase frequency and perceived inflation, because purchase frequency and price level are highly correlated.

### *Global Questions*

In response to the EU consumer survey question on price development over the last 12 months, for 12.7% of the participants inflation had "risen a lot," for 26.6% inflation had "risen moderately," for 29.1% inflation had "risen slightly," for 17.7% inflation had "stayed about the same," and for 1.3% inflation had "fallen." For all participants belonging to the same of the five ranks, a summary *api*-rate can be calculated by first averaging, for each participant belonging to that rank, over all *pi*-values (generated by the three different methods) of the 30 items and then averaging over the *api*-rates of all participants belonging to that same rank. The *api*-rates corresponding to the five consumer survey categories of participants are 6.94%, 5.89%, 6.29%, −0.90%, and −6.45%, respectively.

The average over all 79 answers to the direct question for a global inflation rate provides an inflation estimate of 5.57%.

## Analysis of Method-Specific Api-Rates

For each item, method-specific *api*-rates were calculated and used to examine the effect of the four factors subject to the three elicitation methods and to compare the three methods with one another.

Averaging over the method-specific *api*-rates of all 30 items provides a summary *api*-rate that is specific for a given method. The summary *api*-rate resulting for method 1 is 7.05% (SD=11.46), for method 2 it is 1.91% (SD=9.66), and for method 3 it is 3.63% (SD=15.04). An ANOVA with repeated measures showed a significant effect of methods [$F_{(2,78)}$=4.18, $p$<.05; $\eta^2$=0.05].

The statistical analyses for the 30 summary *api*-rates, that is, for the pi-values aggregated over the three methods, were also conducted separately for the *api*-values specific to each method. These analyses will not be presented in detail. Table 3 reports only if, for a given factor, the method-specific *api*-values were strongly (++), weakly (+) or not at all (−) in accordance with the effect of a factor as could be expected on the basis of the IPI hypotheses presented in the section "The IPI Hypotheses of Perceived Inflation." If method 1 is coded as ++ with respect to purchase frequency, this means that the *api*-rate which

**Table 3** The effect of the four factors observed with the three methods and the measures *r* and *diff*

| | Method 1<br>PI=7.05 | Method 2<br>PI=1.91 | Method 3<br>PI=3.63 |
|---|---|---|---|
| Purchase frequency | ++ | − | ++ |
| Direction of price change | ++ | + | ++ |
| Product segment | ++ | + | − |
| Level of price | + | + | ++ |
| EU survey question[a] | $r$=0.40 | $r$=−0.10 | $r$=0.14 |
| Direct question ($M$=5.57%)[b] | diff=−1.48 | diff=3.66 | diff=1.94 |

[a] $r$ = correlation between an individual's response to the EU-question and his or her perceived inflation, elicited with the respective method.

[b] diff. = difference between the response to the direct question, averaged over participants, and the method-specific perceived inflation.

resulted from that method for often purchased goods is higher than the *api*-rate for occasionally purchased goods, which in turn is higher than the *api*-rate for never purchased goods. Table 3 shows the pattern of results.

The last two rows relate the *api*-rates to the responses to the two global questions. The second row from the bottom shows the correlation $r$ between the individual responses to the EU consumer survey question and the individual summary *api*-rates elicited with the respective method. These individual method-specific summary *api*-rates result from averaging, for each participant, over all *pi*-values of a given participant elicited by a given method. As the *pi*-values of only 10 of the 30 items were elicited using the same method, these averages result from averaging over only 10 items. The last row shows the average differences between the individual method-specific summary *api*-rate and the response to the direct inflation question. As can be seen, *pi*-rates elicited with method 1 correlate highest with the responses to the EU survey question and differ least from the responses to the direct question.

Only for method 1 is the pattern of results consistent. That is, only the *pi*-rates resulting from this method show, for all the four factors, the effects expected on the basis of the IPI hypotheses. The two other methods show only some of the expected effects. The only effect that is shown with all three methods is the effect of the direction of price change from 2004 to 2005: Perceived inflation is higher for goods whose prices increased than for goods whose prices decreased. Altogether, the statistical analyses for the method-specific summary *api*-rates show that *method 1* is best suited for measuring perceived inflation.

## Average Perceived Inflation Rates, Loss Aversion Coefficients, and IPI

### *Comparison of Api-Rates, CPI, and IPI*

It is interesting to compare the *api*-rates obtained in this study with the official Berlin CPI rate and the IPI rate calculated for the restricted basket of the 30 goods and services chosen for this study. For such a comparison, the method-specific summary *api*-rates for these items have to be amalgamated to a single overall perceived inflation rate. For that purpose, the unweighted averages over the method-specific summary *api*-rates of all 30 items were calculated. The resulting overall *pi*-rates are given in the first column of Table 4. For the calculation of the Berlin CPI corresponding to the restricted market basket, the official Berlin price relatives characterising the price development (from October 2004 to October 2005) of the items contained in that basket were weighted using the official German expenditure weights renormalized to unity. This resulted in an official (restricted) Berlin CPI of 3.08, as indicated in the second column of Table 4.

For the calculation of the (restricted) Berlin IPI, as for the Berlin CPI, the official Berlin price relatives were taken which characterise the price development from October 2004 to October 2005 of the restricted market basket. According to the IPI formula (cf. Brachinger 2006), price relatives indicating price increases were transformed by means of the loss aversion coefficient $c=2$ used by Brachinger for the calculation of the German IPI (cf. Brachinger 2006); price relatives indicating a price decrease or a constant price were taken as such. The transformed and the non-transformed price relatives were weighted by the (renormalized) purchase frequencies established in the context of the calculation of the IPI for Germany (cf. Bechtold et al. 2005) resulting in a (restricted) Berlin IPI ($c=2$) value of 6.72. This value is given in the third column of Table 4.

A comparison of the first three columns of Table 4 shows that the overall *pi*-rate obtained with method 3 (3.63%) best matches the Berlin inflation rate, whereas the overall

**Table 4** *pi*-rate, Berlin CPI and IPI values

| | *pi*-rate | Berlin CPI | IPI ($c$=2.0) | IPI (with method-specific $c$) |
|---|---|---|---|---|
| Method 1 | 7.05 | 3.08 | 6.72 | 6.79 |
| Method 2 | 1.91 | 3.08 | 6.72 | 7.53 |
| Method 3 | 3.63 | 3.08 | 6.72 | 10.52 |

*pi*-rate obtained with method 1 (7.05%) best matches the value of the Berlin IPI (6.72%). The overall *pi*-rates as well as the IPI ($c$=2) value are about twice as high as the official inflation rate.

*Estimated Loss Aversion Coefficients*

There is no evidence in the literature of the level of the loss aversion coefficient in the context of inflation perception. The data elicited in this study allow an estimation of the loss aversion coefficient as defined by the IPI.

In the IPI it is assumed that the perception $\Delta p_t$ of a price change $p_t(i)-p_0(i)$ can be quantified by $c((p_t(i)-p_0(i))/p_0(i))$. According to the loss aversion hypothesis, a difference exists between price increases and price decreases: The constant $c$ will be greater for losses ($c_1$) than for gains ($c_2$). As the "true" perception of a price change is unknown, the parameters $c_i$ ($i$=1, 2) are unknown. However, as according to Eq. 1, the loss aversion coefficient is given by the ratio $c = c_1/c_2$ only this ratio has to be estimated.

Theoretically, the loss aversion coefficient $c$ is, for any fixed (positive) change rate $(p_t - p_0)/p_0$, given by the ratio between the perception of a price increase at that rate and (the absolute value of) the perception of a price decrease at that same rate, because it holds

$$\frac{\Delta p_+}{|\Delta p_-|} = \frac{c_1(p_t - p_0)/p_0}{|c_2(p_t - p_0)/p_0|} = \frac{c_1(p_t - p_0)/p_0}{c_2|(p_t - p_0)/p_0|} = \frac{c_1}{c_2} = c \tag{4}$$

where $p_+$ denotes the perception of the price increase and $p_-$ that of the price decrease. The true perceptions $c_i((p_t - p_0)/p_0) = c_i(p_t - p_0)/p_0$ $(i = 1, 2)$ cannot be observed and have to be estimated.

The true perceptions have empirical counterparts, namely the *pi*-values $pi = (ep05 - rp04)/rp04$ elicited through any elicitation method, because the difference $ep05-rp04$ will reflect the valuation that the price change $p_t-p_0$ undergoes when perceived. However, any empirical *pi*-value will contain a random error. Therefore, statistically, the true perception $c_i(p_t - p_0)/p_0$ of a price increase or decrease at the rate $r = (p_t - p_0)/p_0$ can be regarded as the expectation of the distribution of the *pi*-values elicited for that rate through any elicitation method. A reasonable estimator for the true perception of a price increase at the rate $r$ is then the average $ave_{Lr}(pi)$ over the *pi*-values that have been observed for factual price increases at that rate. The average $ave_{Gr}(pi)$ over the *pi*-values that have been observed for factual price decreases at the rate $r$ is a reasonable estimator for the true perception of price decreases of that extent. According to Eq. 4, an estimator $\widehat{c}$ of the loss aversion coefficient results from dividing the former average by the latter,

$$\widehat{c} = ave_{Lr}(pi)/ave_{Gr}(pi). \tag{5}$$

In our experimental study we did not ask for several *pi*-values for a given change rate $r = (p_t - p_0)/p_0$. The 30 goods had not been selected accordingly. However, there is a sub

sample of 11 goods the price increases of which closely vary around a certain rate, namely 3.5%, as well as a subsample of seven goods, the price decreases of which also closely vary around the same rate. Therefore, for each elicitation method, the average over the 11 *pi*-values $pi = (ep05 - rp04)/rp04$ corresponding to the goods with a price increase of approximately 3.5%, yields an estimation of the perception of a price increase at 3.5%. The average over the 7 *pi*-values corresponding to the goods with a price decrease of approximately 3.5%, delivers an estimation of the perception of a price decrease at 3.5%. An estimation of the loss aversion coefficient results from Eq. 5. The estimated loss aversion coefficients resulting from the three methods are 2.02, 2.23, and 3.07.

*Adapted IPIs*

For the calculation of the Berlin IPI value 6.72 (see Table 4, column 3) the loss coefficient was set to $c=2$ by default. Given the empirical estimates of the loss aversion coefficient, adapted IPIs can be calculated by employing method-specific (estimated) loss aversion coefficients. The adapted IPIs are given in the fourth column of Table 4. If an adapted IPI fits well to the method-specific *pi*-rate, the IPI model receives external validation by the respective elicitation method.

The adapted IPI values obtained with the estimated loss aversion coefficient derived from the data elicited with method 1 (6.79%) match well with the corresponding *pi*-rate (7.05%). This substantiates that, among the methods employed in this study, method 1 is best suited for measuring perceived inflation.

## Conclusions

The empirical study reported in this paper showed that the different methods used to measure perceived inflation produced quite different *pi*-values. It may be difficult to find one best method for measuring perceived inflation. However, the data elicited with the three methods are not equally plausible. Only method 1 generated data patterns which are consistent and can be well interpreted.

Furthermore, the analysis of the summary *api*-rates where the data have been averaged over the three methods showed that the key hypotheses underlying Brachinger's index of perceived inflation were supported: Perceived inflation is higher for goods with high purchase frequency than for goods with low purchase frequency, higher for goods whose prices have increased than for goods whose prices have decreased, higher for food products than non-food products and services, higher for cheap goods than for expensive goods. Only the data elicited by method 1 are in accordance with these hypotheses. These data, in fact, imply loss aversion coefficients around the value of 2 suggested in the literature. Furthermore, the overall *pi*-value of 7.05 generated by this method matches closely with the IPI value calculated with a loss aversion coefficient of $c=2.0$ (the coefficient assumed by Brachinger) and with the adapted IPI value calculated with the empirically derived loss aversion coefficients. Therefore, it is concluded that the study provides empirical evidence for the hypotheses on which Brachinger's IPI is based, and that method 1 provides a reasonable and easily applicable approach for measuring perceived inflation.

It has been argued that perceived inflation may not reflect the perception of price changes but primarily the quantitative inflation rate reported regularly in the media. That is, people read or hear that the inflation rate is, for instance, 2.2%, and that number will stick in their head and determine their judgment of inflation. However, although the inflation rate

in Berlin had been 3.08 from 2004 to 2005, the average answer to the direct question in our study was 5.57%, almost twice as high. More importantly, if consumers' judgment of inflation perception were determined by the reported inflation rate, one should observe the same judgment of a price change (in percentage) for each good. Furthermore, one should not observe the systematic differences in inflation judgments depending on purchase frequency, direction of price change, product segment and price level. In other words, the data supported the hypothesis that perceived inflation is based on the perception of individual prices. It remains to be examined whether and how the media presentation of inflation rates influences perceived inflation, and how information about the general inflation rate (received from the media) and information about individual prices and price differences (received while shopping) may interact.

A final observation deserves attention: We compared the *api*-rates and the official inflation rates separately for goods whose prices had increased (in terms of prospect theory: *losses*) and goods whose prices had decreased (in terms of prospect theory: *gains*). The official inflation rate of the loss-items was 6.47%, the *api*-rate for these items was 4.72%, that is, perceived inflation was *lower* than the official rate (with data aggregated over methods). The official inflation rate for gain-items was −7.28%, the *api*-rate for these items was 1.19%, that is, perceived inflation was *higher* than the official rate, or, in other words, inflation was perceived although there was no inflation. These relations between *api*-rates and official rates were observed with all three methods. The findings suggest another explanation for perceived inflation rates being higher than official rates: Whereas price increases (losses) are relatively adequately perceived, price decreases (gains) are simply not perceived at all, as if people could not imagine that anything ever gets cheaper.

Several questions remain open, for instance: (1) Does the Weber–Fechner psychophysical law also hold for the perception of price changes, that is, is the perception of price relatives independent of the price level and a linear function of relative price changes? The study does not allow answers to this question. The study did not include enough items, and the included items were not sufficiently varied over scale units and product categories. Neither were there enough participants from different consumer segments. (2) What is the subjective reference price or reference period that consumers have in mind when asked to estimate inflation? In this study, a fixed reference price (the prices in October 2004) and the reference period (twelve months) was given, but there are no clues as to what people's intuitive reference prices and periods are. (3) How strongly do the estimated purchase frequencies and subjective frequencies correlate? For an answer, a more refined method to elicit consumers' subjective purchase frequencies would be required. (4) Finally, the IPI index was calculated for Germany on the basis of the 740 products and services of the official market basket, which is used for CPI calculations. In the present empirical study, 30 goods from this basket were chosen. It would be interesting to examine, however, which and how many goods the purchasers' mental basket contains, that is, which goods come to purchasers' mind if they think about inflation. For instance, one could assume that this basket contains goods for which consumers pay in cash, but not goods whose costs are paid with a debit order to a bank.

It is suggested that any approach to assess perceived inflation should focus on individual prices and price changes. Even if direct questions like the EU consumer survey question on the price development over the last 12 months or a direct question for a numerical inflation estimate show similar figures, an empirical study based on the IPI hypotheses provides much more detailed information about the structure of perceived inflation, and thus more valuable information for consumer policy.

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