Does “000,000” matter? Psychological effects of Turkish monetary reform

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Abstract

Turkish monetary reform, which took effect in January 2005, introduced the New Turkish Lira (NTL) by deleting six zeros from the former currency, the Turkish Lira (TL). Two experiments investigated how the introduction of the NTL might affect price estimation. In the first, conducted in December 2004, 202 students were first presented with high or low anchor values and then estimated the average price of a “new Turkish mid-sized car” in different currencies (TL, NTL and Euro). Although anchoring bias was not significantly different across familiar (TL) and unfamiliar currencies (NTL and Euro), price estimates in Euro and NTL were significantly higher than those in TL. In the second experiment, carried out 6 months later, 212 adult consumers estimated the prices of 13 items in one of three currencies. For five items prices estimated in Euros were significantly higher than those expressed in either TL or NTL. However, there were no significant differences between TL and NTL, suggesting that Turkish consumers had quickly adapted. Such ease of adaptation is consistent with a rescaling hypothesis: when one or more zeros are dropped from a currency, consumers rescale all prices relatively quickly rather than relearn them selectively through gradual exposure.

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1. Introduction

This article presents two studies of the Turkish citizen’s adaptation to a new system of currency introduced in January 2005 based on the New Turkish Lira (NTL, about 0.60 euro). Since one NTL equals one million old Turkish Lira (TL), this is one of the largest nominal changes in currency in recent times. As our title indicates, the change required ‘000,000’ to be dropped from prices. At first sight, this may seem a rather easy computation, which prompts our general question: does it matter? The answer depends on the cognitive mechanisms that underlie adaptation to a new currency. Marques and Dehaene (2004) postulated two possible mechanisms: exemplar price relearning and global currency rescaling. The former assumes that exemplar prices in the former currency are stored in memory, and these must be relearned in the new currency selectively as consumers are exposed to them. From this perspective it should matter. Moreover, price re-learning would be relatively slow, especially for infrequently bought products. However, from a ‘rescaling’ perspective, and assuming that rescaled prices can quickly substitute for old ones (rescaling is fast), it should matter for a short time only. Despite the big difference in nominal values, such rescaling may involve a relatively straightforward scale translation from TL to NTL. Such a learning process could operate in any change, which involves dropping zeros from a currency.

In our investigations, adaptation to the NTL was assessed in two price estimation tasks. The first assessed adaptation about one month before the introduction of the NTL by measuring differences in the susceptibility of price estimation to anchoring bias in the old and new currency (TL versus NTL). We also included a third currency, the less familiar Euro, and further assessed adaptation by analysing other differences in price estimation across currencies. The second experiment was carried out six months after the introduction of the NTL to investigate the extent to which any currency effects on price estimation had persisted.

2. Experiment 1

2.1. Hypotheses

2.1.1. Anchoring bias

Mussweiler and Englich (2003) used the classic anchoring paradigm of Tversky and Kahneman (1974) to investigate the extent to which price estimates were influenced by anchor prices presented before estimation. For example, the first question might be: does 100 g of Turkish Delight on average cost more or less than 3.00 NTL (the anchor)? This would be followed by the estimation question: What is the average price of 100 g of Turkish Delight? Using this paradigm, Mussweiler and Englich found that between winter 2001 and summer 2002, the effect of anchors on German students’ estimates in Euros and German Marks reversed. The effect of Euro anchors was much greater before the introduction
of the Euro than afterwards, whereas the effect of Mark anchors was much smaller before than afterwards. They argued that these changes in anchoring bias reflected adaptation to the new currency in the first six months after the introduction of Euro notes and coins. The present study aimed to replicate and extend the findings of the first part of Mussweiler and Englich’s study in the context of the new Turkish currency. For reasons explained later, we did not attempt to replicate the second part of their study.

The apparently clear findings described above supported the Mussweiler and Englich (2003) view that the degree of susceptibility to anchoring bias may be a useful indicator of degree of adaptation to an unfamiliar currency. They argued that previous research had shown over a range of contexts that the extent to which quantitative judgements are susceptible to the anchoring bias depends upon people’s knowledge of the target to be judged (Mussweiler & Strack, 2000). Thus, the more uncertain people are about a target, the more a previously presented anchor affects their judgement of it. Since people will be more uncertain about prices in an unfamiliar currency, degree of anchoring bias is predicted to be greater in the unfamiliar currency compared to the familiar one. Furthermore, as people adapt to a new currency, their uncertainty will decrease and susceptibility to the anchoring bias will consequently reduce. However, it is not clear that similar predictions would be justified in the context of Turkish monetary reform. Certainly, the NTL would be relatively unfamiliar to Turkish citizens just prior to its introduction, and this may well be accompanied by greater uncertainty in price estimation in NTL compared to TL. However, the conversion between TL and NTL may involve a straightforward rescaling process and any difference in uncertainty may not lead to differences in anchoring bias across these two currencies. On the other hand, the Euro is clearly unfamiliar to Turks compared to TL, and consequently, a difference in anchoring bias between TL and Euro can be predicted from Mussweiler and Englich’s theory. This leads to our first hypothesis:

**H1: Anchoring bias.** There will be an interaction between anchoring bias and currency such that the effect of anchors will be greatest for the Euro, and least for the TL.

### 2.1.2. Price estimation accuracy

The study by Mussweiler and Englich (2003) seems to be the only previous investigation of price estimation anchoring biases in familiar and unfamiliar currencies. Other studies have investigated currency-related biases in price estimation and evaluation without presenting external anchor prices. For example, Gamble, Gärling, Charlton, and Ranyard (2002) carried out four studies testing the hypothesis of a ‘euro illusion’. This is the phenomenon related to the money illusion (Shafir, Diamond, & Tversky, 1997) that, due to differences in nominal values of currencies, the same goods or services will be rated as less expensive when the money unit is larger. For example, an item priced NTL or Euro will be judged less expensive than the same item priced in TL. In Gamble et al.’s studies the hypothesis of a euro illusion was generally supported, especially in two studies that used fictitious currencies to control for the familiarity of the currency unit. Related findings using real familiar and unfamiliar currencies include those in which evaluative judgements were expressed as willingness to pay judgements (Raghubir & Srivastava, 2002) or as importance ratings for gains and losses (Tyszka & Przybyszewski, 2006).

Similar biases in price estimation (as opposed to evaluation) that are consistent with the euro illusion have also been reported. For example, Jonas, Greitemeyer, Frey, and
Schulz-Hardt (2002) found that before the introduction of the Euro, German participants’ price estimates in German Marks were systematically lower than those of a control group’s price estimates in Euros. As with the anchoring bias, a follow-up study found that when the Euro had become the familiar currency, six months after its introduction, the euro illusion bias had reversed (Jonas, 2003). This suggests that it is not nominal values as such that determine such biases. Rather, internal reference prices stored in long-term memory influence price estimation in the unfamiliar currency. This is a similar effect to the classic anchoring bias discussed earlier, but involving internal, rather than external anchors (Ranyard, Charlton, & Williamson, 2001). This leads us to our second hypothesis:

H2: Euro illusion bias. There will be a main effect of Currency such that price estimates in unfamiliar currencies with lower nominal values (NTL and Euro) will be generally higher than those in the familiar TL.

Finally, it is important to consider a third difference in price estimation that has been observed. Dehaene and Marques (2002) studied the accuracy of price estimation in familiar currencies in three eurozone countries before 2002 and in the relatively unfamiliar Euro. Their main findings were that price estimation in all currencies had the characteristic of scalar variability (the accuracy of price estimates decreases systematically as actual prices increase) and that price estimation, regardless of price, was less accurate in Euros compared to that in the familiar currency. Accuracy was assessed by the Weber fraction, i.e. the standard deviation of estimates divided by the mean. Following up this work, Marques and Dehaene (2004) investigated Euro price estimation in Portugal and Austria from October 2001 to June 2002, i.e. from just before to six months after the introduction of the Euro. They found that, in Portugal, price accuracy in Euros improved over time but by June 2002 it was still more variable than in the former currency some years before the transition. Following this, our third hypothesis was:

H3: Price estimation variance. There will be differences in the Weber’s fractions for price estimates such that those for the unfamiliar currencies (NTL and Euro) will be greater than those for the familiar TL.

In summary, then, three possible effects on price estimation accuracy of using unfamiliar currencies were examined: the degree of anchoring bias (H1) and differences in the means (H2) and variances (H3) of price estimates across currencies.

2.2. Method

2.2.1. Design
The experiment was a 3 (Currency: NTL versus TL versus Euro) × 2 (Anchor: high versus low) factorial between-subjects design. Participants were randomly assigned to experimental conditions.

2.2.2. Participants
A sample of 205 students (65 male, 137 female) was recruited from Ege University and Izmir University of Economics, Turkey. The age of the participants ranged from 17 to 36 years (M = 20.66; SD = 2.0).
2.2.3. Procedure and materials

The study was conducted during lectures (maximum 20 students in each classroom) in December 2004, about one month before the introduction of NTL notes and coins. Upon agreement to participate students were handed the task materials. The procedure followed the standard anchoring paradigm used by Mussweiler and Englich (2003). Participants were informed that they were taking part in research on shopping habits. They were also told that the values used in the questions were selected randomly and were not related to the actual values of the targets, in order to control the expectation of the experimenter being maximally informative (Mussweiler & Englich, 2003). They were asked to read the instructions carefully and answer the questions as accurately as possible.

The questionnaire consisted of one comparative and one absolute anchoring question followed by questions concerning gender, socio-economic status and difficulty with computing prices. In the comparative question, participants indicated whether the average price of a new Turkish midsize car is higher or lower than an anchor value (“Does a new Turkish mid-size car cost more or less than X?”). About half of the participants compared the target quantity to a high anchor value (38,000,000,000 TL; 38,000 NTL; 21,000 Euro); the other half compared the target to a low anchor value (16,000,000,000 TL; 16,000 NTL; 8500 Euro). The exchange rate used to convert NTL prices to Euro was 1 NTL = 1.88 Euro. In the absolute anchoring question, which was on the next page, participants indicated their best estimate for the average price of a new Turkish mid-size car. For 72 participants the comparative and absolute judgments were required in TL, for 65 participants judgments were required in NTL and for 65 participants judgments were required in Euro.

2.3. Results

Three subjects were not included in the analysis because their price estimates were outliers, more than four standard deviations above the mean. To compare estimates across the different currencies, all prices were first converted into NTL (1 NTL = 1.88 Euro at the time of the study). First, following Mussweiler and Englich (2003), an analysis of variance examined the effect of anchor and currency on price estimation (see Fig. 1). However, since Levene’s test showed that variances were not homogeneous across conditions ($F(5,196) = 4.85$, $p < 0.001$), additional analyses were carried out, including comparisons of Weber fractions (Dehaene & Marques, 2002). Nevertheless, in order to facilitate comparison with Mussweiler and Englich’s study, we first report the analysis of variance.

Results of the 2 (Anchor: high vs. low) × 3 (Currency: TL, NTL, Euro) analysis of variance showed a significant main effect for anchor ($F(1,196) = 89.19$, $p < 0.001$) indicating that participants who were provided with the low anchor values estimated lower prices ($M_{\text{low anchor}} = 19,943$) than those provided with the high anchor values ($M_{\text{high anchor}} = 29,504$). The main effect for currency was also significant ($F(2,196) = 3.41$, $p < 0.05$). Post hoc multiple comparisons tests using the LSD method indicated that price estimates in Euro ($M_{\text{Euro}} = 25,975$) were significantly higher than those in TL ($M_{\text{TL}} = 22,736$, $p < 0.01$). NTL estimates ($M_{\text{NTL}} = 25,084$) were also higher than TL estimates ($p = 0.056$). There was no significant interaction between Currency and Anchor level ($F(2,196) = 0.67$, $p > 0.05$).

In a second analysis, differences in degree of anchoring bias (H1) were assessed further by comparing the effect sizes for the anchor variable in single factor ANOVAs within each
currency. In these analyses, Levene’s test showed that variances were homogeneous across Anchor conditions except in the case of the Euro currency ($F(1,63) = 6.76, p < 0.05$). Comparisons of effect sizes in the three ANOVAs confirmed that H1 was not supported since the anchoring bias was no greater in the less familiar currencies. In fact, the effect size of the Anchor variable was actually largest for the TL ($\eta^2 = 0.409$) and somewhat smaller for the NTL ($\eta^2 = 0.314$) and the Euro ($\eta^2 = 0.267$).

The above analyses produced two main findings. First, as Fig. 1 shows, there was a large anchor effect in all currencies, and since no significant interaction was found, there was no evidence that the anchor effect was greater in the unfamiliar currencies (NTL and Euro) compared to the familiar TL. This was confirmed in the comparison of effect sizes of the Anchor factor across currencies in the second analysis. We conclude, therefore, that H1 was not supported. The second main finding was that price estimates in the unfamiliar currencies were significantly higher than those in the familiar TL. Thus, the significant Currency main effect and post hoc tests of differences in mean estimates across currencies supports H2, the euro illusion bias.

The final analysis examined differences in the variances of price estimates across currencies (H3). Table 1 shows the means and SDs for each Anchor and Currency condition. It can be seen that the SDs for the low anchor are smaller than those for the high anchor condition, and those for the Euro are higher than the other currencies. Dehaene and Marques (2002) proposed that three components of price estimation variance can be identified across currencies: scalar variability, product price uncertainty and currency uncertainty. They argue that Weber fractions control for scalar variability and their magnitudes reflects both product price and currency uncertainties. Since we only used one product, we have controlled for product price uncertainty. Table 1 shows that the Weber fractions for the

![Fig. 1. Experiment 1: Mean price estimates converted to NTL.](image-url)
Euro conditions were higher than for the two Turkish currencies, about 0.35 compared to 0.25, which reflects Euro currency uncertainty. In order to test the significance of these differences in variances across currencies, price estimates were transformed to weighted absolute errors (wae) as follows: \( \text{wae} = \frac{\text{abs}(\text{estimate} - \text{condition mean})}{\text{condition mean}} \). This transformation controls for scalar variability. The transformed scores were analysed using a 2 (Anchor) \( \times \) 3 (Currency) between subjects ANOVA. This showed first that according to the Levene statistic, the homogeneity of variance assumption was not violated. The main analysis revealed a significant main effect of Currency (\( F(2,196) = 5.61, p < 0.005 \)) but no significant main effect of Anchor and no significant interaction. Post hoc Scheffe tests found that the difference between TL and NTL in mean weighted absolute error were not significant, but those between the two Turkish currencies and the Euro were (\( p < 0.05 \)). This confirms that the weighted absolute errors, and therefore the Weber fractions, were significantly higher in the less familiar Euro currency as predicted by H3. However, contrary to H3, weighted absolute errors for the relatively unfamiliar NTL were not significantly different to those for the TL.

In order to check whether there were any participant characteristics that moderated these findings we repeated the same procedure with gender, socioeconomic status and reported ratings of difficulty in computing prices as independent variables. We again used the transformed price estimation scores (wae) as the dependent variable and conducted a series of ANOVAs. These analyses revealed the same basic pattern of findings. Although the low SES group showed higher mean wae than their high SES counterparts (\( F(1,190) = 6.27, p < 0.05 \)), currency effects remained significant (\( F \) values between 4.51 and 6.65, \( p < 0.05 \)), and there were no significant anchor effects or interactions. Therefore we conclude that our results were not moderated by the participant characteristics measured in this study.

2.4. Discussion

2.4.1. Anchoring bias as an indicator of adaptation to a new currency

Mussweiler and Englich (2003) investigated German adaptation to the Euro using a single measure of adaptation, susceptibility to the anchoring bias. They found a greater degree of anchoring bias in the unfamiliar Euro prior to its introduction. However, we did not find such a difference between TL and NTL currencies prior to the latter’s introduction. Consequently there would be no point in fully replicating Mussweiler and Englich’s study by investigating changes in degree of anchoring bias across currencies over

<table>
<thead>
<tr>
<th>Currency</th>
<th>Anchor</th>
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<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>TL</td>
<td>18,210</td>
</tr>
<tr>
<td>NTL</td>
<td>21,250</td>
</tr>
<tr>
<td>Euro</td>
<td>20,591</td>
</tr>
</tbody>
</table>

Note: Prices in Turkish Lira (TL) and Euro converted to New Turkish Lira (NTL).
time. In addition we failed to replicate Mussweiler and Englich’s finding of a greater anchoring bias with the unfamiliar Euro compared to the familiar currency. Therefore, H1 was not corroborated. We can explain the lack of support for H1 with respect to the NTL in terms of adaptation to the proposed new currency. However, the lack of support for H1 with respect to the Euro cannot be explained in terms of adaptation processes, since the Euro was clearly unfamiliar to our participants.

Our analysis of the variances of price estimates across conditions contributed to a greater understanding of factors that moderate differences in anchoring bias across currencies. Table 1 shows that price estimate variances (measured by SDs) were markedly different across Anchor and Currency conditions. Furthermore, our analysis of weighted absolute errors and Weber fractions across currency revealed that those for the Euro were significantly higher than those for the two Turkish currencies, indicating a lack of adaptation to the Euro. These significant differences across currencies in price estimation variance, as measured by Weber fraction differences, militate against the detection of any possible anchoring bias differences across currencies: even if anchoring bias is greater in unfamiliar currencies, if price estimation variance is also greater, anchoring bias differences are less likely to be detected. For this reason, then, anchoring bias difference across currencies is likely to be an unreliable indicator of currency adaptation. As well as differences in Weber fractions between the Turkish currencies and the unfamiliar Euro, we also observed a euro illusion bias in Euro price estimates. We would argue, therefore, that euro illusion bias and differences in Weber fractions are both likely to be more useful behavioural indicators of currency adaptation than degree of anchoring bias.

2.4.2. Price estimation bias in NTL

Overall our results suggest that one month prior to its introduction, Turkish students were already quite well adapted to the NTL. There was no difference between TL and NTL in susceptibility to the anchoring bias, and price estimation accuracy, as measured by Weber’s fractions, were also similar. However, there was one indication of incomplete adaptation, the systematic over-estimation of the price of the car in NTL compared to TL. This suggests that the price estimation process in NTL immediately prior to its introduction was influenced by reference prices stored in memory in TL values, i.e. internal anchor prices. Our second study investigated the extent to which such price estimation biases persisted in the general public six months after Turkish Monetary Reform.

3. Experiment 2

Six months after the introduction of the NTL we conducted a second experiment in which participants estimated the price of several products and responded to questions about currency change. As explained earlier, we did not use the anchoring paradigm in this study. Rather, we tested H2 and H3 again using the free estimation procedure used by Del Missier, Bonini, and Ranyard (submitted for publication) in a study of adaptation to the Euro in Ireland and Italy. Since we expect adaptation to the NTL to be well advanced six months after its introduction, we predicted that the euro illusion bias (H2) would be found only in the case of the Euro, since internal reference prices in either TL or NTL would influence Euro price estimates in the same direction, i.e. to be higher than those given in the Turkish currencies. Similarly, as we found in Experiment 1, we would expect price estimation variance, as measured by Weber fractions and wae, to be greater for Euro
prices (H3). Additional information on self-reported adaptation to the NTL was obtained using a brief questionnaire based on the one used by Del Missier et al.

3.1. Method

3.1.1. Design

The main task given to participants was to estimate typical prices of 13 different products and services in TL, NTL or Euro. The products and services were divided into three price ranges (less than 10 NTL, 11–250 NTL, or more than 251 NTL) and two purchasing frequency categories (low or high). Therefore, the experiment had a 3 (Currency: NTL versus TL versus Euro) × 3 (Price of product: less than 10 NTL, between 11 and 250 NTL or more than 251 NTL) × 2 (Purchasing frequency: low versus high) nested design. Currency was a between participant factor and both Price of product and Purchasing frequency were within participant factors. Purchasing frequency was only varied for the lowest priced items, given that the majority of high-priced products in the market are not frequently bought. Participants were randomly assigned to currency conditions and the basic dependent variable was the price estimate given for each item.

3.1.2. Participants

The final sample consisted of 212 participants from the general public (109 male, 103 female). The age range of the participants was 18–83 years (M_age = 34.03, SD = 13.04). Initially, 240 participants had been recruited from the entrance of one of the biggest supermarkets in Izmir, Turkey, but 28 participants were removed from the sample because they failed to understand the estimation task. We conducted a series of statistical tests to see whether there were any differences between excluded and included parts of the sample. Results showed that more subjects failed in the NTL and EURO conditions compared to TL (χ² = 13.181, p < 0.001). On the other hand, there were no differences with respect to age (t(238) = 0.664, p > 0.05), gender (χ² = 1.456, p > 0.05), education level (χ² = 5.012, p > 0.05) or income (χ² = 10.335, p > 0.05). Thus, we can assume that our final sample was derived from the same population as the excluded part of the sample and that it was representative.

3.1.3. Procedure and materials

Participants were invited to participate in a study of shopping habits. They were handed a questionnaire immediately after they agreed to take part and completed the task before doing their shopping. The questionnaire consisted of 3 parts: Part 1, price estimation questions; Part 2, questions about currency change; and Part 3, questions about personal details.

*Price estimation questions.* In this part, participants were supplied 13 products and services with their pictures and verbal expressions and were asked to estimate the typical price for each of them. These products were milk, potatoes, cheese (low price/high purchasing frequency); office scissors, paprika, compass (low price/low purchasing frequency); wardrobe, DVD player, dentist (medium price/low purchasing frequency); apartment building, hotel, flight, car (high price/low purchasing frequency). As a manipulation check, participants were asked to rate the purchasing frequency of each product (expressed in a 7-point verbal scale for frequently bought products and in a 4-point verbal scale for infrequently bought products).
Questions about opinions on currency change. The first three of these questions were taken from the Eurobarometer survey and adapted for the Turkish Currency Reform context: (1) “Today, would you say that the NTL continues to cause you a lot of difficulty, some difficulty or no difficulty at all?”, with response categories “a lot of difficulty”, “some difficulty” and “no difficulty”; (2) “Today, when purchasing, do you count mentally most often in NTL, most often in TL, or as often in NTL as in TL when it concerns exceptional purchases such the purchase of a car or a house for example?”, with response categories “most often in NTL”, “most often in TL”, “as often in NTL as in TL”; (3) “Today, when purchasing, do you count mentally most often in NTL, most often in TL, or as often in NTL as in TL when it concerns common purchases such as day to day shopping?”, with response categories “most often in NTL”, “most often in TL”, “as often in NTL as in TL”. These questions allowed us to assess the participants’ perceived degree of adaptation. An additional question was used to detect the degree of spontaneous conversion from the NTL to the old currency, and to understand whether the consumers back convert the prices to make sense of the new currency: “How often do you convert the price of a product in TL in order to understand how expensive is it?”, with response categories “Never”, “Seldom”, “Sometimes”, “Frequently”, “Always”. In addition, we used the following question to obtain the perceived degree of adaptation to the new currency: “How difficult was your adaptation to the NTL?”, with response categories “Very Difficult”, “Difficult”, “Not difficult nor easy”, “Easy”, “Very easy”, “Don’t know”. Finally, two questions were used to assess attitudes towards the new currency and price increases: (1) “Are you for or against the NTL transition?”, with response categories “Very Unfavourable”, “Unfavourable”, “Neither unfavourable nor favourable”, “Favourable”, “Very Favourable”, “Don’t know”; (2) “Do you believe that goods had become less or more expensive with the new currency?”, with response categories “Much less expensive”, “Less expensive”, “Not less expensive nor more expensive”, “More expensive”, “Much more expensive”, “Don’t know”.

Questions about socio-demographic status. In this part, participants indicated their socio-demographic details including age, gender, education level, and household’s income.

3.2. Results

We will first give the results of some manipulation checks for frequency and price. Following this we will present the main findings on differences across currencies in mean price estimation (H2) and Weber fractions (H3). Finally, we will present the findings of the self-report questionnaire, which aimed to measure the participants’ perceived degree of adaptation.

3.2.1. Manipulation checks

The frequency of purchase was checked with reference to the modal values of the frequency reports on a product by product basis. As can be seen in Table 2, products that we considered as high frequency, were reported as being more frequently bought (potatoes, milk, cheese), while products considered as being low frequency were reported as being either low frequency or not purchased at all (compass, apartment, hotel, dentist, paprika, DVD, wardrobe, scissors, car). The price level check was made by calculating the mean reported price of each product, and checking whether these were within the previously defined boundaries for that product (less than 10 NTL, or between 11 and 250 NTL, or
more than 251 NTL). As can be seen from Table 3 the mean price estimates reported for the products are in accordance with our expectations. The low-priced products are compass, potatoes, paprika, milk, scissors, and cheese; medium priced ones are hotel, dentist, DVD player, and wardrobe, while high-priced are flight, apartment building and car.

3.2.2. Price estimation bias

Table 4 shows the comparisons of participants’ mean price estimations across the three currency conditions (TL, NTL and Euro). In order to examine the effect of currency on price estimates, we conducted a series of one-way ANOVAs, one for each product. For the products with different variances across currency (compass, apartment building, potatoes, dentist, paprika, DVD player, milk, scissors, and car) the Welch procedure was used. This is a robust test of differences in means that is not sensitive to heterogeneity of variance (see Table 4). The results showed that there were significant effects of currency on following six products: Compass, potatoes, paprika, DVD, milk and flight.
Follow up Dunnett’ C tests (a test that does not assume equal variances among the groups) were conducted to evaluate pairwise differences. The results of these tests as well as the means and standard deviations of each product in each currency are reported in Table 5. There were significant differences between Euro and TL estimations for compass, flight, paprika, potatoes, and milk. Participants overestimated the prices in Euro compared to TL. In addition, significant differences between Euro and NTL estimates were found for potatoes and milk where Euro prices were again overestimated. Euro was overestimated mostly in low priced products. Therefore, with respect to the Euro compared to

Table 4
Experiment 2: Mean price estimates across currency

<table>
<thead>
<tr>
<th>Product or service</th>
<th>Currency</th>
<th>TL</th>
<th>NTL</th>
<th>EURO</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compass</td>
<td>TL</td>
<td>1.79 (n = 74)</td>
<td>2.17 (n = 64)</td>
<td>2.80 (n = 64)</td>
<td>( F^2(2,119.7) = 6.27, \ p &lt; .01 )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>11155.84 (n = 77)</td>
<td>120166.67 (n = 60)</td>
<td>111724.14 (n = 58)</td>
<td>( F^2(2,192) = 0.26, \ ns )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>75.79 (n = 76)</td>
<td>70.37 (n = 68)</td>
<td>83.93 (n = 61)</td>
<td>( F^2(2,124.9) = 4.65, \ p &lt; .05 )</td>
</tr>
<tr>
<td>Apartment building</td>
<td>NTL</td>
<td>0.44 (n = 74)</td>
<td>0.50 (n = 59)</td>
<td>0.75 (n = 62)</td>
<td>( F^2(2,144.0) = 9.26, \ p &lt; .001 )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>76.20 (n = 79)</td>
<td>62.81 (n = 64)</td>
<td>60.46 (n = 65)</td>
<td>( F^2(2,135.7) = 2.40, \ ns )</td>
</tr>
<tr>
<td>Potatoes</td>
<td>TL</td>
<td>213.57 (n = 78)</td>
<td>164.90 (n = 61)</td>
<td>170.33 (n = 61)</td>
<td>( F^2(2,128.4) = 3.75, \ p &lt; .05 )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>5.73 (n = 79)</td>
<td>5.96 (n = 68)</td>
<td>6.37 (n = 62)</td>
<td>( F^2(2,206) = 1.24, \ ns )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>2.85 (n = 77)</td>
<td>3.00 (n = 67)</td>
<td>2.67 (n = 57)</td>
<td>( F^2(2,129.0) = 0.52, \ ns )</td>
</tr>
<tr>
<td>Wardrobe</td>
<td>TL</td>
<td>190.99 (n = 76)</td>
<td>169.28 (n = 64)</td>
<td>173.13 (n = 64)</td>
<td>( F^2(2,210) = 0.91, \ ns )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>271.09 (n = 78)</td>
<td>285.06 (n = 65)</td>
<td>350.77 (n = 65)</td>
<td>( F^2(2,205) = 4.46, \ p &lt; .05 )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>7701.30 (n = 77)</td>
<td>55370.97 (n = 62)</td>
<td>25327.59 (n = 58)</td>
<td>( F^2(2,118.9) = 0.18, \ ns )</td>
</tr>
<tr>
<td>DVD</td>
<td>TL</td>
<td>213.57 (n = 78)</td>
<td>164.90 (n = 61)</td>
<td>170.33 (n = 61)</td>
<td>( F^2(2,128.4) = 3.75, \ p &lt; .05 )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>5.73 (n = 79)</td>
<td>5.96 (n = 68)</td>
<td>6.37 (n = 62)</td>
<td>( F^2(2,206) = 1.24, \ ns )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>2.85 (n = 77)</td>
<td>3.00 (n = 67)</td>
<td>2.67 (n = 57)</td>
<td>( F^2(2,129.0) = 0.52, \ ns )</td>
</tr>
<tr>
<td>Milk</td>
<td>TL</td>
<td>1.20 (n = 79)</td>
<td>1.20 (n = 68)</td>
<td>1.60 (n = 63)</td>
<td>( F^2(2,121.4) = 8.71, \ p &lt; .001 )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>1.04 (n = 79)</td>
<td>1.14 (n = 68)</td>
<td>1.55 (n = 64)</td>
<td>( F^2(2,124.9) = 4.65, \ p &lt; .05 )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>1.55 (n = 79)</td>
<td>1.20 (n = 68)</td>
<td>1.00 (n = 62)</td>
<td>( F^2(2,129.0) = 0.52, \ ns )</td>
</tr>
<tr>
<td>DVD</td>
<td>TL</td>
<td>213.57 (n = 78)</td>
<td>164.90 (n = 61)</td>
<td>170.33 (n = 61)</td>
<td>( F^2(2,128.4) = 3.75, \ p &lt; .05 )</td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>5.73 (n = 79)</td>
<td>5.96 (n = 68)</td>
<td>6.37 (n = 62)</td>
<td>( F^2(2,206) = 1.24, \ ns )</td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>2.85 (n = 77)</td>
<td>3.00 (n = 67)</td>
<td>2.67 (n = 57)</td>
<td>( F^2(2,129.0) = 0.52, \ ns )</td>
</tr>
</tbody>
</table>

\( ^a \) Asymptotically distributed Fs used in the Welch procedure.

Table 5
Experiment 2: Differences among currency groups for each product

<table>
<thead>
<tr>
<th>Product</th>
<th>Currency</th>
<th>( M )</th>
<th>SD</th>
<th>TL</th>
<th>NTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compass</td>
<td>TL</td>
<td>1.79</td>
<td>1.12</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>2.17</td>
<td>1.46</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>2.80</td>
<td>2.09</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>TL</td>
<td>0.44</td>
<td>0.20</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>0.50</td>
<td>0.20</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>0.75</td>
<td>0.54</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Paprika</td>
<td>TL</td>
<td>1.04</td>
<td>0.63</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>1.14</td>
<td>0.67</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>1.55</td>
<td>1.20</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>DVD</td>
<td>TL</td>
<td>213.57</td>
<td>129.02</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>164.90</td>
<td>86.20</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>170.33</td>
<td>82.80</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>TL</td>
<td>1.20</td>
<td>0.32</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>1.20</td>
<td>0.34</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>1.60</td>
<td>0.74</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Flight</td>
<td>TL</td>
<td>271.09</td>
<td>150.88</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTL</td>
<td>285.06</td>
<td>143.36</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO</td>
<td>350.77</td>
<td>201.86</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

NS: nonsignificant differences between pairs of means. (\(^*\)): significance using the Dunnett’s C.
the Turkish currencies, H2 was supported for certain products. However, the most important finding was that H2 was not supported in comparisons between the NTL and the former currency since there were no differences between the TL and NTL estimates (except in the case of the DVD player).

3.2.3. Price estimation variance

The variances of estimates given by the participants for each product were analysed to complete the investigation of estimation accuracy in different currencies. As discussed earlier, price estimation variance is another measure of currency adaptation, with lower variability indicating greater adaptation. As in Experiment 1, in order to distinguish scalar variability and item-related variability from that related to currency adaptation, analyses of Weber fractions and weighted absolute errors (wae) were carried out. These analyses aimed to identify differences in price estimate variability across products and currencies while controlling for scalar variability (Marques & Dehaene, 2004). The Weber fractions for each product in each currency are shown in Fig. 2. None of the Weber fractions were found to be outliers.

To test whether the differences in Weber fractions evident in Fig. 2 were significant, a 3 × 13, Currency × Product, ANOVA was carried out. The first factor was between participants, the second factor was within participants and the dependent variable was wae. The sample sizes across currency conditions were reduced to between 38 and 55 per condition in this analysis because of missing data of at least one product per participant. There was a significant main effect for Product \( (F(12,1560) = 10.54, p < 0.001) \), a significant interaction \( (F(24,1560) = 2.05, p < 0.005) \) but no significant main effect for currency. These results show that the wae measure of price uncertainty, and, therefore Weber fractions, varied significantly across product. Also, there were some differences across currencies but these were not consistent across products.

To elucidate this complex pattern further, differences across currencies for the wae scores were analysed using one way ANOVA for each product (independent variable,
Currency; dependent variable, wae). Separate one way ANOVAs, rather than tests of contrasts following up the two-factor ANOVA were used to examine currency differences. This was because substantially larger samples were available for this analysis. Significant differences between currencies were found for three products: potatoes \((F(2,205) = 11.17, p < 0.001)\); milk \((F(2,207) = 5.52, p < 0.005)\), and the car \((F(2,194) = 6.14, p < 0.005)\). Post hoc Scheffe tests found that the wae differences between TL and NTL were not significant while differences between Euro and the two Turkish currencies were significant, with higher mean wae for the Euro currency.

3.2.4. Self-reported adaptation to the NTL

The self-report questionnaire aimed to measure the participants’ perceived degree of adaptation to the NTL six months after its introduction. Most participants (70.3%) reported that the NTL caused no difficulty when purchasing, although for exceptional purchases, 55% continued to count mentally in TL and for common purchases, 43%. Also, 34% of participants reported that they never converted NTL to TL to understand how expensive a product is, while 25% reported that they frequently or always did so. In addition, 54% of participants thought that it was easy to adapt to the new currency (NTL), and 82% reported being favourable or very favourable towards the currency reform. Finally, 60% thought that prices had not changed after the reform, while 35% thought that they had become more expensive.

4. Discussion and conclusion

4.1. Indicators of currency adaptation

Surveys such as the Eurobarometer have assessed a population’s adaptation to currency change using relatively straightforward self-report questions such as those used in our second study. Rather than rely on self-report measures, however, the main aim of our experiments was to explore the adaptation process using behavioural measures of price estimation accuracy. In Experiment 1 we used three behavioural indicators that have been used in previous studies, assessing price estimation differences across currencies in: (1) the degree of anchoring bias (Mussweiler & Englich, 2003); (2) biases due to the nominal value of the currency, e.g. Jonas et al. (2002); and (3) variances of estimates after controlling for scalar variability (Dehaene & Marques, 2002), as measured by Weber fractions and weighted absolute error (wae). Unlike Mussweiler and Englich (2003) in their investigated German adaptation to the Euro, we did not find a greater degree of anchoring bias with estimates in the unfamiliar Euro or in the relatively unfamiliar NTL prior to its introduction. Therefore, the anchoring bias hypothesis (H1) was not corroborated. The lack of support for H1 with respect to the Euro cannot be explained in terms of adaptation processes, since the Euro was clearly unfamiliar to our participants. Our analysis of weighted absolute errors and Weber fractions across currency revealed that those for the Euro were significantly higher than those for the two Turkish currencies. As argued earlier, these differences militate against the detection of any possible anchoring bias differences across currencies: even if anchoring bias is greater in unfamiliar currencies, if price estimation variance is also greater, anchoring bias differences are less likely to be detected. For this reason, we conclude that anchoring bias difference across currencies is an unreliable indicator of currency adaptation.
Given the above argument, we should ask why Mussweiler and Englich (2003) were able to detect such differences whereas we were not. It could be that the variance differences observed in the Turkish case were not present in the German study. Unfortunately, Mussweiler and Englich did not report the SDs or Weber fractions of price estimates across Currency and Anchor conditions and so further comparison between the two studies is not possible. Nevertheless, our analysis clearly shows how the detection of differences in degree of anchoring bias across currencies can be strongly moderated by differences in the variance of price estimation across currencies.

On the other hand, in both studies we found evidence of lack of adaptation to the Euro from the Weber fraction measure of adaptation similar to that found by Dehaene and Marques (2002) in three European countries more than one year before the introduction of the Euro. Furthermore, we also observed a euro illusion bias in Euro price estimates similar to that found by Jonas et al. (2002) prior to the introduction to the Euro. Therefore, our main conclusion concerning measures of currency adaptation is that euro illusion bias and differences in Weber fractions are both more reliable than degree of anchoring bias.

4.2. Adaptation to the NTL

Consumers’ self-reports in the second study suggested that they were already quite well adapted six months after the introduction of the NTL. The majority were not counting in the former currency for common purchases, and only a quarter reported frequently or always converting back to evaluate how expensive something was. However, not all of these consumers felt that they were fully adapted. For example, more that half of them reported that they continued to count mentally in TL for less common purchases. In terms of behavioural indicators, in our first study we found that students’ mean estimate of the price of a mid-sized car was higher in NTL than in TL. Following Jonas et al. (2002), we explained this euro illusion bias (H2) in terms of the influence of internal anchor prices for the product stored in long-term memory in the familiar currency. However, in our second study, although we found estimation biases in the unfamiliar Euro, there was a significant difference between TL and NTL mean price estimates in only one of the 13 products presented, the DVD player. This implies that euro illusion effects involving the NTL disappeared rapidly, six months at most after its introduction for almost all products. This finding, in conjunction with the overestimation biases in the unfamiliar Euro, supports the hypothesis that participants were well adapted to the New Turkish Lira. Table 4 shows that mean differences between TL and NTL were not consistently less even for the rarely purchased items (car, office scissors, apartment building, compass etc.), which tends to support the rescaling hypothesis. Since adaptation appears to have been fast and uniform across products, rescaling rather than selective price relearning is the more likely adaptation process in this case.

Turning to the second indicator of adaptation, the Weber fractions and mean wae measures of accuracy that control for scalar variability, in Experiment 1 these measures of the variability of price estimates for the car were not significantly different in TL compared to NTL. Similarly, in Experiment 2 there were no significant differences between TL and NTL Weber fractions for any of the products or services. The findings on this measure also, therefore, corroborate the conclusion that adaptation had proceeded relatively smoothly across all products and services, again supporting the rescaling hypothesis.
Acknowledgements

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References


