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Does Money Illusion Matter?: Reply

By Ernst Fehr and Jean-Robert Tyran*

The data in Fehr and Tyran (FT, 2001) and Luba Petersen and Abel Winn (PW, 2013) show that money illusion plays an important role in nominal price adjustment after a fully anticipated negative monetary shock. Money Illusion affects subjects’ expectations, and causes pronounced nominal inertia after a negative shock but much less inertia after a positive shock. Thus PW provide a misleading interpretation both of our and their own data.

In Fehr and Tyran (FT, 2001), we examine the role of money illusion in the adjustment of nominal prices after a fully anticipated monetary shock in a price setting game with strategic complementarity. We show that nominal prices adjust much more slowly to the new equilibrium after a negative shock in the presence of the “veil of money”, i.e. when we present payoff information in nominal terms compared to when we present it in real terms. In contrast, nominal prices adjust relatively quickly to the new equilibrium after a positive monetary shock even under the veil of money, suggesting that money illusion exerts asymmetric effects across fully anticipated positive and negative shocks.

Petersen and Winn (PW, 2012) question our interpretation of the evidence in terms of money illusion and claim that money illusion only plays a slight or no role in post-shock price adjustment. In the following, we challenge PW’s conclusions and argue that PW’s main claims are misleading and not tenable. Our response proceeds as follows. Section 1 argues that PW use an exceedingly narrow and psychologically implausible definition of money illusion that is not in line with the definition of money illusion as a behavioral consequence of the veil of money that economists have traditionally been using. Section 2 demonstrates that their narrow definition of money illusion leads to several questionable assertions. Section 3 shows that despite the various modifications PW implement to ease subjects’ difficulties in piercing the veil of money (compared to FT’s design), FT’s results are remarkably robust and the overall effect of money illusion on nominal inertia is similar in FT and PW. Section 4 discusses

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the key role of expectations in explaining nominal inertia and shows that the veil of money causes sticky expectations. Section 5 concludes the paper.

I. Behavioral money illusion and psychological mechanisms behind money illusion

One major problem in PW’s paper is that their comment is not based on a general definition of money illusion, but that they focus on a narrow and implausible psychological mechanism behind behavioral money illusion, the simple (i.e. unconditional) maximization of nominal income. Moreover, their description of our work generates the incorrect impression that we put forward this narrow mechanism as the main and only explanation of money illusion in our experiments. However, the notion of money illusion that we defined in FT (2001) is much more general and clearly implies that there are many other plausible psychological mechanisms that may contribute to money illusion aside from the one specific mechanism that PW consider.

We define money illusion as a framing or representation effect that exists if people’s behavior in a given economic situation differs between a nominal and a real payoff representation. Because the nominal and the real representation of payoffs are just different descriptions of the same objective economic situation, an illusion-free individual should make the same real choices under these two representations. This definition of money illusion captures the essence of how economists have used this term in the past. It is important to stress that economists have traditionally defined money illusion in terms of behavior and not in terms of specific psychological mechanisms; our definition is in line with this tradition.¹

Empirically, however, the fact that the nominal and the real representation describe the same objective economic situation does not mean that the behavior under the two descriptions is necessarily identical. In fact, the very reason why economists have used the metaphor of “piercing the veil of money” is that the nominal representation casts a “nominal veil” which may conceal real economic

¹ Leontieff (1936), for example, defined money illusion as a violation of the “homogeneity postulate” which stipulates that supply and demand functions depend only on relative and not on absolute nominal prices. This definition implies that people without money illusion do not change their real consumption and labor supply choices in response to purely nominal changes. Thus, money illusion is defined here as a behavioral response to absolute nominal prices and any psychological mechanism that produces this behavioral response is considered to be money illusion. Although other authors have used slightly different definitions (see Howitt 1989), the intuition behind their definitions is very similar. This intuition says that if the real trade-offs between various actions, i.e. the objective situation an individual faces, remain unchanged, an illusion-free individual's real decisions will also remain constant, regardless of how this objective situation was framed or described. In this view, the framing of a given situation in nominal or in real terms will not affect rational individuals (i.e. those without money illusion).
incentives. There are many potential reasons and psychological mechanisms why people may fail to pierce the veil of money, i.e. why they may exhibit behavioral money illusion. One possibility is that if people have difficulty piercing the veil of money, and are thus uncertain about their best choice, a rule of thumb of treating (changes in) nominal payoffs as a proxy for (changes in) real payoffs may affect their behavior. They may then move their behavior in the direction of higher nominal payoffs because they fail to realize that this decreases their real payoffs, or they may believe that others will behave in this way.

Both in FT and in PW (2011) many subjects indicate in a post-experimental survey that they used such a rule of thumb and we argue that this rule can explain some important aspects of the data (see our online appendix for details). However, this rule of thumb is not identical to the hypothesis that subjects unconditionally maximize their nominal payoff under the nominal payoff frame. For example, if the experimenter makes it transparent and easy for the subjects in an individual decision-making problem to pierce the veil of money (e.g. by computing the optimal, real-payoff maximizing, solution), the subjects are unlikely to rely on this rule of thumb. The very notion of a “proxy” means that the proxy is only used if the perfect solution is not available to an individual. In our context, this means that subjects are unlikely to simply be nominal income maximizers under the nominal frame. Instead, they will probably only use the above rule of thumb if they cannot pierce the veil of money – an inability that may result from, e.g., cognitive load or biased attention. Thus, the proxy hypothesis always presupposes some other sources of bounded rationality. Nominal income considerations are therefore only a co-determinant of subjects’ behavior. In this view, the proxy hypothesis is closer to what PW call second-order money illusion because nominal income is only one of several determinants of

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2 This is nicely illustrated by Arthur C. Pigou who gave a whole book the title the “The Veil of Money”. Metaphors like “money is a veil behind which the action of real economic forces is concealed” (Pigou 1949, p. 16) were in common use among economists during Pigou’s time. Dennis H. Robertson coined the familiar phrase (Cambridge Economic Handbook on Money, 1922, p. 1) that “it is necessary for the economic student to try from the start to pierce the monetary veil in which most business transactions are shrouded”.

3 For example, different representations of the same situation may render certain aspects of the decision problem (i.e. certain parts of the payoff space) more salient, and may thus be associated with different focal points. In fact, framing effects often occur because different representations of the same situation highlight different features of a decision problem (Tversky and Kahneman 1981; Shafir, Tversky and Diamond 1997). Likewise, it may be more difficult to find the equilibrium in the nominal representation because it imposes a higher cognitive load on people, or it may be more difficult to predict other people’s behavior (thus generating more uncertainty), or it may induce different beliefs about other people’s behavior because subjects believe that others are prone to money illusion.

4 PW considerably reduce the complexity of the decision problem by providing subjects with a computerized income converter that readily transforms nominal payoffs into real payoffs, and they teach subjects how to use them. In addition, they inform subjects explicitly about the best reply to their opponents’ prices by using visual cues. These devices will obviously simplify piercing the veil of money. We discuss some of these aspects in more detail in section 3.
subjects’ behavior under the veil of money. PW’s identification of the proxy hypothesis with the unconditional maximization of nominal income is therefore problematic, and their assertion that that we argue for this simple nominal income maximization hypothesis is incorrect.

II. Misleading conclusions arise from an exclusive focus on nominal income maximization

As the previous section indicates, there are a large number of potential psychological mechanisms that may contribute to money illusion, and an important task for future research consists of disentangling the different mechanisms behind money illusion (see also Shafir, Tversky and Diamond 1997 for a discussion). However, the examination of a single mechanism behind money illusion should not induce the mistake of neglecting the many other potential mechanisms and treating them as something different from money illusion. For example, statements in PW such as “a nominal payoff frame may slow price adjustment because it increases agents’ cognitive load, not (only) because it induces money illusion” are misleading because they construct an opposition between cognitive load and money illusion where there is in fact none. If piercing the veil of money is difficult (what else does cognitive load generated by the nominal payoff frame mean?), and subjects therefore adjust nominal prices more slowly to the post-shock equilibrium, their behavior should be classified as a manifestation of behavioral money illusion as much as when they would straightforwardly maximize nominal payoffs under the nominal frame. Thus, just because PW do not find evidence for one particular psychological mechanism behind money illusion – the unconditional maximization of nominal income – it is misleading to conclude that money illusion plays no or little role in the experiments of FT and PW.

The following claim on page 1 of their paper provides a further example of the problems that stem from PW’s narrow definition of money illusion: “A visible focal point in the participants’ real payoff space is obscured in their nominal payoff space. This may have slowed coordination to the new equilibrium apart from money illusion.” As we explained above, the effects of the nominal payoff representation may be due to shifts in the salience of certain aspects of the payoff space. There is absolutely no reason to neglect this effect of the “veil of money” and treat it as something different.

5 The current literature on money illusion also emphasizes multiple psychological mechanisms. Modigliani and Cohn (1979) hypothesize that stock market investors undervalue equity in times of high inflation because they discount future cash flows with the nominal interest rate. Cohen, Polk, and Vuolteenaho (2005) and Acker and Duck (2012) provide evidence supporting this hypothesis. In contrast, Genesove and Mayer (2001) and Stephens and Tyran (2012) focus on the role of nominal loss aversion in the housing market, and Noussair, Richter and Tyran (2012) examine nominal loss aversion in experimental asset markets. Brunnermeier and Julliard (2007) put forward the hypothesis that buyers in the housing market mistakenly interpret decreases in nominal interest rates that are due to decreases in inflation as a decrease in real interest rates, i.e. they underestimate the real future costs of mortgage payments.
from money illusion. A general feature of the nominal representation of payoffs is that it tends to
generate different focal points compared to the real payoff representation; this is one reason why our
design choice of comparing behavior under the real and the nominal payoff frame is interesting.
Moreover, most of the economic transactions in the real world are “shrouded in money”, i.e. take place
in a nominal frame. So why should we neglect this important aspect of the nominal payoff frame? It is
not a confound of our design – as PW claim. Instead, it is an important and interesting feature of our
design that may contribute to the existence of money illusion.6

III. Overall similar effects of money illusion in Fehr-Tyran and Petersen-Winn

PW implemented several changes – relative to FT – in their experiments that were intended to make it
easier for the subjects to pierce the nominal veil. For example, PW provide subjects with a
computerized income converter that converts the nominal payoff from any given nominal price vector
into the real payoff. In contrast, subjects in FT had to figure out their real payoffs themselves.
 Obviously, this change reduces the difficulty of piercing the veil of money in PW (relative to FT)
because it relieves subjects from the burden of transforming nominal payoffs into real payoffs.
Likewise, PW explicitly highlighted the incomes associated with the best reply to the opponents’
actions on the subjects’ payoff sheets by writing them in bold, red font. They thus told the subjects in
essence the best reply to the opponents’ actions.7 In contrast, subjects in FT had to find the best reply to
others’ expected average price themselves. Nevertheless, Figure 1 shows that the overall qualitative
pattern of behavioral money illusion is remarkably similar across the FT and the PW data. The main
regularity identified in FT is thus remarkably robust across designs.

In Figure 1, the overall effect of money illusion is measured by the difference in subjects’
nominal price choices between the nominal and the real payoff representation. This difference is large
in PW and qualitatively similar to FT’s results after a negative shock8 (see left panels). Under the
nominal payoff representation (treatment NH), the adjustment of nominal prices to the equilibrium

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6 The failure to distinguish between behavioral money illusion and the various potential psychological mechanisms behind
money illusion is also the basis for PW’s assertion that our experimental design is in principle not capable of measuring
individual-level money illusion. A more detailed rebuttal of this claim is provided in our online appendix.
7 PW state in the instructions of the treatments with the nominal payoff representation: “Notice that on both tables, some of
the incomes are displayed in bold, red font. These are the highest real incomes that can be earned in a given round” (Bold
in the original).
8 PW do not report the average prices before the shock in the AER version of the paper. We use the data from their working
paper version (Petersen and Winn 2011) to construct the graph for the PW results. PW have 15 pre-shock and 15 post-
shock periods. For better comparability, we show the same number of pre-shock and post-shock periods for the FT data
here (we had 20 pre-shock and 20 post-shock periods).
(which is at a price = 6) after a fully anticipated negative monetary shock is slow both in PW (upper left panel) and FT (lower left panel). In contrast, prices converge quickly to the new equilibrium in both data sets under the real payoff representation (RH). Because PW implemented important changes that made it considerably easier to pierce the veil of money in the nominal treatment, the adjustment to the post-shock equilibrium is quicker: the average nominal price reaches equilibrium in period 8 after the negative shock in PW, while equilibration occurs in period 13 in FT (see Table 5 in PW and Table 4 in FT). This shows that seeing through the veil of money is not something that subjects do naturally, but that they need support to mitigate money illusion. Moreover, the total effect of money illusion remains substantial in PW because post-shock equilibration already occurs in period 3 in the real treatment.

** Figure 1 about here **

Figure 1 also illustrates that FT's second main result is robust across designs. The effect of money illusion on nominal inertia (i.e. the differential price adjustment between the nominal and the real treatment after the shock) is much smaller after a positive than after a negative shock (compare left and right panels). After the positive shock, subjects in PW already reach the new equilibrium in the 4th post-shock period (upper panel) of NH. Likewise, subjects in FT already reach the new equilibrium in the 4th post-shock period. Thus, PW and FT find that money illusion causes substantial nominal inertia after a negative shock, and that the effect of money illusion is asymmetric (i.e., less pronounced after a positive shock).

**IV. The role of expectations in price adjustment**

How can we explain the greater amount of nominal inertia under the nominal veil? A key argument in FT is that money illusion can cause pronounced nominal inertia at the aggregate level after a negative shock even if money illusion has only minor effects at the individual level. FT argue that money illusion affects expectations, and agents' choices are mostly optimal given these expectations. Prices in FT (2001) are strategic complements, implying that sticky expectations about others’ price adjustment
after the shock will induce sticky price adjustment. In short, prices are sticky after a negative shock because expectations are sticky.

In contrast, PW argue that fully adaptive best reply behavior explains the adjustment of prices after a nominal shock both in the real and the nominal representation of payoffs. In other words, PW claim that money illusion does not play a role in post-shock price adjustment because the nominal treatment has no independent effect on subjects’ price adjustment behavior. The data fail to support this conclusion, however, for several reasons. First, PW arbitrarily remove the first period after the shock from the regressions that are intended to show that fully adaptive best reply behavior explains subjects’ choices in both the real and the nominal treatment. However, as Figure 1 shows, the biggest impact of the nominal treatment on price adjustment occurs exactly in period 1 after the shock, where the price adjustment towards the new equilibrium is much bigger in the real treatment than in the nominal one. This means that even if it were true that there are no treatment differences in price adjustment behavior after the first post-shock period, money illusion has a big impact on nominal inertia because it would determine the starting point for adaptive best reply behavior after the first post-shock period.

Second, however, we will show below that the adaptive best reply hypothesis has no predictive power if one directly controls for subjects’ expectations about the average price that the other players will choose. Rather than playing a best reply to the average price of the previous period, subjects play a best reply to their opponents’ expected average price in the current period. Moreover, the expected average price is systematically higher in the nominal treatment throughout the disequilibrium phase of the post-shock period, i.e. it causes sticky expectations that translate into sticky prices because subjects play a best reply to their expectations.

The regressions in Table A1 of our online appendix document that subjects play a best reply to the expected average price regardless of whether they are in the real or the nominal treatment. The best reply to the expected average price determines almost one-for-one subjects’ actual price choices in the post-shock phase, and this holds regardless of whether subjects are in the nominal or the real treatment or whether the shock is negative or positive. We also included the adaptive best reply (ABR, as defined

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9 The strategic properties of the environment, i.e. whether strategic complementarity or strategic substitutability in price setting prevails, play a key role in this transmission. Fehr and Tyran (2008) provide a detailed examination of how strategic complementarity and substitutability affects nominal price adjustment.

10 We study this question on the basis of the data from the NH and the RH treatment in FT (2001) because PW do not report any expectations data.
by PW) into these regressions. Interestingly, however, the coefficient of ABR and the interaction term between ABR and the nominal treatment are close to zero and insignificant. Moreover, the inclusion of the ABR leaves the explained variance in subjects’ price choices (i.e. the $R^2$) completely unaffected. Our analysis therefore supports the conclusion that subjects play a best reply to their price expectations regardless of the treatment and the nature of the shock, and that the best reply to expectations is a much better predictor of price setting behavior than the lagged average price.\footnote{These conclusions also hold if we neglect (as PW do) the data from the first post-shock period.}

Table 1 below shows that the nominal treatment systematically affects subjects’ expectations, and that money illusion therefore has an indirect effect on subjects’ price setting behavior via expectations. We regress subjects’ expected average price on the deviation of the lagged average price from the post-shock equilibrium, the nominal treatment dummy (NH), and the interaction of the two variables.\footnote{Instead of the absolute level of the lagged average price, we used the deviation of the lagged price from the post-shock equilibrium because we know that the subjects in both the real and the nominal treatment (NH) propose a price of 6 and expect an average price of 6 in equilibrium. In fact, NH can only play a role in disequilibrium. In equilibrium expectations and prices are by definition no longer different between the real and the nominal treatment. For this reason it is important to include the interaction term between NH and the deviation of the lagged price from equilibrium into the regressions because this allows us to capture “deviation-dependent” influences of the nominal treatment on expectations. Also note that PW’s “adaptive best reply hypothesis” and the hypothesis that the nominal representation systematically shapes expectations can empirically only be discriminated in disequilibrium.} The equation for the negative shock treatment shows that the nominal treatment causes a significant increase in price expectations for positive deviations of the lagged average price from the equilibrium. Likewise, in the positive shock treatment the NH causes a stronger deviation of expectations from equilibrium for a given deviation of the lagged average price from equilibrium. The regressions in Table 1 also show that if the subjects are close to or at the equilibrium (i.e., if the deviation of the lagged average price from equilibrium is close to zero), subjects’ price expectations do not differ between the treatments because they expect a price close to the equilibrium in both the nominal and the real treatment. However, the price expectations are systematically and significantly higher for larger deviations of the lagged price from the equilibrium in the nominal treatment. Therefore, because subjects generally play a best reply to their expectations and these expectations are stickier, prices are also stickier in the nominal treatment.\footnote{If we conduct the regressions in Table 1 without the first post-shock period data we get similar results: The nominal treatment significantly increases price expectations after the negative shock. However, because in the second post-shock period play already converged far towards the equilibrium the impact of the NH is smaller and not significant.}
V. Concluding Remarks

PW make several strong claims in their comment: (1) “Money illusion cannot be measured in their [FT’s] experiments”; (2) “A nominal payoff frame may slow price adjustment because it increases cognitive load, not (only) because it induces money illusion”; (3) “A visible focal point in the participants’ real payoff space is obscured in their [FT’s] nominal payoff space. This may have slowed coordination to the new equilibrium apart from money illusion”. All these claims are either untenable or seriously misleading because (i) they are based on the incorrect assertion that we rely on a narrow and psychologically implausible definition of money illusion (the simple, unconditional, maximization of nominal income). If behavioral money illusion is properly defined, and the multiplicity of psychological mechanisms behind behavioral money illusion is acknowledged, the questionableness of these claims becomes apparent.

PW also claim (4) that fully adaptive best reply behavior explains the post-shock price adjustment well, and that this implies that money illusion has no effect on expectations formation or prices. However, the adaptive best reply strategy has no predictive power for subjects’ price choices if one controls for price expectations, as we show in a series of regressions in the online appendix (Table A1). In addition, the nominal treatment affects these expectations significantly, indicating that money illusion does indeed play a significant role. Thus, taken together, all four major claims in PW are questionable.

In fact, the main results arising from FT (and PW) speak loud and clear: behavioral money illusion matters for nominal inertia when prices are strategic complements. The “veil of money” causes pronounced inertia after a negative monetary shock, but is much less pronounced after a positive shock (see Figure 1). The nominal inertia after a negative shock is likely to be due to both sticky price expectations and to individual-level money illusion. However, FT should not be read as a contribution investigating the deep psychological mechanisms behind money illusion. While the fact that the “veil of money” causes sticky expectations and nominal inertia is clear and robust, the specific psychological mechanisms behind behavioral money illusion remain to be identified. PW’s data provide some progress over previous work in this regard. In particular, their comparison between the RS and the NS treatment, where one subject determines the price choices of all four “players”, shows that the “veil of money” makes finding the equilibrium considerably more difficult. Note, however, that this observation does not yet explain the direction of disequilibrium. If subjects just cannot find the new
equilibrium, why are they not equally likely to overshoot relative to the new equilibrium than to undershoot? In other words, one needs an additional argument why the “veil of money” generates nominal inertia. The fact that many subjects report in post-experimental questionnaires in FT and PW (2011) that they take nominal payoffs as a proxy for real payoffs and that they believe that others do so as well provides a plausible answer to this question. If some subjects are partially attracted by higher nominal payoffs because they cannot fully see through the veil of money, they will naturally choose higher prices after a negative monetary shock.

References


**Table 1:** Expectations about others’ average price in the post-shock periods in FT (2001)

<table>
<thead>
<tr>
<th>Price of others</th>
<th>Negative shock</th>
<th>Positive shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation of lagged average price from equilibrium (Dev)</td>
<td>0.354*** (.046)</td>
<td>0.338*** (.037)</td>
</tr>
<tr>
<td>Nominal treatment (NH = 1)</td>
<td>-0.045 (.197)</td>
<td>-0.080 (.070)</td>
</tr>
<tr>
<td>Dev × NH</td>
<td>0.477*** (.064)</td>
<td>0.289*** (.068)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.423*** (.160)</td>
<td>25.01*** (.037)</td>
</tr>
</tbody>
</table>

$R^2 = .718$  
$N = 1680$

$R^2 = .518$  
$N = 1380$

**Notes:** Random effects GLS regression, standard errors in parentheses (clustered by group). Regressions are based on data from all post-shock observations in treatments with human opponents (NH and RH) of FT (2001). Significance: * = 10 percent, ** = 5 percent, *** = 1 percent.
Figure 1: The effect of money illusion on nominal inertia after a negative (left) and positive (right) monetary shock

[PW data upper panel, FT data lower panel, data from treatments with human opponents]