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MONEY ILLUSION*

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The term "money illusion" refers to a tendency to think in terms of nominal rather than real monetary values. Money illusion has significant implications for economic theory, yet it implies a lack of rationality that is alien to economists. This paper reviews survey questions regarding people's reactions to variations in inflation and prices, designed to shed light on the psychology that underlies money illusion. We propose that people often think about economic transactions in both nominal and real terms, and that money illusion arises from an interaction between these representations, which results in a bias toward a nominal evaluation.

"A nickel ain't worth a dime anymore" [Yogi Berra].

> We have standardized every other unit in commerce except the most important and universal unit of all, the unit of purchasing power. What business man would consent for a moment to make a contract in terms of yards of cloth or tons of coal, and leave the size of the yard or the ton to chance? . . . We have standardized even our new units of electricity, the ohm, the kilowatt, the ampere, and the volt. But the dollar is still left to the chances of gold mining [Fisher, 1913].

> There is probably no defect in the world's economic organization today more serious than the fact that we use as our unit of value,

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> not a thing with a fixed value, but a fixed weight of gold with a widely varying value. In a little less than a half century here in the United States, we have seen our yard-stick of value, namely, the value of a gold dollar, exhibit the following gyrations: from 1879 to 1896 it rose 27%. From 1896 to 1920 it fell 70%. From 1920 to September, 1927, it rose 56%. If, figuratively speaking, we say that the yard-stick of value was thirty-six inches long in 1879 when the United States returned to the gold standard, then it was forty-six inches long in 1896, thirteen and a half inches long in 1920 and is twenty-one inches long today (Professor E. W. Kemmerer at a meeting of the Stable Money Association, December, 1927, quoted in Fisher [1928]).

Recognition of money illusion has a long tradition in economics. Indeed, nearly seventy years ago Irving Fisher devoted an entire book to it [*The Money Illusion* 1928]. Patinkin [1965], who defined money illusion as any deviation from "real" decision making,[1] wrote: "An individual will be said to be suffering from such an illusion if his excess-demand functions for commodities do *not* depend solely on relative prices and real wealth" [p. 22]. Money illusion would be observed if, in the presence of inflation, nominal accounting methods affected decisions, a possibility recognized by Fischer and Modigliani [1986]. Moreover, with changing relative prices, an effect of past nominal values on purchase or sale decisions would be a form of money illusion even in the absence of inflation. This could manifest itself in a reluctance to sell a house or shares of stock at a nominal loss, or in a reluctance to accept nominal wage cuts. Using survey questions, this paper contends that money illusion is a widespread phenomenon in the United States today. Moreover, the paper proposes a psychological account of money illusion based on the presence of multiple representations. By illustrating the interaction between money illusion and other decision factors such as loss aversion, risk attitudes, and fairness concerns, the paper underlines the potential importance of money illusion in the economy.

Despite its long history, money illusion has been regarded with mixed feelings. The ambivalence that characterizes the economics profession's attitude to money illusion is depicted in Howitt's entry on money illusion in the *New Palgrave Dictionary of Economics* [1987, Vol. 3, pp. 518–19]:

1. Of course, an exception needs to be made for nominal elements based on nominal constraints, such as are commonly found in tax laws.

> The absence of money illusion is the main assumption underlying the long-run neutrality proposition of the quantity theory of money. But the presence of money illusion has also frequently been invoked to account for the short-run non-neutrality of money, sometimes by quantity theorists themselves, as in the case of Fisher. On the other hand, many monetary economists have reacted adversely to explanations based on such illusions, partly because illusions contradict the maximizing paradigm of microeconomic theory and partly because invoking money illusion is often too simplistic an explanation of phenomena that do not fit well into the standard equilibrium mold of economics. Behavior that seems irrational in a general equilibrium framework may actually be a rational response to systemic coordination problems that are assumed away in that framework . . . Although monetary economists have thus been reluctant to attribute money illusion to private agents they have not hesitated to attribute it to governments . . . In short, the attitude of economists to the assumption of money illusion can best be described as equivocal. The assumption is frequently invoked and frequently resisted. The presence of a concept so alien to economists' pervasive belief in rationality indicates a deeper failure to understand the importance of money and of nominal magnitudes in economic life. This failure is evident, for example, in the lack of any convincing explanation for why people persist in signing non-indexed debt contracts, or why the objective of reducing the rate of inflation, even at the cost of a major recession, should have such wide popular support in times of high inflation.

Restating Howitt's comments, there are three classes of anomalous observations. One is that prices are "sticky." A second is that indexing does not occur in contracts and laws as theory would predict.[2] The third class manifests itself through conversation, rather than behavior: people talk and write in ways that seem to indicate some confusion between money's nominal and real worth.

That changes in the money supply have their impact first on quantities and only later on prices is a widely accepted description of economies in many times and many places.[3] This observa-

2. In general, economists do not expect to find the same level of economic rationality in governments as among private agents. However, it is hard to see how a satisfactory theory of government behavior would account for policies incorporating money illusion if none of the citizen-voters or politicians were subject to money illusion.

3. For a recent test of such lags, see Romer and Romer [1989].

tion often leads to an examination of the "stickiness" of prices and wages. Stickiness is documented in a variety of ways. At one extreme of aggregation, there are the lags in aggregate price equations.[4] Some studies of individual markets also show large quantity movements and small price movements. The theoretical mold that tries to derive these results from overlapping contracts or costs of price adjustment must recognize the presence of similar phenomena in markets, like housing, where prices are negotiated.

Economists do not find indexed contracts in nearly as many places as theory suggests they should be found. Furthermore, when indexed contracts are found, their form often seems peculiar to economists.[5] Moreover, there is only a slow introduction of indexed contracts when inflation picks up and, more strikingly, the partial disappearance of indexed contracts when inflation slows down. Frequently, governments also use unindexed contracts and have tax systems that are unindexed or incompletely indexed. Courts do not treat inflation the same as unexpected events that destroy the value of contracts.[6]

Common discourse and newspaper reports often manifest money illusion, even in familiar contexts and among people who, at some level, know better. There are frequent newspaper comparisons of unadjusted costs, charitable donations, and salaries across time.[7] There are newspaper accounts of debt-financed projects that add together the initial costs and the interest costs coming from debt financing and report a single sum. Naturally, one

4. See, e. g., Gordon [1983].

5. For a discussion of the difficulty of writing indexed contracts and the patterns in actual contracts for the delivery of coal, see Joskow [1988]. For a history of COLAs in U. S. labor contracts, see Hendricks and Kahn [1985]. For a history of labor market indexation in Israel, see Kleiman [1986]. For a description of COLAs in Canadian labor contracts, see Card [1983]. For discussion of indexation more generally in Canada, see Howitt, [1986]. For a discussion of responses to inflation in the United States, see Fischer [1982].

6. The Supreme Court of Canada upheld an unindexed 65-year contract between Quebec and Newfoundland for the delivery of hydropower despite subsequent inflation (Fortin, personal communication, 1995). For an example of the refusal of English courts to revise contracts in response to inflation, see Hirschberg [1976], p. 101. For a discussion of the refusal of courts to extend the rewriting of contracts for unexpected events to inflation, see Leijonhufvud [1977].

7. See, e.g., "Largest gifts in higher education," *The New York Times*, July 7, 1992, in which a ranking of largest gifts is presented entirely in nominal terms so that, for example, the gift ranked tenth (nominally) would actually rank second when all are adjusted to 1992 dollars. In some circumstances, of course, one may consider the difficulty involved in doing the calculations correctly. Since the posting of unit price information (thus saving the difficulty of dividing) and the adjacent listing of prices (thus saving on memory) both appear to affect purchases [Russo 1977], there may be a relationship between the difficulty of the correct calculation and the extent of systematic error.

would expect to find greater awareness of the difference between nominal and real values when inflation is high than when it is low. Nevertheless, residues of money illusion are observed even in highly inflationary environments. When inflation was high in Israel, it was common to use the U. S. dollar for both analysis and transactions. Yet, this substitution did not seem to preclude the continuation of money illusion relative to the changing value of the dollar.[8] The persistence of money illusion indicates that this phenomenon is not readily eliminated by learning. People may resort to an analysis in real terms when inflation is high, but may then go back to relying on nominal evaluations when the inflation subsides. For example, there is evidence that COLAs disappear from some contracts when inflation rates diminish, indicating that the appeal of a nominal evaluation persists despite extensive experience with evaluation in real terms.[9]

The present paper proposes a psychological account of money illusion, which may help economists understand and model this phenomenon, rather than ignore it or model its consequences in alternative ways.[10] Section I presents an analysis of money illusion in terms of multiple representations. Section II reports a series of studies that examine people's representations of various economic transactions. Section III provides summary and discussion, and sketches a model that incorporates some aspects of money illusion.

I. Multiple Representations: A Psychological Account

Research in cognitive psychology indicates that alternative representations of the same situation can lead to systematically different responses. For example, choice between risky prospects may be represented either in terms of gains and losses, which

8. Similarly, Fisher [1928, p. 8] tells about a woman with a mortgage debt denominated in marks but thought about in dollars. In discharging her debt, she refused to take advantage of the change in the exchange rate (which altered the value of the debt from $7000 to $250), but did not adjust for the decline in the value of the dollar.

9. Of the workers covered by major collective bargaining agreements in the United States, for example, the percentage covered by COLAs was 50.0 percent in 1958, 20.0 percent in 1966, 61.2 percent in 1977, 57.3 percent in 1984 [Hendricks and Kahn, 1985, Table 2–7.]

10. Several authors have constructed alternative models that produce results similar to those generated by money illusion. Lucas [1972], for example, creates an inference problem that permits rational agents to exhibit behavior similar to that of agents with money illusion. For alternative accounts that assume particular forms of contracting, or of price or wage stickiness, see Barro and Grossman [1971], Fischer [1977], Lucas [1989], Malinvaud [1977], and Taylor [1979].

seems natural to most people, or in terms of final assets, as recommended by normative theory. Consider an individual who faces a choice between a total wealth of $250,000, and an even chance at a total wealth of either $240,000 or $265,000. The same situation can also be represented in terms of gains and losses, as a choice between the status quo (here, $250,000) and an even chance to win $15,000 or to lose $10,000. These alternative representations of the same choice problem tend to induce different responses. When the problem is framed in terms of final assets, with no reference to changes in wealth, people tend to prefer the risky prospect, which has a higher expected value. But when the same problem is presented in terms of gains and losses, people prefer the status quo over the risky prospect, presumably because, in accord with the principle of loss aversion, a potential $10,000 loss offsets an equal chance of a $15,000 gain [Kahneman and Tversky 1979; Tversky and Kahneman 1991].

In another demonstration, McNeil, Pauker, Sox, and Tversky [1982] (see also McNeil, Pauker and Tversky [1988]) presented respondents with a choice between two alternative treatments for lung cancer, surgery and radiation therapy, whose outcomes were described either in terms of mortality rates or in terms of survival rates. Although the alternative representations were logically equivalent, they led to markedly different preferences: the percentage of respondents who favored radiation therapy rose from 18 percent in the survival frame to 44 percent in the mortality frame. This result was observed among experienced physicians, statistically sophisticated business students, as well as clinic patients.

In the above examples, as in other demonstrations of framing effects, people tend to adopt the particular frame that is presented (e.g., wealth versus changes in wealth; mortality versus survival), and proceed to evaluate the options in that frame. The reliance on a particular frame is typically guided by what is more salient, simpler, or more natural, not by strategic calculations. Because certain aspects of the options loom larger in one representation than in another, alternative framings of the same options can give rise to different choices.

In other situations, instead of evaluating the options in terms of a single representation, people entertain multiple representations contemporaneously. In such cases, the response is often a mixture of the assessments induced by the different representations, each weighted by its relative salience. This

mechanism, we suggest, underlies money illusion. Economic transactions can be represented either in nominal or in real terms. The nominal representation is simpler, more salient, and often suffices for the short run (in the absence of hyperinflation), yet the representation in real terms is the one that captures the true value of transactions. People are generally aware that there is a difference between real and nominal values, but because at a single point in time, or over a short period, money is a salient and natural unit, people often think of transactions in predominantly nominal terms. Consequently, the evaluation of transactions often represents a mixture of nominal and real assessments, which gives rise to money illusion.

As an example, consider a person who receives a 2 percent raise in salary in times of 4 percent inflation. (We assume that the person is aware of inflation, and momentarily ignore other factors, such as the possible social significance of a salary raise.[11]) Naturally, this person would be happier with the same raise in times of no inflation. However, because the nominal evaluation is positive (i.e., the person is making more money), we expect the person to find the change less aversive than a 2 percent cut in times of no inflation, in which both the nominal and the real evaluations are negative. Thus, we propose that holding real change constant, people's reactions will be determined by the nominal change. Moreover, in some situations a nominal change may even offset a real change, as will be illustrated below.

Finally, we also expect money illusion to arise in situations where there has been a relative change in prices, even if unaccompanied by a change in the price of money. Consider someone trying to sell his house (say, with the intention of buying another) during noninflationary times when housing prices have gone down by 5 percent relative to other prices. This person, even if aware of the true value of houses, may anchor on the (historical) price that he paid for the house and may be reluctant to sell the house for less than that nominal anchor. Holding real (replacement) value constant, we propose that in times of changing relative prices people's reactions will be determined by the change between an item's current price and its historical, nominal anchor. Loss aversion occurs relative to a reference point, and the

11. With positive interest rates, there is a similar possibility of multiple representations of dollar values at different times without necessarily having inflation.

reference point can often be nominal, yielding further manifestation of money illusion.

We thus interpret money illusion as a bias in the assessment of the real value of economic transactions, induced by a nominal evaluation. Reliance on a nominal evaluation is not strategic or motivational in nature. Rather, it is due to the ease, universality, and salience of the nominal representation. The strength and persistence of this bias is likely to depend on several factors, notably the relative salience of the nominal and real representations, and the sophistication and experience of the decision maker. Biases induced by multiple representations can be observed also in perception, as is illustrated by the visual illusion in Figure I.

The blocks in Figure I can be interpreted either as two-dimensional figures or as three-dimensional objects. The illusion that the farthest block is larger than the closer ones—although the three are actually identical—arises because the observer spontaneously adopts the more natural three-dimensional interpretation, in which the farthest block is indeed largest. Consequently, the perception of (two-dimensional) picture size is biased by the simultaneous assessment of (three-dimensional) object size. It is noteworthy that people's perceptions are inconsistent with either the three- or the two-dimensional interpretation of the figure. Rather, they correspond to a mixture of the two (see Tversky and Kahneman [1983, pp. 312–13 for discussion). Similarly, in the case of money illusion, people's judgments do not correspond to either the real or the nominal evaluation but, rather, to a mixture of the two. Thus, a person who receives a 2 percent raise in times of 4 percent inflation does not react as he would to a 2 percent raise, or to a 2 percent cut, in times of no inflation. Rather, this person's reaction to the real loss is tempered by the nominal gain. Just as the natural three-dimensional interpretation of Figure I interferes with the two-dimensional interpretation, so the familiar nominal evaluation interferes with the real evaluation in the salary example.

We next present a series of studies that investigate the effects of nominal and real changes on people's stated choices and evaluation of economic conditions. The studies are divided into six subsections. Subsection A addresses people's attitudes toward salary raises in times of inflation; subsection B investigates people's evaluation of monetary transactions; subsection C demonstrates the effect of framing transactions in nominal or in real terms on a choice between indexed and unindexed contracts; sub-

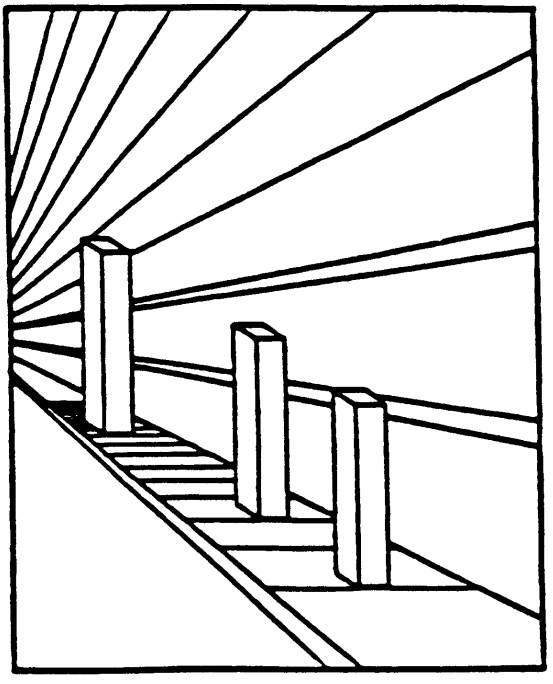

FIGURE I
The Block Illusion

section D describes money illusion in an experimental study of investment; subsection E explores intuitive accounting practices; subsection F considers judgments regarding fairness and morale.

II. EXPERIMENTAL STUDIES

The data presented in this paper come from survey questions presented to people in Newark International Airport, and in two New Jersey shopping malls (Menlo Park Mall in Edison, and Woodbridge Center Mall in Woodbridge). In addition, we have also surveyed undergraduate students at Princeton University. (Unless otherwise specified, all problems presented to undergraduates were posed, embedded among other, unrelated problems, in a questionnaire format. People in the malls and airport received the problems on single sheets of paper.) In most cases, responses from these diverse groups did not differ significantly, and the data are reported in a combined format. Whenever significant dif-

ferences were observed, we report the data separately. The use of surveys has obvious limitations. First, one may question whether people's intuitions in the context of hypothetical questions extend to actual behavior in real-world settings. Second, one may wonder about the extent to which people interpret the situation as conceived by the experimenter, and do not bring to bear other, unspecified assumptions, such as hypothesized prior savings, unmentioned debts, or presumed interest rates. We are keenly aware of these limitations, but believe that carefully constructed survey questions can provide useful information about the problem under study. In fact, behavioral phenomena first observed in hypothetical contexts have often been replicated in realistic settings involving high stakes and serious deliberation (see, e.g., Benartzi and Thaler [1995]; Johnson, Hershey, Meszaros and Kunreuther [1993]; Kachelmeier and Shehata [1992]; and Lichtenstein and Slovic [1973]). The initial explorations of money illusion reported below will hopefully stimulate further research into the psychological causes and the economic consequences of this phenomenon.

A. Earnings

It has long been argued that people's degree of satisfaction with their income depends not only on its buying power but, among other things, on how it compares with an earlier salary or with the salaries of coworkers (see, e.g., Duesenberry [1949]). We asked subjects, for example, to consider two individuals, Carol and Donna, who graduated from the same college, and upon graduation took similar jobs with publishing firms. Carol was said to have started with a yearly salary of $36,000 in a firm where the average starting salary was $40,000. Donna started with a yearly salary of $34,000 in a firm where the average starting salary was $30,000. Note that Carol has a higher absolute salary whereas Donna has a higher income relative to her coworkers. When we asked subjects who they thought was happier with her job situation, 80 percent of respondents (N = 180) chose Donna, the woman with the lower absolute salary, but with the better relative position. Furthermore, when we asked a second group of respondents (N = 175) who they thought was more likely to leave her position for a job with another firm, 66 percent chose Carol, the one with the higher absolute salary but the lower relative position. A similar discrepancy between an absolute and a comparative job evaluation was reported by Tversky and Griffin

[1991], who presented subjects with two hypothetical job offers, one with a higher yearly salary in a company where others with similar training earn more, and the other offering a lower salary in a company where others with similar training earn less. Whereas a majority of subjects chose the job with the higher absolute salary and lower relative position, the majority anticipated higher satisfaction in the job with the higher relative position and lower salary. Even in cases where it is clear that Option A is better than Option B, people sometimes expect to be happier with Option B than with Option A, when it is favored by comparative considerations.

Similar effects in the perception of well-being can be produced from a very different source, namely, the interaction between nominal and real representations. Money illusion is observed when, evaluating a higher income, an individual is content with more money income although a simultaneous rise in prices keeps real income unchanged. What matters when economic conditions change, of course, is a person's buying power (say, the *ratio* between income and costs) rather than how much money the person actually has (the *difference* between income and costs). If everything doubles—you make twice as much, everything costs twice as much, etc.—you will also save twice as much, but it will have the same buying power as before: the set of commodity bundles available for purchase is unchanged. On the other hand, if people's evaluation of their income is based not only on its actual buying power, but also on the sheer number of dollars, then their preferences may correlate with nominal changes even when there is no real change.

The following survey presented three different groups of subjects with a scenario involving two individuals who receive raises in salary. One group was asked to rate the two protagonists' salary raises on purely "economic terms;" a second group was asked to indicate which of the two they thought would be happier; the third group was asked to indicate which of the two was more likely to leave her present job for another position. (The number of respondents is denoted by N. To the right of each option is the percentage of subjects who chose it.)

Problem 1

Consider two individuals, Ann and Barbara, who graduated from the same college a year apart. Upon graduation, both took similar jobs with publishing firms. Ann started with a yearly salary of

$30,000. During her first year on the job there was no inflation, and in her second year Ann received a 2% ($600) raise in salary. Barbara also started with a yearly salary of $30,000. During her first year on the job there was a 4% inflation, and in her second year Barbara received a 5% ($1500) raise in salary.

Economic terms (N = 150):

As they entered their second year on the job, who was doing better in economic terms?

Ann: 71% Barbara: 29%

Happiness (N = 69):

As they entered their second year on the job, who do you think was happier?

Ann: 36% Barbara: 64%

Job attractiveness (N = 139):

As they entered their second year on the job, each received a job offer from another firm. Who do you think was more likely to leave her present position for another job?

Ann: 65% Barbara: 35%

When economic terms are emphasized, the majority of respondents correctly evaluate the above scenario in real rather than in nominal terms. (The minority who do not may have interpreted "economic terms" sufficiently broadly to incorporate, e.g., issues of happiness as discussed in what follows. Alternatively, they really may not understand the logic of inflation.) When the emphasis is not purely economic, however, the attribution of well-being is driven primarily by a nominal rather than a real evaluation. The majority of respondents attribute happiness to people based on greater nominal raises, despite lower real raises. Thus, the attribution of happiness incorporates money illusion, even when an analysis in terms of real value is easily accessible. Finally, the majority of respondents thought that a nominal evaluation not only would underlie feelings of well-being, but would also have consequences for action. Thus, the majority predicted that Ann, who is doing better in economic terms but is perceived to be less happy, would be more likely than Barbara to leave her present position. (Note the indistinguishable pattern of responses for the "Happiness" and "Job attractiveness" questions, despite what may initially look like a reversal due to the semantics of the questions.) As the overall pattern of responses makes clear, it is not

the case that people simply cannot distinguish between nominal and real representations (any more than they could not distinguish between absolute and comparative considerations in the context of the previous examples.) Rather, it appears that while an evaluation in real terms dominates when the need to think in purely economic terms is made salient, less transparent judgments trigger evaluations that are heavily biased by a nominal representation.

B. Transactions

We turn now from people's assessment of income to their evaluation of specific transactions. As noted earlier, economic transactions can be represented either in nominal or in real terms, which can lead to different evaluations. Clearly, in times of inflation we can make a nominal profit and incur a real loss; in times of deflation we can suffer a nominal loss and enjoy a real gain. (In addition, there is the complexity of inventory-holding costs, including opportunity costs). To the extent that people consider the nominal in addition to the real representation, their perception will be influenced by the number of dollars they earned or lost, not only by their real worth. Consider the following problem.

Problem 2 (N = 431):

Suppose Adam, Ben, and Carl each received an inheritance of $200,000, and each used it immediately to purchase a house. Suppose that each of them sold the house a year after buying it. Economic conditions, however, were different in each case:

* When Adam owned the house, there was a 25% deflation—the prices of all goods and services decreased by approximately 25%. A year after Adam bought the house, he sold it for $154,000 (23% less than he paid).

* When Ben owned the house, there was no inflation or deflation—prices had not changed significantly during that year. He sold the house for $198,000 (1% less than he paid for it).

* When Carl owned the house, there was a 25% inflation—all prices increased by approximately 25%. A year after he bought the house, Carl sold it for $246,000 (23% more than he paid).

Please rank Adam, Ben, and Carl in terms of the success of their house-transactions. Assign '1' to the person who made the best deal, and 3 to the person who made the worst deal.

Half the subjects saw the problem as it appears above; the other half saw the three cases in reversed order. Because order had no effect on responses, the data were combined and are presented below:

	Adam	Ben	Carl
Nominal transaction:	−23%	−1%	+23%
Real transaction:	+2%	−1%	−2%
Rank:			
1st:	37%	17%	48%
2nd:	10%	73%	16%
3rd:	53%	10%	36%

Clearly, the protagonists' transactions rank differently in nominal and real terms, as shown in the first two rows above. Adam, who sold his house for a 23 percent nominal loss, received for the house approximately 2 percent more than its real purchase value. Ben and Carl, on the other hand, both sold their houses for less than their real purchase value. Ben's 1 percent real loss was also nominal, whereas Carl made a 2 percent real loss but a 23 percent nominal "gain."

It is clear from the data above that subjects' evaluations are influenced by the nominal transactions. The modal ranking, chosen by roughly half the subjects, was Carl first, Ben second, and Adam third. Thus, Carl, the only one to make a nominal gain (but a real loss), was the modal choice for the best deal. Adam, who was the only one to make a real gain (but a nominal loss), was the modal choice for the worst deal. Ben, who suffered a 1 percent real and nominal loss, was ranked above Adam, who had a 2 percent real profit but a large nominal loss, and below Carl, who had a 2 percent real loss but a large nominal gain. We have replicated this pattern in another version of this problem involving 2 percent inflation or deflation.

If people are influenced by nominal changes, then selling a house following times of rising prices should appear more attractive, whereas buying one should be less attractive.[12] To compare people's attitudes to nominal changes in sales and acquisitions, we constructed the following simple pair of questions, regarding consumer goods.

12. The psychology of buying has been studied extensively by consumer and marketing researchers (for a review see, e.g., Lea, Tarpy, and Webley [1987]).

Problem 3 (N = 362):

Changes in the economy often have an effect on people's financial decisions. Imagine that the U. S. experienced unusually high inflation which affected all sectors of the economy. Imagine that within a six-month period all benefits and salaries, as well as the prices of all goods and services, went up by approximately 25%. You now earn and spend 25% more than before.

Six months ago, you were planning to buy a leather armchair whose price during the 6-month period went up from $400 to $500. Would you be more or less likely to buy the armchair now?

More: 7% Same: 55% Less: 38%

Six months ago, you were also planning to sell an antique desk you own, whose price during the 6-month period went up from $400 to $500. Would you be more or less likely to sell your desk now?

More: 43% Same: 42% Less: 15%

Half the subjects received the above version, in which changes were described in dollar terms (i.e., "up from $400 to $500"); the rest received an identical scenario that differed only in that changes were described in percentages (e.g., "went up by 25%.") Also, the order of the two questions (buy and sell) was counterbalanced across subjects. Both manipulations had no effect on preferences: hence the data were combined. To the right of each response is the percentage of subjects who chose it. The proportions of subjects who were more and less likely to buy and sell differed significantly ($X^2 = 128$, $p < .0001$). The majority of subjects thought they would be more likely to sell for a larger nominal price, and the modal choice also indicated a diminished tendency to buy. Higher nominal prices—although real prices had not changed—were conducive to selling and aversive to buying. It is noteworthy that less than half the subjects chose to answer "Same" in both questions.

The reluctance to buy when nominal prices have increased can explain the buy-now-and-beat-inflation psychology that often characterizes times of high inflation. In a Gallup Poll in August 1979, for example, 27 percent of respondents answered yes when asked, "Have you or your family bought anything during the last few months because you thought it would cost more later?" (see Maital [1982]). In fact, advertisers seem to believe that playing on consumers' aversion to increases in nominal prices can be an effective ploy for boosting sales. Consider the following typical

advertisement (in Maital and Benjamini [1980]): ". . . all prices will probably go up including car prices. So if you're thinking about a new car, think about buying a ___ now. There will probably never be a better time." This argument, of course, ignores the role of interest and the question of whether the nominal interest rate is higher in inflationary times. It is based on the assumption that, in times of inflation, framing purchase decisions in terms of rising nominal prices is likely to boost sales.

C. Contracts

Imagine signing a contract for a future transaction in an inflationary context, and having to decide whether to agree upon a specified amount to be paid upon delivery or, instead, agree to pay whatever the price is at the future time. A risk-averse decision maker is likely to prefer an indexed contract since, at a future time, a predetermined nominal amount may be worth more or less than its anticipated real worth. On the other hand, a nominally risk-averse decision maker may perceive indexed contracting as riskier since the indexed amount may end up being greater or smaller in nominal terms than a fixed dollar amount. We next show that alternative framings of a contracting decision lead people to think of a problem in either real or nominal terms, thereby influencing their choices between contracts.[13] The following problem was presented to 139 subjects in the spring of 1991.

Problem 4:

Imagine that you are the head of a corporate division located in Singapore that produces office computer systems. You are now about to sign a contract with a local firm for the sale of new systems, to be delivered in January, 1993.

These computer systems are currently priced at $1000 apiece but, due to inflation, all prices, including production costs and computer prices, are expected to increase during the next couple of years. Experts' best estimate is that prices in Singapore two years from now will be about 20% higher, with an equal likelihood that the increase will be higher or lower than 20%. The experts agree that a 10% increase in all prices is just as likely as a 30% increase.

You have to sign the contract for the computer systems now. Full

13. For other illustrations and a discussion of framing effects, see Tversky and Kahneman [1986].

payment will be made only upon delivery in January, 1993. Two contracts are available to you. Indicate your preference between the contracts by checking the appropriate contract below:

One group of subjects (N = 47) chose between contracts A and B below. (The percentage of subjects who chose each contract is indicated in brackets.)

Contracts framed in real terms:

Contract A: You agree to sell the computer systems (in 1993) at $1200 a piece, no matter what the price of computer systems is at that time. Thus, if inflation is below 20% you will be getting more than the 1993-price; whereas, if inflation exceeds 20% you will be getting less than the 1993-price. Because you have agreed on a fixed price, your profit level will depend on the rate of inflation. [19%]

Contract B: You agree to sell the computer systems at 1993's price. Thus, if inflation exceeds 20%, you will be paid more than $1200, and if inflation is below 20%, you will be paid less than $1200. Because both production costs and prices are tied to the rate of inflation, your "real" profit will remain essentially the same regardless of the rate of inflation. [81%]

Contracts A and B are framed in terms of real values. Contract A (agreeing to sell for a fixed nominal amount) is risky: you will get more than the 1993-price if inflation is lower than expected, and you will get less if it is higher. Contract B (agreeing to sell for the indexed price) is riskless: your profit is guaranteed and will not depend on the rate of inflation. As expected, the majority of subjects opt for the riskless option. Another group of subjects (N = 49) chose between contracts C and D:

Contracts framed in nominal terms:

Contract C: You agree to sell the computer systems (in 1993) at $1200 apiece, no matter what the price of computer systems is at that time. [41%]

Contract D: You agree to sell the computer systems at 1993's price. Thus, instead of selling at $1200 for sure, you will be paid more if inflation exceeds 20%, and less if inflation is below 20%. [59%]

Contracts C and D are equivalent to contracts A and B, respectively, except that they are framed in terms of nominal rather than real values. Contract C, in contrast to A, is framed as (nominally) riskless; Contract D, in contrast to B, now appears risky: depending on inflation you may be paid more or less than the fixed nominal price. Thus, the first decision was between a guaranteed real price (contract B) and a nominal price that could be larger or smaller than the real (contract A), whereas the second decision is between a guaranteed nominal price (contract C) and a real price that could be larger or smaller than the nominal (contract D). As expected, subjects are influenced by the frame presented in each problem, and tend to exhibit the risk-averse attitudes triggered by that frame: a larger proportion of subjects now prefer contract C, the seemingly riskless nominal contract, than previously preferred the equivalent contract A ($X^2 = 5.34$, $p = .02$). The disposition to evaluate options in the frame in which they are presented could have significant consequences for bargaining and negotiation. Ratification of union contracts, for example, may partly depend on whether contracts are proposed in nominal or in real terms.

A third group of subjects (N = 43) read Problem 5 and was presented with the following, neutral version of the problem:

Contracts under a neutral frame:

Contract E: You agree to sell the computer systems (in 1993) at $1200 a piece, no matter what the price of computer systems is at that time. [46%]

Contract F: You agree to sell the computer systems at 1993's prices. [54%]

Contracts E and F are economically equivalent to the previous two pairs of contracts, but they are framed in neutral terms. Contract E is to be signed in nominal prices (and is thus riskless in nominal terms), Contract F is to be signed in terms of 1993 prices (and is, therefore, riskless in real terms). A substantial proportion of subjects now opt for the nominally riskless option. Thus, the present pattern of preferences is similar to that observed between contracts C and D, which were framed in nominal terms, and it is significantly different from that observed between contracts A and B, which were framed in real terms ($X^2 = 7.7$, $p < .01$). It appears that people naturally tend to evaluate the contracts in predominantly nominal terms and avoid nominal rather than

real risk. This observation is reminiscent of the tendency noted earlier to favor unindexed contracts.

We have run a second version of the above study, this time exploring people's contracting preferences as buyers rather than sellers. The following problem, along with the alternative framings of contract choices, are identical to those of Problem 4 except that the subject is now buying instead of selling.

Problem 4:

Imagine that you are the head of a financial services firm located in Singapore, and that you are now about to sign a contract with a local corporation for the purchase of new computer systems, to be delivered to your firm in January, 1993.

These computer systems are currently valued at $1000 apiece but, due to inflation, all prices, including those of computers and financial services, are expected to increase during the next couple of years. Experts' best estimate is that prices in Singapore two years from now will be about 20% higher, with an equal likelihood that the increase will be higher or lower than 20%. The experts agree that a 10% increase in all prices is just as likely as a 30% increase.

You have to sign the contract for the computer systems now. Full payment will be made only upon delivery in January, 1993. Two contracts are available to you. Indicate your preference between the contracts by checking the appropriate blank on the scale below:

Contracts framed in real terms: (N = 50)

Contract A': You agree to buy the computer systems (in 1993) at $1200 apiece, no matter what the price of computer systems is at that time. Thus, if inflation exceeds 20%, you will be paying for the computers less than the 1993-price; whereas if inflation is below 20%, you will be paying more than the 1993-price. Because you have agreed on a fixed price, your profit level will depend on the rate of inflation. [36%]

Contract B': You agree to buy the computer systems at 1993's price. Thus, if inflation exceeds 20%, you will pay more than $1200, and if inflation is below 20%, you will pay less than $1200. Because the prices of both computer systems and financial services are tied to the rate of inflation, your "real" profit will remain essentially the same regardless of the rate of inflation. [64%]

Contracts framed in nominal terms: (N = 47)

Contract C': You agree to buy the computer systems (in 1993) at $1200 apiece, no matter what the price of computer systems is at that time. [51%]

Contract D': You agree to buy the computer systems at 1993's price. Thus, instead of buying at $1200 for sure, you will pay more if inflation exceeds 20%, and less if inflation is below 20%. [49%]

Contracts under a neutral frame: (N = 44)

Contract E': You agree to buy the computer systems (in 1993) at $1200 apiece, no matter what the price of computer systems is at that time. [52%]

Contract F': You agree to buy the computer systems at 1993's price. [48%]

As in the previous problem, subjects exhibit frame-dependent risk aversion: a larger proportion opt for the contract that is nominally riskless when the contracts are framed in nominal terms than when they are framed in real terms. Clearly, by opting for the "sure" nominal value, subjects are in effect taking a real risk. As before, the neutral version yields results remarkably similar to those obtained under the nominal as opposed to the real frame. Finally, in all three versions there is a somewhat smaller tendency to opt for the indexed contracts when buying than when selling, although the differences are not statistically significant. This tendency may be due to the belief—contrary to our explicit instructions—that inflation is more likely to exceed rather than fall below the 20 percent forecast. To the extent that inflation is higher than expected, one is better off signing for a fixed nominal price when buying but not when selling.

D. Investments (Market Experiments)

Experimental evidence for money illusion comes from a study of financial investment by Thaler and Tversky [1996]. The participants in the experiment were asked to imagine that they were a portfolio manager for a small college, and were told that they would be required to allocate a portfolio of 100 shares between two funds. Fund A was drawn from a normal distribution with a mean real return per month of 0.25 percent and a standard deviation of 0.18 percent. Fund B was drawn from a normal distribution with a mean real return of 1 percent and a standard deviation of 3.5 percent. These values correspond approximately

to the actual return of bond and stock investment over six weeks. These distributions were not described to the subject; they were learned from experience.

Each subject made 200 decisions, and received immediate feedback. At the conclusion of these trials each subject made a final allocation that would be binding for 400 trials. Subjects' payoffs were proportional to the results of their decisions. Subjects' earnings ranged from $5 to $30.

One group of subjects evaluated the investments in a noninflationary context; whereas the second group evaluated the investment under conditions of a 10 percent yearly inflation. In accord with money illusion, inflation had a profound impact on subjects' allocations. The mean allocation to the risky fund was 42.3 percent in the no-inflation condition and 71.5 percent in the inflation condition. Because of the overwhelmingly positive nominal returns in the inflation condition, people exhibited much less risk aversion in that condition, and consequently earned considerably more money. Loss aversion occurs relative to some reference point, which in the present context is perceived in nominal terms. Evidently, a real loss of 5 percent in the presence of 10 percent inflation, which appears as a 5 percent nominal gain, is much less aversive than a 5 percent loss in a period of no inflation, in which the nominal and the real values coincide.

E. Mental Accounting

With changing relative prices, an effect of past nominal values on purchase or sale decisions is a form of money illusion that could be present even if the inflation rate is zero. Examples would be reluctance to sell a house at a nominal loss, or reluctance to accept a nominal wage cut. In these as well as in standard inventory valuation decisions, money illusion may arise from the use of historic cost, which can differ from replacement cost because of a change in the value of money or because of a change in relative prices.

With nominal and real prices changing, people's assessment of the value of their possessions presents them with some conflicting intuitions, as illustrated by the following problem presented to experienced wine collectors and subscribers to a wine newsletter [Shafir and Thaler 1996]:

> Problem 5 (N = 76):
>
> Suppose you bought a case of a good 1982 Bordeaux in the futures market for $20 a bottle. The wine now sells at auction for about $75

a bottle. You have decided to drink a bottle of this wine with dinner. Which of the following best captures your feeling of the cost to you of drinking this bottle?

Twenty percent of respondents evaluated the cost of drinking the bottle at $75, its replacement value; 30 percent opted for the option, "drinking the bottle does not feel like it costs me anything. I paid for the bottle already, many years ago, and probably don't remember exactly what I paid for it anyway;" and 25 percent reported that "drinking the bottle feels like I saved $55, because I am able to drink a $75 bottle for which I only paid $20." Other versions, involving breaking the bottle, or giving it as a gift, yielded similar results.[14]

Evidently, people have conflicting intuitions about current value, and do not fully appreciate considerations of replacement cost. As they earn, borrow, spend, save, and invest money, people's intuitive accounting is often based on multiple representations rather than on a single representation of the transaction. Some representations, moreover, even in inflationary times, are grounded in nominal calculations and can lead to erroneous results. To further explore contexts in which profits are estimated on the basis of nominal rather than real changes, we invoked comparisons between sellers who acquired their inventories at different times and sold at the same time.

Problem 6 (N = 130):

Two competing bookstores have in stock an identical leather-bound edition of Oscar Wilde's collected writings. Store A bought its copies for $20 each. Tom, who works for Store A, has just sold 100 copies of the book to a local high school for $44 a copy. Store B bought its copies a year after Store A. Because of a 10% yearly inflation, Store B paid $22 per copy. Joe, who works for Store B, has just sold 100 copies of the book to another school for $45 a copy.

Who do you think made a better deal selling the books, Tom or Joe?"[15]

Eighty-seven percent of subjects chose Tom. Apparently, selling at a lower price ($44 versus $45) was perceived as constituting a better deal as long as inventory was acquired at an even

14. A variant of this problem conducted at Princeton University (N = 85) yielded identical results among students with no formal education in economics and students who had had at least a one-semester course in economics.

15. Some were asked who they thought "was more successful in selling the books, Tom or Joe?" Responses to the two versions of the question were statistically indistinguishable.

lower price ($20 versus $22). Subjects felt justified in ignoring inflation and computed the relevant transaction based solely on nominal differences. This was further confirmed by variations on the problem, in which we asked subjects not only to indicate who they thought made a better deal, but also to estimate by how much. Profit estimates, in these cases, mostly amounted to plain nominal differences.

It is worth pointing out that the mental accounting difficulties exhibited by our subjects arise in a variety of traditional accounting methods. Methods like FIFO (first in, first out) and LIFO (last in, first out) rely on historic prices, not replacement cost. It is also true that U. S. tax laws do not adjust properly for inflation. Churchill [1982] discusses the fact that many businesses continue selling the old stock at old prices, despite the fact that replacement costs have gone up with inflation. This could be fatal for small businesses that, after having sold the old stock at old prices, cannot afford to pay the replacement costs. Of course, even when businesses are aware of the accounting dangers, there is always the consumers' perception to contend with. To the extent that consumers suffer from money illusion, they may object to higher prices on items sold from old stocks.[16]

F. Fairness and Morale

Community standards of fairness appear to have a significant influence on economic behavior. Kahneman, Knetsch, and Thaler [1986] have presented a number of findings regarding people's perception of fairness, some of which bear directly on money illusion. Respondents in a telephone interview were asked to evaluate the fairness of a grocery store owner who has several months supply of peanut butter in stock, on the shelves and in the storeroom. The owner hears that the wholesale price of peanut butter has increased and immediately raises the price on the current stock of peanut butter. This vignette captures essentially the same accounting requirements as those described in the context of Problem 6, and addressed in Churchill [1982]. Unlike many of our subjects, the store owner in the present vignette sees the importance of selling his goods at their current value rather than their original price (plus markup). Seventy-nine percent of Kahneman, Knetsch, and Thaler's subjects, however, found this

16. Witness the American public's indignation during the United States–Iraq war at the substantial rise in the price of oil that was reported to be supplied from stocks acquired before the war.

"unfair." To the extent that subjects are estimating profits based on nominal rather than real changes, the store owner's action would bring her an unwarranted higher (nominal) profit. She benefits from having inventories when the price rises, compared with if she had not had them. The fact that her real profit (from selling and replacing, not holding) remains unchanged does not justify her action in the eyes of the majority of subjects.

Another vignette explored by Kahneman, Knetsch, and Thaler [1986] addresses the role of money illusion in judgments of fairness. In this vignette a company that is making a small profit is said to be located in a community experiencing a recession with substantial unemployment. Half the respondents were told that there is no inflation and the company decides to decrease wages and salaries by 7 percent. Other respondents were told that there is a 12 percent inflation and that the company decides to increase salaries by only 5 percent. Although the real income change is practically the same in the two versions, the percentage of respondents who judged the action of the company "unfair" was 62 percent in the case of the nominal cut but only 22 percent in the case of the nominal raise. Evidently, judgments of fairness are based largely on nominal rather than on real changes.[17] Many people, for example, who would strongly object to a 1 percent cut in salary in times of no inflation, are less likely to complain when they get a 5 percent raise in times of 6 percent inflation. Based on extensive interviews, Bewley [1994] reports that businessmen are sensitive to the implications of nominal wage cuts for worker morale.

The perception of fairness is expected to impinge on worker morale and, consequently, may have implications for actual job decisions. To explore this issue, we presented Princeton students with the hypothetical scenario below, followed by one of two questions: half the subjects received the "morale" question, the other half the "job decision" question:

Problem 7 (N = 72):

Ablex and Booklink are two publishing firms, each employing a dozen editors. Because the firms are small, unequal raises in salary

17. Furthermore, similar phenomena are likely to arise in the context of other ethical judgments. Exploring people's perception of distributive justice, for example, Yaari and Bar-Hillel [1984] present numerous studies in which nominally equal distributions are rated as most just, despite the fact that they involve dubious interpersonal comparisons.

can create morale problems. In a recent year of no inflation, Ablex gave half its editors a 6% raise in salary and the other half a 1% raise. The following year there was a 9% inflation, and Booklink gave half its editors a 15% raise in salary and the other half a 10% raise.

Morale:

In which firm do you think there were likely to be more morale problems?

Ablex:	49%
Booklink:	8%
Same in both:	43%

Job decision:

Suppose that an editor who received the lower raise in each firm was then offered a job with a competing company. Which editor do you think was more likely to leave their present position for another job?

The editor who received the lower raise in Ablex	57%
The editor who received the lower raise in Booklink	5%
The two were equally likely	38%

Problem 7 describes two situations where salary raises were the same in real terms, but proportionally different in nominal terms. The discrepancy between raises of 10 percent and 15 percent (i.e., a 50 percent difference), appears less offensive than the discrepancy between raises of 1 percent and 6 percent (a fivefold difference). As a result, our respondents expected greater morale problems in the latter situation than in the former. Furthermore, most participants thought that the workers who received a 1 percent rather then a 6 percent raise will be more likely to leave their present job than those who got 10 percent instead of 15 percent. We obtained similar data in another version of the problem ($N = 71$) in which the second company, Booklink, gave its (10 percent and 15 percent) raises in a context of 11 percent inflation. Note that here half the workers are getting a real pay cut. Nonetheless, 52 percent of our subjects still expected greater morale problems for Ablex (where raises were 1 percent and 6 percent in no inflation), and 43 percent thought the Ablex workers were more likely to leave their present position.

It appears that money illusion enters into our subjects' perceptions of fairness and worker morale, and then naturally ex-

tends to their views regarding workers' propensity to quit their present position. This observation, of course, is not new:

> Now ordinary experience tells us, beyond doubt, that a situation where labor stipulates (within limits) for a money-wage rather than a real wage, so far from being a mere possibility, is the normal case . . . It is sometimes said that it would be illogical for labour to resist a reduction of money-wages but not to resist a reduction of real wages . . . But, whether logical or illogical, experience shows that this is how labour in fact behaves [Keynes 1936, p. 9].

III. Discussion

In this paper we have investigated the effects of variations in nominal values on people's evaluations of monetary transactions and on their economic decisions. The responses of the participants in our surveys departed systematically from standard economic prescription in a manner suggestive of money illusion. We proposed that economic agents often entertain both nominal and real representations of economic transactions, and we interpreted money illusion as a bias in the assessment of the real value of transactions, induced by their nominal representation. We also illustrated the role of money illusion in other decision phenomena, such as framing, anchoring, mental accounting, and loss aversion. The present research does not tell us to what extent the attitudes documented in our surveys will be observed in the real economy, in people's decisions to quit jobs, sign contracts, etc. However, the consistency of trends observed across diverse subject populations (students, shoppers, airline passengers), and a variety of problem contexts (contracts, acquisitions, fairness perception, judgments about others, trading experiments, etc.), provide strong presumptive evidence. Furthermore, the data are consistent with various observations of anomalous behavior in contracting and legislation.

People attend to nominal value because it is salient, easy to gauge, and in many cases provides a reasonable estimate of real worth. Furthermore, it fits with the general notion that most objects around us, particularly units of measurement, do not regularly change. We rarely encounter constant changes of unit, especially when it is not transparent what it changes relative to.[18]

18. Another interesting domain in which nominal–real confusions may arise is in thinking about time. When the Gregorian calendar was adopted in England in 1752, omitting eleven days so that the day ensuing to September 2 was Septem-

Money illusion, we suggest, arises in large part because it is considerably easier and more natural to think in nominal rather than in real terms. This tendency, we suspect, is likely to persist despite economists' attempts to educate the public (e.g., Fisher [1928]).[19]

Both Fisher [1928] and Fischer and Modigliani [1978] assume, in effect, that individuals would be making the correct decisions if only they were not confused by inflation. On this account, one might think that the elimination of inflation should eliminate money illusion and restore rational behavior. However, because money illusion influences reactions to nominal price and wage cuts per se, the effects of money illusion are likely to extend to noninflationary settings. Moreover, the study of individual decision making has revealed systematic departures from rationality that go beyond reactions to inflation and are likely to interact with money illusion. Common examples include the undue influence of sunk costs, and the underweighting of opportunity costs relative to out of pocket costs (see, e.g., Thaler [1992]). Recognizing that decisions do not always conform to the classical account and that people may be prone to money illusion raises the possibility that different rates of inflation have normative implications different from those assumed in standard rational models. Thus, moderate inflation will affect the allocation of labor and housing insofar as people are particularly averse to nominal wage cuts and to nominal losses resulting from home ownership. Conversely, money illusion may result in a larger contribution of inflation to poverty among the elderly as a result of the choice of nominal annuities along with confusion about the difference between real and nominal interest rates. In addition, money illusion may affect multinational trade and tourism. As Fisher [1928, p. 4] observed, "almost everyone is subject to the 'money illusion' in respect to his own country's currency. This seems to him to be stationary while the money of other countries seems to change." As former Israeli foreign minister Abba Eban remarked (in jest) at a time when Israel was experiencing three-digit inflation, "the dollar is an extremely unstable currency: one month it is worth

ber 14, "much discontent was provoked among uneducated people who imagined that they were being defrauded of the omitted days; and there were riots with the cry 'Give us back our 11 days'" (*The Chambers Encyclopedia*). We thank Philip Johnson-Laird for pointing this out to us.

19. This is in line with the finding of Tolley [1990] that the price decline anomaly in fantasy baseball auctions is reduced roughly in half in experienced players compared with novices. But the fact that people know that there is a price decline anomaly is not sufficient to make it go away.

100 Israeli pounds, the next month it's worth 200. . . ." It appears that the choice of an optimal inflation target should not overlook the effects of money illusion. Indeed, the implications of money illusion may be the most important factor to consider when contrasting between zero and other low rates of inflation.

More generally, cognitive illusions on the part of individual agents can have important economic consequences. As a number of researchers have argued (see, e.g., Akerlof and Yellen [1985], Haltiwanger and Waldman [1985], and Russell and Thaler [1985]), small departures from optimality on the part of individual agents can have a significant impact on the characteristics of economic equilibria. A better understanding of people's view of money, and of the impact this has on their economic systems, may lead to an improved descriptive economic theory. For those readers interested in technical developments along these lines, we conclude this paper with an illustration of an equilibrium model that incorporates money illusion. Those less concerned with economic modeling can skip the following section.

Money Illusion in Solow's Model of Efficiency Wages

In order to understand the effects of money illusion on the workings of the economy, we need to examine equilibrium with behavior that is influenced by money illusion. In part, equilibrium effects can be studied by observing economies with different inflation rates. In part, understanding requires formal theoretical models. The psychological insights in this paper have been developed and tested by manipulating a description of the economic environment in which individuals make judgments or decisions. In order to integrate such insights into economics, we need to understand how the economic environment is determined. For example, Problem 1 above examined individual responses to different patterns of wage increases. But wage increases are endogenous variables, ones that are set in light of their implications, including those that derive from the presence of some money illusion. Thus, a challenge for economic modeling is to incorporate money illusion in economic models where equilibrium determination is responsive to the assumed pattern of money illusion.

Developing equilibrium models with money illusion goes against the grain of "rational" modeling. Indeed, Tobin [1972] comments on attitudes in the economics profession by saying: "An economic theorist can, of course, commit no greater crime than to assume money illusion." But we need such models of the many interactions that are affected by inflation if we are to make prog-

ress in determining a good inflation target for monetary policy. As an illustration of the process of incorporating money illusion in equilibrium models, we extend a very familiar model; the model of efficiency wages of Solow [1979]. That is, we incorporate a concern about nominal wage increases as well as real wage levels in the willingness to supply effort.[20] Using this model then involves an interaction of real and nominal "rigidities."[21]

In the original Solow model, effort is a function of the real wage, $e(w/s)$, where w is the nominal wage and s is both the output price of the firm and the consumption price for the worker. The profits of a firm hiring L workers and paying wage w are written as $sF(e(w/s)L) - wL$. There are two first-order conditions for the choices of L and w:

$$(1) \qquad \begin{aligned} sF'e &= w; \\ F'e' &= 1. \end{aligned}$$

From these first-order conditions we obtain the familiar equation for the efficiency wage:

$$(2) \qquad \frac{(w/s)e'(w/s)}{e(w/s)} = 1.$$

As suggested by Problem 1 above, now assume that effort provided depends on both the real wage paid and the ratio of the current nominal wage to the previous nominal wage, $e(w/s,n)$, where $n = w/w(-1)$.[22] To begin, we assume that the effort function is continuous and differentiable. Below, we will consider a discontinuity at constant nominal wages. Now, profits are written as $sF(e(w/s,w/w(-1))L) - wL$. Assuming that current period profits are maximized (rather than a criterion with a longer time horizon), there are two first-order conditions for the choices of L and w:

$$(3) \qquad \begin{aligned} sF'e &= w; \\ sF'\left[\frac{e_w}{s} + \frac{e_n}{w(-1)}\right] &= 1. \end{aligned}$$

20. Similarly, one could incorporate a concern about nominal pay increases into the quit rate of workers. This could be done by extending the efficiency wage model in Salop [1979].

21. On interactions between nominal and real rigidities, see Ball and Romer [1990].

22. More generally, a longer history of wage inflation might be relevant for the mental processes that are modeled here by adding the wage increase to the effort function.

From these first-order conditions we obtain the new equation for the efficiency wage:

$$\frac{w}{e}\left[\frac{e_w}{s} + \frac{e_n}{w(-1)}\right] = 1. \tag{4}$$

Comparing (2) and (4), there are two effects from the change in the model. First, the nominal wage increase appears directly in the model in the term e_n, and second, the inflation rate can affect the impact of the real wage on effort if e_{wn} is not zero. That is, we assume that effort is affected by the size of the nominal pay increase and that the response of effort to the level of the real wage is influenced by the size of the nominal wage increase.

We have modeled the firm as maximizing profits in a single period, ignoring the impact of current wages on desirable future wage increases. One way to extend this model would be to solve the dynamic optimization problem for a firm. In addition, it is interesting to explore the implications of this (myopic) model over time. In a steady state, with s growing geometrically at rate $n - 1$, w will also grow geometrically at rate $n - 1$. Thus, from (4) the steady state efficiency wage with myopic wage setting can be written as

$$\frac{(w/s)e_w + ne_n}{e} = 1. \tag{5}$$

Differentiating the steady state real wage with respect to the steady state inflation rate in (5), we have

$$\frac{d(w/s)}{dn} = -\frac{(w/s)e_{wn} + ne_{nn}}{(w/s)e_{ww} + ne_{wn}}. \tag{6}$$

Thus, the impact of steady state inflation on the equilibrium real wage depends on second derivatives. As suggested by Problem 7, e_{wn} may well be negative (over some range). Assuming, plausibly, that e_{ww} and e_{nn} are both negative, we can conclude that over some range higher inflation would result in a lower real wage.

Also interesting would be to consider the dynamics of nominal wages to a change in the inflation rate. In this case the nominal wage satisfies the difference equation,

$$\frac{w(t)}{s(t)}e_w\left(\frac{w(t)}{s(t)}, \frac{w(t)}{w(t-1)}\right) + ne_n\left(\frac{w(t)}{s(t)}, \frac{w(t)}{w(t-1)}\right) = e\left(\frac{w(t)}{s(t)}, \frac{w(t)}{w(t-1)}\right). \tag{7}$$

For a given function *e,* one could plot the response of real wages to a change in inflation rate.

Wage Cuts and Money Illusion

A continuous relationship was assumed for the trade-off between the cost of raising wages and the effort provided by workers. Plausibly, the relationship is not continuous; there is a discontinuity coming from nominal wage cuts. Bewley [1994] finds businessmen sensitive to the implications for worker morale of nominal wage cuts. In PSID data Kahn [1995] examines the distribution of wage increases given the level of the median wage increase. She finds fewer negative and small positive wage increases and more changes of precisely zero than would be predicted by a relative distribution independent of the median wage increase.

A central issue is how to model such a discontinuity. An extreme version would be the Keynesian assumptions of a single labor market with no nominal wage cuts. Tobin's [1972] analysis assumed many labor markets, with the absence of nominal wage cuts in any particular market generating a nonlinear relationship between wage adjustment and the overall imbalance between demand and supply. Tobin's model makes two assumptions: local labor markets where everyone gets the same wage, and no wage decreases. But we know that workers in nearby jobs have a distribution of wages (just like identical consumer goods in nearby stores). Moreover, we know that firms sometimes implement widespread wage cuts and that some individual workers get wage cuts [Kahn 1995; McLaughlin 1994]. So one question is how to extend the insight of the Tobin model, that there is resistance to nominal wage cuts, in a way that incorporates wage-setting firms (or wage bargaining) and allows wage cutting in some circumstances. Moreover, recognizing that some firms may have more compressed schedules of wage increases due to a reluctance to cut nominal wages implies that there are labor market effects from this form of money illusion even for workers who receive wage increases. Thus, money illusion may affect the allocation of workers across jobs, as well as the aggregate level of employment, which was the focus of the model above.

To model this, we would use a theory of the determination of the wage structure in a firm that recognized the presence of money illusion on the part of (some?) workers and, possibly, on

the part of the firm. Imagine, for example, firms that had a "wage bill" to be divided among workers. This might be the case for a liquidity constrained firm that paid workers first, receiving revenue later. In such a case, higher real wages for some workers, as a result of avoiding nominal cuts, would result in lower real wages for other workers. Alternatively, one might combine real and nominal effects, as above, by having labor productivity depend on relative wages within the firm, real wages, and nominal wage increases. Then, a larger wage level for some workers (for money illusion reasons) translates into a greater cost of preserving relative wage schedules. Higher real wages for some, due to money illusion, may affect real wages of others. One would want to explore the institutions that firms use to reduce some of the effects of money illusion on worker morale. Money illusion seems to be widespread among economic agents and can be systematically studied and modeled.

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