PENNIES, PRICING, AND ROUNDING:

IS ALL THE RELEVANT ANALYSIS IN?

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In my earlier paper, I argued against analysis by anecdote and for a careful economic analysis of the costs and benefits which might be associated with the possible elimination of the penny. Robert Whaples has followed this lead and offered some welcome new evidence bearing on the question. As an economy evolves, the underlying dynamics driving prices and behavior affect estimates of costs and benefits, implying that periodic reassessments are a necessary element of sensible policy making.

Whaples points out that the surge in zinc prices, along with the fact that the penny is comprised of about 97.5 percent zinc, implies that the previous seigniorage earned by the US Mint on the penny has disappeared; indeed, for fiscal year 2006, the Mint estimates the cost of producing and distributing a penny at about 1.23 cents. Assuming that the higher level of zinc prices persists, this development, along with the ongoing decline in the purchasing power of the penny which accompanies the increases in the overall price level, could well represent a necessary but not a sufficient condition for eliminating the penny.

The distinction between necessary and sufficient conditions is important. First, the alloys used to produce the penny could be altered to lower production costs, as was the case in 1982, when the price of copper soared and the composition of the penny was changed from 95 percent copper to 97.5 percent of the then much less expensive zinc. Second, seigniorage is but one of an array of issues one must consider in estimating the net benefits or net costs of eliminating the penny. More specifically, the effects of eliminating the penny on pricing, including my earlier discussion of a "rounding tax" and more recent research bearing on "strategic pricing," are crucial. To sharpen the point, the Mint estimates the cost of producing and distributing the nickel, as of July 2006 [Lebryk, 3], at approximately 7 cents; is anyone ready to argue we should eliminate the nickel and round to the nearest dime?

WHAPLES' ANALYSIS AND EVIDENCE ON ROUNDING

In contrast to the simulations which I ran with data from the price book from a convenience store chain, Whaples acquired data on actual transactions from a convenience store chain. While this is potentially useful, an important limitation, as Whaples acknowledges, is that the data mix together cash and non-cash transactions. This is unfortunate since, as a recent Federal Reserve study on payments practices

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notes [Gerdes et al., 2005, 198], we know all too little about the number and average value of cash transactions.[1]

The data, which Professor Whaples kindly provided, also include transactions comprised of both taxed and non-taxed items. Since the evidence presented leads him to conclude that sales taxes, along with multiple item purchases, eliminate the rounding tax, I have taken a closer look at this question.

DO SALES TAXES MATTER?

The details of state and local sales taxes are constantly evolving and thus represent a "moving target" for anyone trying to analyze financial and economic impacts. That said, there are certain common threads and key features of the way in which state sales taxes are set and administered. First, in many states food is exempt from such taxes. In fact, in the ten largest states (California, Florida, Georgia, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, and Texas), food is exempt (http://www.taxadmin.org/fta/rate/sales.html). This is noteworthy because these states account for 55 percent of total gross state product in the nation and thus the majority of transactions in the aggregate. Moreover, food purchases at convenience and grocery stores represent a large portion of total cash transactions, suggesting the existence of sales taxes may be much less important than Whaples has alleged.

A second and equally important consideration in analyzing the way in which sales taxes affect rounding is the convention whereby retailers are permitted to round up sales taxes. To illustrate, suppose the cash total on a purchase is $4.96 and the sales tax is 4.5 percent and applies to all items ; the resulting price would be $5.1832, which would be rounded up to $5.19. The rationale for permitting the rounding up is that states are in effect compensating retailers for collecting the tax. Of particular importance for this note is the fact that the purchase ignoring taxes ($4.96) would be rounded down under the typical scheme suggested (i.e., prices ending in 1, 2, 6 and 7 are rounded down, prices ending in 3, 4, 8 and 9 are rounded up) from $4.96 to $4.95. However, the price with taxes would be rounded up twice, once from $5.1822 to $5.19 (sales tax rounding) and again from $5.19 to $5.20 (rounding in the absence of the penny).

Clearly, the existence of taxes can make a difference, but the direction of the effect is not obvious. Accordingly, I utilize my original data to quantify the several effects.

As in the previous study, I utilize the price book for a typical convenience store in a large chain of such stores in the mid-Atlantic region. I then simulate transactions involving the purchase of from one to three items where the final sum is not taxable and when it is subject to a 3, 5 and 7 percent tax. The tax rates are chosen for illustrative purposes; choosing other rates (or making only one of the items of a multiple item purchase taxable) would not alter the general contour of the results reported below. Each transaction represents, in effect, a single customer purchasing a random set of from one to three items from among all those available in the store. The bill is calculated for each transaction. Then, in the no tax case, column (1) in the table below, the rounding scheme typically proposed is applied. In the case of taxes, columns (2)-(4), the bill is calculated for each transaction, the particular sales tax rate is applied, rounded up to the nearest penny, and then the rounding scheme is applied.

Net Rounding with Sales Taxes
(in dollars per 1000 transactions)

Number of Items Purchased	(1) No Sales Tax	(2) 3% Sales Tax	(3) 5% Sales Tax	(4) 7% Sales Tax
1	9.11	1.09	5.04	3.85
1-2	13.01	2.66	4.57	4.09
1-3	3.90	3.42	4.80	4.38

The results in the table can be read as follows: when up to two items are purchased and there is no sales tax, the net rounding in a random set of 1000 transactions is $13.01. When sales taxes apply to the same set of transactions, the net rounding up is smaller, $2.66 to $4.57, depending on the tax rate. Similarly, when up to three non-taxable items are purchased, net rounding up is $3.90; and when sales taxes apply, net rounding up in a range of $3.42 to $4.80 occurs. Interestingly, in some separate simulations (not shown), if exactly three items are purchased 1000 times and no sales taxes apply, there is net rounding down. But when the various tax rates are applied, there is net rounding up.

Thus, sales taxes matter in the sense that the degree of net rounding changes across different scenarios. However, with well over 100 billion transactions a year in the United States, and perhaps 50-70 billion or more of those in cash (see note 1 and [Gerdes et al., 2005]), the aggregate amount of net rounding up would still be in the hundreds of millions of dollars at a minimum, even if all goods were taxed. For example, if the average amount of rounding up is 0.5 cents per transaction (taking say $5.00 from calculations such as those in the table above, and dividing by 1000), the economy-wide rounding up, ignoring all other factors, would be 50 or 70 billion x 0.5, or $250-350 million. Of course, we know that, in fact, a large portion of cash purchases are tax exempt. Put simply, there is little evidence to support the assertion that multiple purchases in combination with sales taxes would eliminate net rounding, *even* if we ignore strategic pricing by retailers, a topic to which we now turn.

STRATEGIC AND PSYCHOLOGICAL PRICING

In my original paper, I suggested that in a penny-less world with rounding we could well see strategic pricing behavior by firms to take advantage of rounding schemes. Whaples has suggested that competitive pressures will limit or eliminate such strategic behavior, such that the effects would be "trivially small."

Since my original paper, a rich and growing literature has addressed the notion of strategic and psychological pricing by firms and rational inattention to the rightmost digits of prices by consumers (see Levy et al., [2006] and the references cited therein).[2] As this literature makes clear, one does not need to abandon the competitive model or rationality as central tenets of economic theory and analysis. Rather strategic pricing, "may be an outcome of firms' optimal reactions to consumers' rational inattention to the rightmost digits of prices…. (R)ational inattention by consumers arises for at least two reasons. First, consumers face huge amounts of information, which is costly to gather, absorb, and process. Second, they have time, resource, and cognitive information processing-capacity constraints" [Levy et al., 2006, 12].

The implication is that representative consumers in effect "ignore" small price changes, thereby leaving some room for firms to price strategically and opportunistically, whether

it be to set prices at a psychologically attractive figure to the consumer, for example, a price ending in a "9," or in a manner to take advantage of any rounding scheme accompanying the elimination of the penny, or both. Of particular relevance to the issues under examination here, Levy and his colleagues find that the distribution of price changes over eight years for a large retail grocery chain is not random; they are asymmetric, more price increases than decreases, and over 35 percent of the price changes were in multiples of ten cents, thereby preserving the price's last digit [Levy et al., 2006, 7].

As many, including Levy and his colleagues, note such findings suggest European retailers may have acted opportunistically by rounding their prices upward after conversion to the Euro in an attempt to preserve psychological prices, and, more generally, to take advantage of consumer inattention. Since the conversion to the Euro offers a real world natural experiment akin in some respects to a possible elimination of the penny, the experience is worth a closer look.

CONVERSION TO THE EURO

In early 2002 the introduction of the Euro changed nominal prices in all member states of the European Monetary Union. Prices stated in the home currency had to be converted to a price in Euros. The conversion disturbed psychologically set prices and, more generally, given that the conversions created prices in fractions of cents, raised questions about rounding. Much ink was spilled on this question leading up to the currency shift and government officials claimed that they would monitor closely the resulting pattern of price adjustments. When the dust settled, Eurostat, the European Commission's statistical service, estimated that the impact on the Harmonized Index of Consumer Prices, was approximately 0.2 percent. Interestingly, they found that the price increases were more significant in the services sector and in certain low-price goods bought frequently. For example, price increases in cafes and restaurants were about 4.3 percent over the first year of conversion, almost double the general inflation rate (see the report by the Commission of the European Communities, 2002). To state the obvious, the price increases were largest for those transactions most likely to be in cash. Interestingly, in a November 2002 survey of public opinion across the Euro area, "84.4 percent of the respondents in the euro area thought that prices had been converted rather to the detriment of consumers and 10.9 percent thought that price rises and decreases were balanced" [Commission of the European Communities, 18]. In a careful and wide ranging empirical study, Ehrmann [2006] argues the conversion increased information processing costs for consumers in a manner that helps explain the pattern of price increases observed and consumer perceptions of inflation.

Were the price increases resulting from conversion "large" or "small"? All the analysis I am aware of suggests the price increases traced to conversion are small relative to the longer run benefits of a common currency associated with the increased trade, economic growth and development of the European community.

BENEFITS?

Comparing the costs of conversion to the benefits of a common currency is important because even if we ignore the evidence on the cost of keeping vs. eliminating the penny, I am not aware of any hard evidence on the economic benefits likely to

be associated with the elimination of the penny. To be sure, some might refer to the elimination of negative seigniorage discussed above as a benefit. Beyond this, there is the contention that making change is "costly." However, there is less to this truism than proponents of penny elimination contend. Whaples and others seem to imply that the cost to the retailer of the consumer using a non-cash payment medium, be it credit or debit card or a check, is either zero, or substantially below the cost of making change. There is no credible evidence I am aware of that supports this inference. In fact, common experience and industry data suggest the opposite is true. More specifically, common everyday experience confirms that the "time at the register" cost for non-cash media is certainly not shorter, and to this cost we must add the fees and other processing costs associated with checks and electronic payments. The latter costs, as discussed in Lofstock [2006], and a host of other like sources, are cutting deeply into convenience store profits.

DISTRIBUTIONAL EFFECTS

Whaples offers modest evidence on my contention that the costs associated with elimination of the penny are likely to fall disproportionally on those at the lower end of the income distribution. I find his comparison of the rounding outcomes in two stores in North Carolina, one in an affluent section of Winston-Salem and one in a poorer section, unpersuasive. Setting the small sample size aside, of more potential relevance are his data for Pennsylvania, the only state for which he has detailed data for transactions below $5. The data show a cumulative loss (rounding tax) of $2.88 for all transactions totaling less than $5; but for transactions of less than $4, $3, $2 and $1, respectively, the loss to consumers is $4.90, $4.16, $3.11, and $4.91. Clearly, those making smaller transactions are more likely to lose from rounding, regardless of how many items comprise the transaction.

The most recent Federal Reserve survey of family finances in the United States showing that "Families that did not have any type of transaction account in 2004 were disproportionately likely to have low incomes, to be headed by a person younger than 35, to be nonwhite or Hispanic, to be headed by a person who was neither working nor retired, to be renters, or to have relatively low levels of wealth" [Bucks et al., 2006, A12], and to be unlikely to have credit or debit cards, is clearly relevant to the distributional question. By definition, such families engage in mostly cash transactions. This fact dovetails with the evidence available from the conversion to the Euro suggesting that it is the lower priced, most frequently purchased items most likely to exhibit upward price rounding, that is, those transactions most likely to be paid for in cash. With such transactions most likely to be unevenly distributed across income classes, it seems to me that the claim that net price rounding upward will be small or non-existent with minimal or non-existent distributional effects is still based on a weak statistical and analytical foundation.

WHAT DOES THE PUBLIC THINK?

It seems the public, a group economists are usually fully prepared to assume act rationally, except perhaps when the answers they give to surveys are not consistent with one's theorizing, are not convinced that the adverse effects of eliminating the

penny will be small. Leaving aside an impossible to quantify nostalgia factor, the most recent Coinstar survey [2006], indicates that 76 percent of Americans favor keeping the penny, **up** more than 10 percentage points from 2005; interestingly, in a recent USA Today/Gallup poll, reported by Hagenbaugh [2006], utilizing somewhat different questions, the percentage of Americans that favor keeping the penny increases significantly as incomes fall.

SUMMING UP

As Lincoln said, albeit in a very different context, "With public sentiment, nothing can fail, without it, nothing can succeed" [Basler, 1953, "Lincoln-Douglas Debate at Ottawa," 27]. Given public sentiment, the experience with the introduction of the Euro, accumulation of other evidence suggesting strategic pricing is not just a theoretical curiosum, and the fact that available evidence suggests eliminating the penny would not be distributional neutral, I think Professor Whaples' conclusions are, to put it gently, premature.

ENDNOTES

1. For example, in an often referenced and allegedly authoritative study, jointly undertaken with the American Bankers Association, Dove Consulting [2006] finds that the proportion of in-store cash payments has remained roughly constant at 33 percent over the last six years. Interestingly, the data are from 3008 completed surveys of consumers, 78 percent of which were submitted via the Web. One must question the applicability of such a methodology, particularly in view of the digital divide that limits the access of those with low incomes to computers and the internet. Since those at the lower end of the income distribution are most likely to engage in a disproportionate volume of cash transactions, the study probably underestimates the volume of cash transactions by a non-trivial amount.
2. Psychological pricing is usually linked to the frequently observed practice of ending a price with the digit "9," thereby making the price appear to be well below the following round number.

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