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The Economic Implications of Price Rounding

Steven Meester

ABSTRACT. There has recently been a call to eliminate the penny. Arguments for and against the proposal are presented. The evidence suggests that there would be a net gain if the penny were eliminated and prices were rounded on cash transactions. Unfortunately, the decision to do so is in the hands of politicians who are more interested in narrow self-interest than in the common good.

I. Introduction

John wakes up. Everyday John gets ready for his day the same way. He shaves, brushes his teeth, showers, gets dressed, grabs a handful of change, and heads out the door. Why, you might ask, does John make grabbing a handful of change part of his daily routine? If you are like John, you already know the answer to this question. John is going to take a few pennies with him every day as a defense against having to acquire more pennies! It is a laughable practice, but John takes it seriously. He knows that throughout the course of his day he may have to make a purchase of $5.02 or $2.76, and unless he is prepared, he will be punished with even more pocket change. This simple story suggests that there may be some inefficiency involving the penny.

Money's main function is to serve as a medium of exchange, an item that buyers give to sellers when they want to purchase goods or services [Mankiw, 2004]. Pennies may be an accepted form of payment, but they are certainly not welcome. They are lost in couch cushions, thrown out on the side of the road, or put into storage devices where they sit for months or years because their owner has the farfetched idea that someday he is going to return all of his pennies to the bank for a huge payday. Don't laugh; you might do this yourself. The point is that pennies don't circulate, i.e. they have a low velocity. The United States Mint says Americans take one million pennies out of circulation a day by saving or losing them [Vann, 2005].

N. Gregory Mankiw, economics author and former Chairman of the Council of Economic Advisers, weighed in on this issue on Jan 3, 2006 in an article outlining ways congressmen and presidential candidates could improve economic policy. He wrote,

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> This year I will vote to eliminate the penny. The purpose of the monetary system is to facilitate exchange, but I have to acknowledge that the penny no longer serves that purpose. When people start leaving a monetary unit at the cash register for the next customer, the unit is too small to be useful [Mankiw, 2006].

Mankiw is clear about his thoughts concerning the future of the penny. However, many groups are opposed to any form of penny elimination. Therefore, I will ask, what are the economic effects of phasing out the penny by price rounding? I will convince the reader that there are no major negative effects and that the positive effects vary by user.

II. Background and Related Information

In order to understand the fate of the penny, it is important to know where coins come from. The U.S. Mint is responsible for manufacturing and distributing coins. Manufacturing the coins involves securing the raw materials and minting. Distributing the coins involves packaging and physically moving coins from U.S. Mint locations to Federal Reserve Banks (FRBs). When FRBs receive the coins, they become responsible for distributing to individual banks. The FRBs pay face value for the coins, and they may return excess coin inventories for face value. The difference between the face value of a coin and the value of its metal content is called seignorage. Positive seignorage means the Mint is making coins at a profit. But seignorage is similar to gross profit in that there are more costs to consider. The extra costs include distribution, employee salaries, and anything else the Mint has to pay for. The Mint uses cheap metals to make its coins and makes a net profit each year. The profit is donated to the U.S. Treasury general fund. In FY 2004, the U.S. Mint transferred $665 million to the general fund [2004 Annual Report]. This amount is consistent from year to year. The mint is one of the only profitable government agencies.

The FRBs sell coins to financial institutions within their district and buy excess inventories from them for face value. The financial institutions can then serve demand for coins. Ultimately, the coin user sets coin demand. The only goal of the distribution process is to avoid shortages and excess inventories. To that end, the Mint manufactures coins based on estimates of net user demand. Net user demand is coins needed minus

coins returned. Demand for all coins is subject to huge seasonal fluctuations. Monthly demand from 1998-2002 for the penny averaged 800 million pennies per month, but in this 5 year period, two months actually had negative demands! [Small Change, 1992].

The U.S. Mint has no authority to stop minting coins. It is responsible to meet user demand. The U.S. Congress, however, can pass a bill that would make the penny much less widely used. In 2001, Rep. Jim Kolbe introduced H.R. 2528 "The Legal Tender Modernization Act." The bill prescribes guidelines for rounding cash transaction values to the nearest five cents. After all items purchased are summed and sales tax is applied, values that end in 3, 4, 8, or 9 will be rounded up and values that end in 1, 2, 6, or 7 will be rounded down. The rounding is only for cash transactions. Any non-cash payment is exempt from price rounding. All coins and currencies of the United States would continue to be legal tender [H.R. 2528, 2002]. The bill never became law.

III. What happens when prices are rounded?

Imagine that the likelihood of any cash transaction ending in any digit from 0-9 is 10% for each transaction. 10% of the time, the transaction would end with an eight and the customer would pay an extra 2 cents. 10% of the time, the transaction would end with a seven and the customer would save 2 cents. The expected value of the net benefit to consumers and merchants is zero for each group. Most readers may realize that the last digit of individual items is not evenly distributed. The last value is nine most of the time. Does this matter? Does this mean that one cannot assume that the likelihood of the ending value of any cash transaction is not 10% for each digit?

A study carried out by Dinu Chande and Timothy Fisher asked the same question. Prices were gathered for every one of 123 items offered at a restaurant. It was found that over 50% of the prices ended with nine. A simulation was then set up that drew 10,000 random 1, 2, 3, and 4 item purchases (40,000 simulations in all). A 15% sales tax was added to each purchase. The researchers wanted to test the hypothesis that the number of transactions is distributed equally across the ten ending digits. At the 5% significance level, the hypothesis cannot be rejected for 3 and 4 item purchases. The hypothesis is rejected for the 1 and 2 item purchases. The seller comes out .06 cents and .03 cents better per transaction for the 1 and 2 item purchases [Chande, 2003]. To put it plainly, if this restaurant

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makes 10,000 random one item sales, it will profit about $6 from price rounding. The sales tax and number of items purchased help to make the final digit random.

Supporters of the penny say that retailers will fix prices to take advantage of price rounding. Unless every customer purchases one item, the retailer will have a hard time taking advantage of price rounding. In New Zealand, a country that does round its prices, some supermarkets advertised that they would always round in favor of the customer [Chande, 2003]. The experiment really does suggest a trivial amount of rounding even in the extreme case of majority of prices that end with nine and single item transactions.

Virtually every website advocating that we keep the penny will refer to a $600 million rounding tax on consumers. This figure comes from Raymond E. Lombra, Penn State University economist, who published an economic analysis of eliminating the penny in 2001. Lombra conducted an experiment similar to Chande and Fisher's restaurant rounding experiment. The Lombra experiment used prices of all 3,585 separate items at a convenience store. 82.5% of prices ended in 9. Five thousand 1-3 item transactions were simulated and it was found that 93% of single item transactions involved rounding up. This fact is no surprise because 93% of prices ended in digits that get rounded up. Sixty percent of three item transactions were rounded up [Lombra, 2001]. The experiment supports the idea that number of items adds randomness to the ending digit.

Lombra's experiment does not consider sales tax. Unprepared food items are untaxed in most states, but a lot of items that a convenience store sells are taxed. The experiment then only applies to untaxed purchases. Lombra, however, has loftier goals. The basis for the $600 million comes from the following relationship

*RT = CT * PR * $0.01*
RT: Rounding Tax CT: Cash Transactions in an economy PR: Percent of Transactions that are rounded up

Later, I will suggest some problems with this formula. The American Banker's Association guesses that the number of total transactions by

consumers in 2000 was 106 billion. A further estimation guesses that cash transactions range from 50% to 83% of this number [Lombra, 2001]. Tired of the guesswork yet? Just wait.

Transactions rounded up ranges from 60% to 93%, and transactions that are cash ranges from 50% to 83%. These endpoints are mixed and matched to form a range of estimates.

$$[(.5) * 106 \text{ billion}] * (.6) * \$0.01 = \$318 \text{ million}$$

$$[(.83) * 106 \text{ billion}] * (.6) * \$0.01 = \$528 \text{ million}$$

$$[(.5) * 106 \text{ billion}] * (.93) * \$0.01 = \$493 \text{ million}$$

$$[(.83) * 106 \text{ billion}] * (.93) * \$0.01 = \$818 \text{ million}$$

The midpoint of the four estimates is $598 million. This number is rounded to $600 million and much hoopla is made. I have no faith in this number, and not just because of the liberal use of estimation. This formula says that every time a price is rounded up, it costs the customer one cent. Not true. Every time four or nine is the final digit the customer pays an extra cent, but every time three or eight is the final digit the customer pays an extra two cents. If the extra penny is considered the estimation would be higher, but I point this out to suggest a general sloppy use of the math.

Also, if the customer pays extra 60% of the time, the customer must save the rest of the time. The low estimate should be

$$[(.5) * 106 \text{ billion}] * (.6-.4) * \$0.01 = \$106 \text{ million}$$

There is no such thing as a $600 million tax on consumers due to rounding. The process by which it was acquired is littered with mistakes and illogical estimates. It is very shaky ground on which to base an entire argument. The penny supporters often say the rounding tax is the most important reason to keep the penny.

The direct economic effects of price rounding are trivial due to the randomizing aspects of sales tax and number of items purchased.

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IV. Does the U.S. Mint make a profit selling pennies?

If the answer to this question is yes, the people for keeping the penny have a stronger case. If the answer is no, then there are two options to consider: make it cheaper or don't make it at all. The Mint has influence over the former and Congress has influence over the latter. The Mint should not lose money making any coin. The penny in the form that we recognize it has been around since 1909. Prior to 1982 pennies were composed of 95% copper and 5% zinc. The price of copper rose to the point where the Mint would lose money making copper pennies. The mint began making pennies 97.6% zinc and 2.6% copper and has been doing so ever since. The post 1982 pennies are identical in size and appearance but weigh 19% less than the pre 1982 pennies [Small Change, 1992]. It is interesting to note that the metal content of a penny would be worth more than its face value when zinc hits $3,282/ton. On February 1, 2006 zinc was selling for $2,300/ton - up nearly $1,000/ton since September 2005[Crudele, 2006].

The U.S. Mint breaks down its financial analysis by coin. Cost of goods sold and selling, general, and administrative costs (SG&A) are allocated to each coin. In FY 2004, the U.S. Mint says the total cost of a penny is .93 cents. In FY 2004, the penny represented 53% of all coins produced by volume, 41% of all coins produced by weight, and 7% of all coins produced by face value [2004 Annual Report].

The Mint allocates 1% of SG&A cost to the penny [2004 Annual Report]. The penny should be responsible for soaking up more of this cost. Surely, weight and volume are the two most important factors to consider when charging for transportation and packaging. The large volume of pennies also suggests a need for a larger workforce. The Mint allocates 3 times as much SG&A to the dollar coin as it does the penny, while the amount of pennies made was over 400 times the amount of dollar coins made!

Let's assume that the penny is responsible for 40% of SG&A expenses and see what happens. For FY 2004, the Mint sold $71.3 million worth of pennies and spent $65.7 million making them. Total SG&A for the Mint was $88.9 million [2004 Annual Report]. The revised cost of a penny is

$$[(.4)\ 88.9 + 65.7]\ /\ 71.3 = 1.42\ cents$$

The penny is not profitable. And they keep getting made *because* they are not usable. If pennies actually circulated, the Mint wouldn't have to replace the 1 million per day that are lost or saved [Vann, 2005].

It should be noted that if Congress passes a law that requires price rounding for cash transactions, the U.S. Mint won't stop manufacturing pennies the next day. The Mint will continue to supply the quantity of pennies that satisfy the user's demand. A law requiring price rounding would greatly reduce the demand for pennies.

The Mint loses money manufacturing and distributing pennies and any effects of a rounding tax are trivial. This economic analysis suggests that Congress should make a law that requires price rounding for cash transactions.

V. Other Considerations

I also want to address other interesting topics related to the penny. The user cost of the penny is the amount of time it adds to each cash transaction and can be converted to dollars. It is calculated for a country by Number of Cash Transactions per Consumer per Year times Number of Consumers times Number of Seconds a Penny Adds per Transaction times Average Wage per Hour times Hours per Second [Chande, 2003]. The Average Wage per Hour is $18.09 [National Compensation Survey, 2005]. The Number of Consumers in the U.S. is 115,356,000 [Consumer Expenditures in 2003, 2005]. The Number of Cash Transactions per Year is estimated at 400. The Number of Seconds a Penny Adds per Transaction is two. The total user cost for the United States is $464 million. Persons who would like to eliminate the penny like to refer to user cost as a tangible way to support their beliefs.

The market has responded with its own solutions to the penny problem. Coinstar is a company that operates coin terminals. The terminals accept change and turn it into paper money for a service fee usually stated as a percentage of total dollars. Give a penny, take a penny jars at convenience stores are another market based solution to the penny problem. A person who doesn't wish to keep pennies in his pockets can leave his pennies at the store in good faith that there will be a surplus of pennies the next time he comes up a couple of cents short.

The market based solutions are great because they recognize the inefficiencies of penny usage without reverting to government action. Government intervention concerning pricing seems to be in conflict with

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economic principles [Lombra, 2003].

"A penny saved is a penny earned" may be the most recognizable quote on the subject of thrift. These words first appeared over 250 years ago. Times have changed since then. Ninety percent of people over 65 say they have never thrown away a penny. Fifty percent of all people between ages 18 and 34 say they have thrown away a penny [Burdick, 2003].

It is worth noting the special interest lobbies that affect price rounding legislation. If prices were rounded to the nearest nickel, one suspects that penny production will go down and nickel production will go up. Nickel production will go up as the nickel assumes the roles of couch cushion filler and general bother to deal with. Nickels are made largely from copper and pennies are made largely from zinc. The state of Arizona supplies 64% of the nation's copper. The mineral is considered to be of great importance to Arizona's economy [Shipley, 2000]. The state of Tennessee supplies 25% of the nation's zinc. The mineral is considered to be of great importance to Tennessee's economy [Tennessee's Mineral Industry]. Jim Kolbe, the Representative who last introduced a bill to make price rounding law happens to represent Arizona. Three of the seven representatives that led the charge against the bill were from Tennessee. The copper and zinc lobbies have a lot at stake. It should not be surprising that the lobbies have influenced representatives to act in line with their own interests. The zinc industry supports a pro penny group called 'Americans for Common Cents'. Lombra said this group asked for the penny study and paid for his research assistant [Bair, 2000]

VI. Conclusion

Fears relating price rounding to negative economic benefits are unwarranted. Price rounding makes life a little easier at the cash register. And rest easy, pennies are going to be around forever. The mint has made hundreds of billions of them. A penny will always buy one cent of merchandise. The reason that you shouldn't need them for cash transactions is that their purchasing power has become too small to be of significance.

The way American's live their lives won't be affected by keeping or eliminating the penny. However, the debate does help one understand relationships among consumers, businesses, government, and academia. Consider the Lombra example. Lombra, a member of academia, was

approached by the zinc lobby, a member of business, to persuade government to resist eliminating the penny by suggesting a negative affect on consumers. The interactions among sectors make one appreciate the complexities of our world. At the same time, we must be cautious of things that we read. An author with an agenda can be dangerous if readers don't have the nerve to ask questions.

An educated public recognizes inefficiencies and tries to eliminate them. Penny usage is inefficient. The public is moving towards voluntary penny elimination. The trend towards non-cash transactions, i.e. debit and credit cards, helps reduce penny usage. With the government's backing, the public will move forward more quickly. Individually, managers can adopt price rounding at their own stores. Also, users can commit to circulating their pennies rather than stockpiling.

Now what will John do with all of those annoying nickels?

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