Have a Penny? Need a Penny? Eliminating the One-Cent Coin from Circulation

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Nous montrons que l'on aurait vraiment intérêt, d'un point de vue économique, au Canada, à retirer de la circulation la pièce d'un «cent». En utilisant les données de la Monnaie Royale du Canada nous montrons que le seigneurage généré par cette pièce est négatif. Lorsqu'on y ajoute le coût pour l'utilisateur, associé à l'incommodité de la pièce, il apparaît encore plus impératif de retirer celle-ci de la circulation. Des simulations effectuées à partir de données de prix de la chaîne «Tim Horton» montrent qu'arrondir les prix pour arriver à la pièce de monnaie suivante, d'une valeur de cinq «cents», ne serait pas une mesure inflationniste. Nous en concluons que le Canada devrait suivre l'exemple de l'Australie, de la Nouvelle-Zélande, des Pays-Bas, de la France et de l'Espagne en retirant de la circulation la pièce de la plus petite valeur.

We show there is a strong economic case for removing the one-cent coin from circulation in Canada. Using data from the Royal Canadian Mint, we show that seigniorage on the coin is negative. When the user cost associated with the inconvenience of the penny is added, the case for eliminating it is even more compelling. Simulations using price data from Tim Horton's show that rounding prices to the nearest nickel will not be inflationary. We conclude that Canada should follow Australia, New Zealand, the Netherlands, France, and Spain by removing the lowest denomination coin from circulation.

Introduction

What are the economic benefits and costs of keeping the Canadian penny in circulation? The principal conclusions reached by the paper are as follows. The cost of producing and distributing the Canadian penny is greater than the revenue it generates for the federal government. Because the value of the penny will continue to drop with inflation, the seigniorage loss associated with the penny will only increase into the future. Negative seigniorage alone would seem to be sufficient grounds for removing the penny from circulation. Adding in the user cost of the penny, measured by the time associated with making change for cash transactions, only strengthens the case for its removal. Finally, a 10,000-transaction simulation using price data from Tim Horton's puts to rest any fears that rounding prices to the nearest nickel will be inflationary.

Using data supplied by the Royal Canadian Mint, we compute that seigniorage for the penny amounted to a loss of $30 million in 2000 and a loss of $24 million in 2001. The negative seigniorage exists despite a concerted effort by the Mint in recent years to reduce the manufacturing cost of the coin. The "have a penny, leave a penny; need a penny, take a penny" jars common in convenience stores are an implicit recognition of the existence of the user cost of the penny. The market has provided an explicit option for dealing with the user cost: coin-counting machines, which charge 9.8 cents on the dollar to convert coins into vouchers that can be exchanged for cash or goods, have recently appeared in 32 grocery stores and other retail locations in central Ontario.[1]

Several countries, including France, Spain, the Netherlands, New Zealand, and Australia, have removed their lowest denomination coin(s) from circulation in recent years. However, there exists very little literature detailing the economic effects, either anticipated or realized, experienced by these countries. Lombra (2001) examines the case for eliminating the one-cent coin from the monetary system in the United States. He concludes that the coin should not be removed from circulation because it generates positive seigniorage for the US government and because of simulations of cash transactions showing a net loss to consumers from rounding. We discuss Lombra's work in detail and explain why his conclusions do not apply to Canada.

Seigniorage on the Penny

The Royal Canadian Mint (RCM) is a federal Crown corporation. All Canadian coins are manufactured at the Mint's Winnipeg production facility and then shipped, at the Mint's expense, to unmarked distribution centres across the country. Coin production is adjusted to keep the level of coins at the distribution centres above pre-determined levels. Worn or damaged coins are returned to the distribution centres by financial institutions, and these are returned, at the Mint's expense, to the Winnipeg facility to be melted down for reuse. The RCM is thus engaged in both the production and the transportation of coins. From the point of view of cost, the transportation part of the Mint's operation is significant owing to the sheer weight of coins produced. For example, the 2001 mintage of 918,495,000 pennies at a weight of 2.35 grams per coin results in a total weight of 2.2 billion grams, or 2.2 thousand tonnes of pennies.[2]

The supply of pennies is determined by demand, which in turn is related to the number of cash transactions in the economy. Thus, as the size of the economy increases, so does the number of coins produced. Data from the RCM reveal that production of the penny has increased at an average rate of about 7 percent annually over the last 93 years. Over the same period, the purchasing power of the penny, as measured by the Consumer Price Index, has dropped to less than one-fifteenth of its value in the early 1900s. Penny production represents by far the majority of Canadian coin production: from 1981 to 2002, the penny represented an average of 71 percent of all Canadian coin production. In some years, over 95 percent of the coins produced were pennies.

Seigniorage refers to the net income generated by governments in the course of printing paper money and manufacturing metal coins. Thus, the seigniorage attributable to the penny is the difference between the value of the coins produced and the production and distribution cost of the coin. Lombra (2001, 440) reports that seigniorage on the US one-cent coin is about 0.2 cents per coin, but this figure is supplied by the US Mint and is not verified independently by Lombra. We compute seigniorage on the Canadian one-cent coin using production and cost data supplied by the RCM.

The RCM provided us with the production (or "mintage") cost for each denomination of coin for 2000 and 2001. The Department of Finance pays the RCM just enough to cover the production and distribution cost of the coins. The payments by the Department of Finance for 2000 and 2001 are available from the Mint's 2001 Annual Report (2002, 15). The RCM confirmed that the payment from the Department of Finance can be interpreted as the "total cost" of coin production and distribution because the RCM does not make a profit from the operations it carries out on behalf of the government. Total cost includes mintage cost, distribution cost, and fixed cost allocated by the RCM to coin production. Thus, by subtracting mintage cost from total cost, we can derive the sum of distribution and fixed cost, which we refer to as "other cost." Since the total cost data are not broken down by coin denomination, we allocate other cost to each coin type according to the physical weights produced of each denomination. This method of cost allocation assumes that distribution cost make up the lion's share of "other cost" and that such costs are largely determined by weight, as is common in the transportation industry. The seigniorage calculations for each coin denomination in 2001 are shown in Table 1.[3]

Table 1 shows a seigniorage loss of $24.4 million attributable to the penny for 2001. For 2000 (calculations not shown) the seigniorage loss was even higher at $30.1 million. Put another way, the cost of manufacturing and distributing the one-cent coin was 4.95 cents per coin in 2000 and 3.95 cents per coin in 2001. Negative seigniorage is also apparent for the five-cent coin in both 2000 and 2001, though the losses are smaller than for the penny. Overall, the operations of the RCM added $23.2 million to federal government revenue in 2001, as shown in Table 1, and $89.5 million in 2000. The lower figure in 2001 is due principally to higher production of the penny and lower production of the two-dollar coin compared with 2000.

TABLE 1
Seigniorage Calculation (in dollars) for Canadian Coinage, 2001

Coin	*Total Value of Mintage*	*Mintage Cost*	*Other Cost (allocated)*	*Total Cost*	*Seigniorage*
A	*B*	*C*	*D*	*E = C + D*	*B - E*
0.01	9,184,950.00	734,796.00	32,815,802.59	33,550,598.59	–24,365,648.59
0.05	8,334,300.00	1,883,551.80	10,010,011.86	11,893,563.66	–3,559,263.66
0.10	27,079,200.00	189,554.40	7,204,639.42	7,394,193.82	19,685,006.18
0.25	15,140,500.00	908,430.00	4,051,270.64	4,959,700.64	10,180,799.36
0.50	194,500.00	10,114.00	40,807.23	50,921.23	143,578.77
2.00	23,820,000.00	1,429,200.00	1,321,822.05	2,751,022.05	21,068,977.95
Total	83,753,450.00	5,155,646.20	55,444,353.80	60,600,000.00	23,153,450.00

As the following quote indicates, negative seigniorage was sufficient to convince the Reserve Bank of New Zealand to remove its lowest denomination coins from circulation.

> Critical to the decision (to remove our lowest denomination coins) was the cost of manufacture of the 1 cent and 2 cent coins, along with the perceived value of those coins by the public. At that time the face value of the 1 cent and 2 cent coins were less than the cost of manufacture: it cost 1.6 cents to manufacture a 1 cent coin! (e-mail 22 October 2002)

The Reserve Bank of New Zealand also stated that both New Zealand and Australia are now keeping a close watch on the 5-cent piece, as its cost of manufacture is also getting close to the coin's face value. If Canada were to follow the same rationale as New Zealand, both the one-cent and the five-cent coin would be removed from circulation.

Inflation will only cause negative seigniorage on the penny to rise. Even if the real cost of producing and distributing the penny remains stable, the purchasing power of the penny will decrease, resulting in ever-falling seigniorage. Assuming an annual inflation rate of 2 percent and constant penny production at 2000 levels, negative seigniorage will rise to $37 million in 2010 and $49 million by 2025.

The rising seigniorage loss due to inflation could be mitigated if the RCM were able to decrease the cost of production and distribution. In fact, the RCM has already cut the production cost of the penny by substituting cheaper raw materials in the process. Prior to 1997, the penny was manufactured using a composition of 98 percent copper, 1.75 percent tin, and 0.25 percent zinc. From 1997 to 1999, the composition was switched to 98.4 percent zinc and 1.6 percent copper. Since 2000, the composition of the penny has been 94 percent steel, 1.5 percent nickel, and 4.5 percent copper. It seems unlikely that the RCM will be able to glean significant further reductions in the manufacturing cost of the penny. Further cost reductions, therefore, will depend on reducing the cost of distributing the roughly 2 thousand tonnes of pennies produced annually. Barring a collapse in the price of oil, reductions in the Mint's distribution costs are unlikely.

User Cost of the Penny

Besides seigniorage, another major impact of the penny is the amount of time it adds to each cash transaction, which we refer to as the user cost of the penny. The amount of time added per transaction due to the existence of the penny is debatable, so we provide some estimates based on reasonable assumptions. A recent article in *Discover* states: "It may take up to three seconds longer to complete a transaction that involves pennies."[4] Since not all cash transactions involve pennies, it seems safe to assume that the penny adds between one and two seconds per cash transaction. Assume that 20 million consumers in Canada make an average of two cash transactions each per day. If the penny adds one second to each transaction and the average wage is $16 per hour, the 40 million daily transactions result in a time cost of $64.9 million per year. If the penny adds 2 seconds per transaction, the time cost rises to $129.8 million per year.

The total economic loss associated with the existence of the penny is given by seigniorage plus the user cost. The seigniorage loss for 2001 is $24.4 million which, together with the one-second user cost estimate, implies net economic loss attributable to the penny for 2001 of $89.3 million or about 9.8 cents per penny. Similarly, the net economic loss for 2000 is $95.0 million or about 12.5 cents per penny.

Americans for Common Cents (www.pennies.org), an organization that lobbies in favour of keeping the US penny in circulation, reports on its website a 2002 survey that finds 65 percent of Americans support keeping the penny.[5] It is possible that individuals value the penny intrinsically, perhaps for sentimental reasons. Even if this were the case, it would

require an intrinsic value of about $4.50 per person for the 20 million Canadian consumers in order to overcome the economic loss for 2001. Arguably, Canadians are less sentimental about their currency than Americans: consider the ready adoption of one- and two-dollar coins in Canada against the failure of the "Susan B. Anthony" dollar coin in the US.

The Effect of Rounding

If the penny were removed from circulation, all cash transactions would need to be rounded to the nearest 5 cents. For multiple-item purchases, rounding would take place on the final price, after the prices of all items had been totaled and the appropriate sales tax applied. All non-cash transactions — payments by direct debit, credit card, cheque, or electronic transfer — would continue to be priced to the penny. Final prices ending in 1 or 6 would be rounded down by one cent, those ending in a 2 or 7 would be rounded down by two cents. Final prices ending in 4 or 9 would be rounded up by one cent, and those ending in a 3 or 8 would be rounded up by two cents. Assuming that the last digit is uniformly distributed, the probability that any one digit from 0 to 9 occurs is 10 percent, and the expected value of rounding is zero.

The before-tax final digit of many goods and services in the economy is clearly not uniformly distributed: most prices end with a 9. Lombra (2001) attempts to determine whether rounding to the nearest 5 cents would increase the overall price level of goods in the US economy. He obtained before-tax prices on 3,585 separate items sold in a chain of convenience stores, finding that 82.5 percent of prices ended in 9. Lombra then simulated 5,000 transactions of one to three items randomly selected from the price list. He finds that for one- or two-item purchases, 93 percent of transactions result in rounding up at the consumers' expense, and for up to three items purchased, 60 percent involve rounding up.

Lombra's results are not relevant for Canada, however, because he does not apply sales tax to his prices. Furthermore, Lombra confines his experiment to a small number of items per transaction: as the number of items per transaction increases, the final digit may become more uniformly distributed.

We carry out simulations to determine the randomness of the final digit in multi-item transactions in the presence of a sales tax. To this end, we compiled a price list of 123 distinct items from a Tim Horton's Restaurant.[6] The distribution of prices at Tim Horton's is not uniform: 50 percent of the prices end in 9, 18 percent of the prices end in 5, and 14 percent of the prices end in 0; there are no prices at all that end in 6 or 8. The simulation draws 10,000 transactions each for one-, two-, three-, and four-item purchases with the addition of a 15 percent sales tax. The simulation outcomes are summarized in Table 2. The χ^2 statistic tests the hypothesis that the number of transactions is distributed equally across the ten ending digits.

At the 5 percent level, the simulations reject the hypothesis of uniformly distributed ending digits for both the one- and two-item cases. In both cases, the mean rounding is positive, implying a net gain to the seller from rounding to the nearest nickel due to elimination of the penny. However, in both cases the average size of rounding per transaction is extremely small — less than six-hundredths of a cent — which suggests that the rounding will bear no consequence in everyday life.[7] Simulations for three- and four-item transactions do not reject the hypothesis of uniformly distributed price-ending digits at the 5 percent level. In fact, although the hypothesis is rejected at the 10 percent level for four-item transactions, the rounding in this case actually favours the buyer, although once again the average size of rounding per transaction is very small.

Unlike Lombra (2001), therefore, we reject the hypothesis that rounding will have a noticeable effect on prices if the penny were eliminated from circulation. Lombra's conclusion is based primarily

TABLE 2
Simulation Results for One-, Two-, Three- and Four-Item Transactions: Final Digit Distribution and Mean Rounding

Ending Digit	*Rounding*	*Transactions*			
		1 Item	*2 Items*	*3 Items*	*4 Items*
0	0	340	1,004	1,050	989
1	–1	1,287	1,034	966	975
2	–2	1,151	926	999	1,028
3	2	1,399	1,095	1,001	1,043
4	1	1,414	930	1,012	1,003
5	0	646	1,014	1,037	1,002
6	–1	631	1,090	945	956
7	–2	986	962	998	1,082
8	2	420	1,107	954	963
9	1	1,726	838	1,038	959
	Mean rounding (cents per transaction)	0.059	0.027	0.006	–0.0177
	χ^2-statistic	1,996.516	68.006	11.760	15.102
	p-value	0.000	0.000	0.227	0.088

Note: 10,000 transactions for each single- and multiple-item purchase with a sales tax of 15 percent.

on estimates for transactions without sales tax involving one and two items. The role of sales tax is critical. If all retail prices in the economy ended in 9, then all transactions of one and two items, without sales tax, result in rounding up by 1 and 2 cents, respectively. The same set of prices with a 15 percent sales tax, however, results in a net rounding of zero for both one- and two-item transactions.[8] Even without a sales tax, Lombra finds that rounding against the consumer is less pronounced when transactions involve three items. Table 2 supports Lombra's findings: mean rounding becomes smaller as the number of items increases from one to three. And in the case of four-item transactions, which Lombra does not consider, rounding works in favour of consumers.

THE POSSIBILITY OF STRATEGIC PRICING

Retailers may have an incentive to price goods in order to take advantage of rounding. For example, a large cappuccino at Tim Horton's is currently priced at $1.54 before tax. With the application of 15 percent sales tax, the final price becomes $1.77, meaning a two-cent gain to the consumer because the price would be rounded down to $1.75. If Tim Horton's were to set the price of a cappuccino at $1.55, the after-tax price would be $1.78, so the customer would have to pay $1.80 after rounding. Thus, by "strategically" raising the price of a cappuccino by $0.01, Tim Horton's would receive an additional $0.05. Of course, if the customer were to buy two cappuccinos instead of one at the new price, the after-tax price would be $3.57 and the final price would be rounded down $0.02.

Thus, in order to take advantage of rounding, a retailer would need to know how frequently different combinations of items are purchased. While retailers like Tim Horton's would have access to such data, Table 2 suggests that even if prices were strategically adjusted by firms to squeeze extra revenue

from their customers, the amount per transaction would be so trivially small as to have little impact on consumer behaviour or welfare. Moreover, we have focused on price-setting by a single firm and ignored the reaction of other firms selling in the same market. It is an open question whether an oligopolistic market would lead to equilibrium prices that exploited rounding to the detriment of consumers. Indeed, anecdotal evidence from New Zealand suggests that such fears may be unwarranted. Correspondence with the Reserve Bank of New Zealand, which in 1990 removed its 1- and 2-cent coins from circulation, revealed that some supermarkets at the time advertised they would always round in favour of the customer.

Conclusion

This paper has analyzed the central issues associated with a potential decision to remove the Canadian penny from circulation. Using 2001 figures provided by the RCM, we have estimated that each penny cost 4 cents to produce and distribute. Furthermore, if the existence of the penny adds just one second per cash transaction, its cost to the economy increases to almost ten times its face value. Inflation will only increase the economic loss over time. Concerns that rounding to the nearest nickel will increase the overall price level in the economy are unwarranted. Multiple item transactions, with the application of sales tax, yield prices with random final digits. Even in cases where rounding may not result in a zero impact on prices, the mean impact per transaction is so small that it can have no real impact.

Notes

[1]The machines are owned and operated by a company that also operates 11,000 similar machines in the United States and the United Kingdom.

[2]Unless otherwise noted, all the data in this paper pertaining to Canadian coinage are sourced from the RCM's website www.mint.ca.

[3]Table 1 does not include a row for the one-dollar coin because none were minted in 2001.

[4]"The Math of Pocket Change," *Discover*, October 2003.

[5]The survey was paid for by a leading manufacturer of coin-counting machines. The firm, of course, has a strong interest in ensuring people have lots of pennies to count.

[6]The prices were recorded at 109 King Street North, Waterloo, Ontario, in November 2002.

[7]The average size of rounding for a given number of items is the rounding value in the left-hand column times the frequency of transactions added across all ten digits and divided by 10,000 (the total number of transactions).

[8]Computations are available from the authors upon request.

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