

The Economics of Eliminating or Retaining the U.S. Penny

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Executive Summary

In recent years, some commentators have urged the U.S. government to eliminate the penny, based on the costs to produce and distribute the coin and claims that pennies are “more trouble than they’re worth.” This study found that eliminating the penny would generate large additional costs far greater than the costs to produce it, and that American consumers and businesses value their ability to conduct cash exchanges in pennies, as well as in nickels, dimes and quarters.

- At 2015 metal prices, it cost 1.4 cents to produce a new penny and 7.3 cents to produce a new nickel. At those prices, eliminating the penny and producing more nickels with the same combined face value would *raise* production costs by \$5.3 million per year.
- Global metal prices fluctuate, so we used the low, average and high metal prices for the last decade to estimate the cost or savings from eliminating the penny and producing nickels with comparable total face value. This shift produced net costs in all cases.
 - Applying the lowest metal prices of the last decade, the shift would produce net costs of \$1.3 million per year; using the average metal prices of the last decade, the shift would produce net costs of \$25.1 million per year; and using the highest metal prices of the last decade, the shift would produce net costs of \$54.4 million per year.

A coin’s economic value in a modern cash economy is based not on the price of the metals used to produce it, as it was when coins were made of gold and silver, but on its use as a medium of exchange.

- Based on the number of consumer cash transactions, the 25-year lifespan of an average penny, the average number of pennies received or used in cash transactions and the number of pennies in active circulation, we estimate that an average penny turns over 2.18 times per year or 54.5 times over its useful lifespan. Therefore, the penny’s economic value as a medium of exchange is 55 cents, compared to its current production cost of 1.4 cents.

At the direction of Congress, the U.S. Mint has assessed how changes in the metal composition of American coins might reduce their production costs.

- The Mint found that there were no alternative metal compositions that could lower the cost of producing the penny while preserving its usefulness as a medium of exchange.
- The Mint further found only one alternative composition that could lower the costs of producing nickels, dimes and quarters, but the net savings would be very modest.

Most coins exchanged in the United States are used coins recirculating through the economy. Coin-counting services that accept and collate excess coins from businesses and consumers and sell them to the Federal Reserve account for 66 percent of all coins recirculated through the Federal Reserve and financial institutions.

- Pennies play a key role in this process, as they comprise a majority of the coins recirculated through coin-counting services. When Canada phased out its penny in 2013, the volume of Canadian nickels and dimes recirculated through these services fell 35 percent.
- If the U.S. penny were eliminated, the Mint would have to offset some of any comparable net decline in the recirculation of coins by producing and distributing more new coins.
 - At current metal prices, if the Mint offset 25 percent of the reduced volume of recirculated coins with new nickels, dimes and quarters, it would cost an additional \$77 million per year; if the Mint offset 50 percent of that reduced volume, it would cost an additional \$154 million per year; and if the Mint offset 75 percent of that reduced volume, it would cost an additional \$230 million per year.
 - Applying the lowest metal prices of the last decade, offsetting the reduced volume of recirculated coins to the same extent as above would still cost the Mint an additional \$60 million to \$181 million per year; using average metal prices over the last decade, the Mint's additional costs would range from \$85 million to \$256 million per year; and using the highest metal prices of the last decade, the Mint's additional costs would range from \$111 million to \$334 million per year.

Eliminating the penny while retaining its use as a pricing unit also would impose new costs on consumers, as billions of cash transactions would be rounded up or down to the nearest nickel. Based on studies of consumer cash transactions, between 60 percent and 93 percent of transactions would involve rounding up the final charge.

- The rounding up or down of cash transactions to the nearest nickel would cost consumers an estimated \$438 million to \$1.13 billion per year – and even more if merchants adopt strategic pricing practices to ensure that more transactions are rounded up.

If the U.S. penny were eliminated and its role as a pricing unit also ended, it would impose new costs on U.S. retail investors. In 2001, the Securities and Exchange Commission (SEC) directed U.S. stock exchanges to quote all prices in pennies rather than in sixteenths of a dollar. Researchers found that this change lowered investors' trading costs.

- Based on these studies, moving from penny-based pricing of stocks to nickel-based pricing would increase the trading costs of retail investors by at least \$410 million per year.

Eliminating the penny could cost Americans \$909 million to \$1.93 billion per year: \$1.3 million to \$54.4 million for nickels to replace the face value of pennies, depending on metal prices; \$60 million to \$334 million for the additional nickels, dimes and quarters needed to maintain current levels of coin recirculation, depending on metal prices; \$438 million to \$1.13 billion for the rounding up of cash charges to the nearest nickel; and \$410 million in new costs for retail investors.

Finally, American consumers and businesses continue to prove the penny's value as a medium of exchange by using it. Based on their demand, the Mint produced 103 billion new pennies from 2001 to 2015, and pennies account for the majority of all coins in circulation.

The Economics of Eliminating or Retaining the U.S. Penny¹

Robert J. Shapiro

I. Introduction and Summary

For more than a decade, some commentators have called on Congress to revamp American coinage by eliminating the U.S. penny. These advocates note that the penny costs more than one cent to produce, claim it has little value in modern commerce, and conclude that the United States could save millions of dollars by phasing out its use. This case against the penny is based ultimately on the 18th- and 19th-century view of coins as stores of value, because coins in those years contained gold and silver, and a government could claim “seigniorage” profits by minting coins with face values less than the cost of their precious metals. In modern currency systems in the United States and every other nation, consumers and businesses use coins (as well as paper currency) purely as mediums of exchange, not as stores of value. Moreover, as we will see, economic analysis shows that eliminating the penny as a medium of exchange would result in substantial net costs for the government, the economy, consumers and investors totaling an estimated \$909 million to \$1.9 billion per year.

The circulation of new coins – pennies, nickels, dimes and quarters – is a core function of government. The U.S. Mint estimates the annual demand for new coins and produces and sells them at face value to the Federal Reserve. The Federal Reserve resells those new coins to commercial banks and thrifts through its 12 regional banks, and those banks and thrifts distribute them to businesses and consumers. Most of the coins circulating through the economy, however, are used coins, and the process for recirculating them depends on private entities as well as government. Coin-counting services operate at the center of this process. Coin-counting technologies throughout the United States accept and separate customers' change and provide cash vouchers or gift cards in exchange; they then sell the coins to the Federal Reserve through its 12 regional banks or through more than 175 “sanctioned coin terminals” operated by armored vehicle companies. (These companies also transport coins to and from commercial banks and thrifts for recirculation.) In 2015, the leading firm providing coin-counting services (Coinstar) processed some 37 billion coins for recirculation, or more than twice the volume of new coins produced by the Mint in that year. The coins recirculated through this process accounted for 66 percent of all non-new coins handled by the Federal Reserve in 2015 and 51 percent of all coins, new and old, received by the Federal Reserve for circulation and recirculation.

The penny's critics are correct in one respect: the face value of the penny is less than the cost to produce and distribute it. Similarly, the nickel, which would have to replace the penny as the smallest-denomination coin, also costs more to produce than its face value. In 2015, it cost

¹ I want to acknowledge the superb research assistance of Siddhartha Aneja of Sonecon and the support for that research provided by Outerwall. The views and analyses expressed here are solely those of the author.

\$130.1 million to produce and ship new pennies with a combined face value of \$93.7 million and \$109.7 million to produce and ship new nickels with a face value of \$80 million. At 2015 metal prices, the production of new pennies resulted in net costs of \$36.4 million, compared to net costs of \$29.7 million for new nickels. As noted, the Federal Reserve buys these new coins at face value from the Mint, and the Treasury pays or pockets the difference between the price paid by the Federal Reserve and the Mint's production costs. Therefore, the production of new pennies and nickels in 2015 involved merely transfers of \$36.4 million and \$29.7 million, respectively, in net costs for the Mint to net gains for the Federal Reserve. Moreover, as we will see, shifting the production of new pennies to new nickels of comparable face value would also produce net losses.

Since pennies and nickels, along with dimes and quarters, are purely mediums of exchange, a coin's economic value is based not on its production costs, but on its face value times the number of times it is used or turns over, relative to its costs of production and distribution. An average coin lasts 25 years, until it is withdrawn from circulation due to wear and tear. There are no studies of how often an average penny is used, so we estimated the average turnover of a penny using data on cash transactions, the change that consumers use or receive, and the number of pennies in active circulation. On that basis, we estimate that an average penny is used in cash transactions 2.18 times per year, or 54.5 times over its useful life. A penny's economic value over its lifespan, therefore, is \$0.55, compared to the \$0.014 it cost in 2015 to produce a new penny. Adjusting for inflation over the last 25 years, the economic value of a penny as a medium of exchange is \$0.303, compared to its inflation-adjusted production cost of less than eight-tenths of one cent (\$0.0077).

The costs to produce new coins are determined in part by global commodity metal prices. In 2010, Congress directed the Mint to assess how changes in the metal composition of U.S. coins could reduce those production costs. The Mint concluded that there were no alternative metal compositions that would reduce the penny's production costs while preserving its usefulness as a medium of exchange based on criteria such as hardness, recyclability, toxicity, "wear and tear" and its usability in coin-operated technologies. The Mint further found that only one alternative met those criteria for nickels, dimes and quarters: an 80/20 copper/nickel composition. The Mint also found that the annual net savings from adopting the new composition would be very small: \$3.2 million for nickels, \$800,000 for dimes and \$1.3 million for quarters.

Global metal commodity prices fluctuate. Since eliminating the penny would make the nickel the smallest U.S. coin, we also estimated the costs of shifting from pennies to nickels using the lowest, average and highest metal prices from the last decade. Assuming the Mint would replace new pennies with increased production of new nickels with the same combined face value, we estimate that this shift would produce net losses for the government, ranging from \$1.3 million (at the lowest metal prices) to \$25.1 million (at average metal prices) to \$54.4 million (at the highest metal prices). The only way to reduce total production costs would be to shift the production of new pennies to new dimes – but such a shift also would produce shortages of nickels for cash transactions and additional costs for consumers as merchants round cash charges up or down to the nearest nickel or dime.

Eliminating the penny would generate other significant costs. Pennies are the most common and frequently used coin, and they account for the largest share of coins recirculated through the economy by coin-counting services. Eliminating the penny, therefore, could reduce the frequency and volume with which consumers and businesses use those services to recirculate other coins. In 2013, Canada phased out the Canadian penny, and this policy reduced the volume of five- and 10-cent Canadian coins recirculated through coin-counting services by about 35 percent each. It also reduced the recirculation of 25-cent Canadian coins by some 25 percent.

If the United States eliminated the U.S. penny and the same dynamic occurred here, the Mint would have to increase its production of nickels, dimes and quarters in order to maintain the current availability of those coins. The Mint might not have to offset all of the reductions in the coins recirculating through coin-counting services, since businesses and consumers might recirculate some of the “missing” coins by using more coins in their cash transactions. Businesses and consumers also might increase the number of nickels, dimes and quarters recirculated each time they used coin-counting services. To account for these responses, we estimated the costs if 25 percent, 50 percent or 75 percent of the reduced volume of coins processed by coin-counting services were held back from recirculation at any moment and the Mint offset those shortfalls by producing more new nickels, dimes and quarters. At current metal prices, the Mint would have to spend \$77 million to \$230 million per year to offset these reductions. Applying the lowest, average and highest metal prices from the last decade, the Mint would have to spend, respectively, an additional \$60 million to \$181 million per year, \$85 million to \$256 million per year and \$111 million to \$334 million per year, respectively.

Eliminating the penny also would produce large-scale rounding up or rounding down to the nearest nickel in billions of cash transactions. In one prominent study, a researcher examined the pricing of many thousands of consumer transactions involving one, two or three items to determine the distribution of transactions that could be rounded up or down. The author found that 60 percent to 93 percent of those transactions would involve rounding up the final charge to the nearest nickel.² All told, we estimate that this rounding up or down of cash transactions to the nearest nickel would cost consumers \$438 million to \$1.13 billion per year (in 2015 dollars). These costs to consumers could be much larger if, as expected, merchants engage in strategic pricing to ensure that even more transactions would be rounded up.

Rounding charges up or down assumes that we could eliminate the penny from circulation while retaining its use as a pricing unit. However, history suggests that once a coin is withdrawn from circulation, its use in pricing usually declines and finally ends, as seen in the 1980s when Great Britain withdrew its halfpence from circulation. In that case, phasing out the U.S. penny’s use in pricing would impose additional costs on investors in American equity markets. In 1997, U.S. stock markets moved from quoting prices in units of one-eighth of a dollar to units of one-sixteenth of a dollar; and in 2001, the Securities and Exchange Commission (SEC) directed all U.S. exchanges to adopt “decimalization” and quote all stock prices in pennies. Numerous researchers studied the effects and found that this change reduced the spread between the prices sellers ask and the prices buyers bid, thereby lowering investors’ trading costs.³ Based on these studies, we estimate that moving to nickel-based pricing for U.S. stocks

² Lombra (2001).

³ See, for example, Chakravarty, Wood and Van Ness (2004); Fufine (2003); Hillman (2005); Oppenheimer and Sabherwal (2003); Bessembinder and Vankataraman (2010); and Angel, Harris and Spatt (2013).

would increase the trading costs borne by American retail investors by at least \$410 million per year.

All told, we found that eliminating the penny could cost between \$909 million and \$1.93 billion per year: \$1.3 million to \$54.4 million to produce additional nickels to replace the face value of pennies, depending on metal commodity prices; \$60 million to \$334 million to produce the additional nickels, dimes and quarters required to maintain current levels of recirculating coins, depending on metal commodity prices; \$438 million to \$1.13 billion per year for the net rounding up of consumer charges to the nearest nickel; and \$410 million per year in additional transaction costs for retail investors.

Finally, the most reliable economic evidence for the value of the penny as a medium of exchange comes from how American consumers and businesses use the coin every day. Based on actual demand, the Mint produced 103 billion new pennies over the last 15 years, or 56.7 percent of all new U.S. coins. Given the steady production of an average of 6.87 billion new pennies per year from 2001 to 2015, pennies also account for a majority of recirculating used coins, and therefore for a majority of all U.S. coins in circulation. This evidence refutes any claim that pennies are “worthless” or “more trouble than they’re worth” and demonstrates that American consumers and businesses value the penny and the ability to conduct their exchanges in pennies.

II. Background: The Character of American Money

Economists and governments have long debated the character of money and national currencies, and whether coins and notes are stores of value or simply mediums of exchange. In the 18th and 19th centuries, this debate involved not only the character of coins and notes, but also the nature of economic value itself: is the value of a good or service determined by the costs of its inputs and production, or do markets determine value? This larger debate continues today, but the character of money is more settled. Since gold and silver coinage ended in the 19th century and governments stopped backing up currency with precious metals in the 20th century, coins and paper money have been recognized as purely mediums of exchange, rather than repositories of value. So today, American coins and the dollar are backed by the full faith and credit of the United States government, and nothing else.

As this brief summary suggests, precious metals comprised or backed up U.S. coins and notes for many years. The Coinage Act of 1792 created the U.S. Mint and the legal requirement that every U.S. dollar coin contain 371.25 grains of silver.⁴ The Coinage Act also set the value of gold at 15 times the value of silver; the \$10 eagle coin, for example, had to contain 24.75 grains of gold.⁵ Coins of lower denominations, including the half dollar, quarter dollar, dime and half dime, contained the amount of silver corresponding to their face values under the Coinage Act. Similarly, the cent and half-cent coins contained 11 pennyweights of copper and 5.5 pennyweights of copper, respectively. In most cases, the government claimed “seigniorage,” a profit based on the face value of the coins compared to the costs to produce them.

⁴ U.S. Congress (1792).

⁵ $371.25 \times 10 = 3712.5 / 15 = 247.5$

For the first 75 years of the United States, private banks and the Bank of the United States issued paper currency. By law, these notes could be converted to gold or silver at an exchange rate of 371.25 grains of silver or 247.5 grains of gold for each U.S. dollar. In practice, people could convert their bank notes to gold or silver only at designated places, such as the bank that issued the note, and most banks hired agents to distribute their “dollars” in remote places that made redemptions unlikely. In 1862, Congress formally designated the U.S. dollar as legal tender in the United States for all debts, to meet financing pressures from the Civil War. This move meant that lenders would no longer demand gold or silver, and that the first U.S. paper money issued in 1862 was not backed up or convertible to gold or silver. After the Civil War, Congress returned the United States to coins and notes composed of or backed by precious metals, and the millions of greenbacks issued to help finance the war were withdrawn gradually.⁶

The United States remained on a gold standard for the next 55 years, with full currency convertibility or exchangeability, and all coins above the five-cent piece contained the requisite silver. Over much of this period, the banking system was subject to periodic bank runs. In 1913, Congress created the Federal Reserve System to serve as a lender of last resort to banks during such runs, and to issue Federal Reserve notes as the currency of the United States.⁷ These notes remained redeemable for gold until 1933, when President Roosevelt suspended the gold convertibility of American currency by private individuals or entities. For the next 40 years, the United States remained on this “quasi-gold standard” under which the value of gold was pegged to the dollar, but no person or firm could exchange U.S. dollars for gold.⁸ In practice, U.S. paper currency lost any character as a store of value and became purely a medium of exchange.

The 1933 measures did not address the dollar’s convertibility to gold by governments, but the 1944 Bretton Woods Agreement recognized the right of foreign governments to convert dollars to gold at a fixed exchange rate. For 28 years, the Federal Reserve used gold sales and purchases to maintain the established exchange rate or peg. As the rest of the world recovered from World War II over those decades, however, the official price of gold became increasingly expensive to maintain. Finally, President Richard Nixon halted dollar-gold convertibility by foreign governments in 1972, ending the last vestigial role of precious metals in the U.S. currency system.

III. Measuring the Costs and Value of Coins in a Modern Currency System

Since the supply of new U.S. coins and notes is no longer determined in any way by the government’s stores of gold and silver, supply decisions fall to the Federal Reserve System and the U.S. Mint. The Federal Reserve analyzes the demand for paper bills and submits those estimates as print orders to the Bureau of Engraving and Printing.⁹ The U.S. Mint determines the supply of new coins based on 12-month forecasts from the Federal Reserve, economic indicators and seasonal trends that affect coin demand. The Mint then produces the coins at facilities in Philadelphia and Denver, and the Federal Reserve purchases them at face value and distributes

⁶ Elwell (2011).

⁷ *Ibid.*

⁸ *Ibid.*

⁹ Federal Reserve Bank of San Francisco (2013).

them to its 12 regional banks. The Federal Reserve’s regional banks then circulate the coins to financial depository institutions (banks and thrifts).¹⁰

Most businesses that use substantial amounts of coins and paper currency in their daily operations depend on banks and thrifts, which provide circulating coins and notes for their customers and accept their excess coins and notes. When financial institutions need more coins or currency, they can order them from a regional Federal Reserve Bank; similarly, when these institutions hold excess coins or notes, they can deposit their excess inventory at a regional Federal Reserve Bank. These regional banks check every coin and note for counterfeits and excessive wear and tear, and authentic coins and notes fit for use are returned through the orders from financial institutions. Badly worn coins and notes are deemed “uncurrent,” shipped to the Mint and replaced with new coins and notes.¹¹ In 2015, the Federal Reserve’s regional banks circulated 16.2 billion new coins and recirculated 55.2 billion coins, for a total of 71.4 billion coins. The regional banks also collected 55.9 billion coins in 2015 from sources such as banks, thrifts and coin-counting services; based on a 25-year average lifespan of coins, some 1.68 billion of these coins were deemed “uncurrent” and withdrawn from circulation.¹²

These arrangements represent only part of a larger system for the circulation and recirculation of U.S. coins. The Federal Reserve also authorizes more than 175 “sanctioned coin terminals” operated by armored vehicle carrier companies to receive and process orders for coins from financial institutions and receive coins from independent coin-counting services. The firms that operate the coin terminals also transport the coins, lowering recirculating costs. In a given year, some 60 percent of coins handled by the Federal Reserve have been held in coin terminals.¹³

As suggested above, the independent coin-counting industry plays a critical role in recirculating coins through the U.S. economy. For a small fee, coin-counting services separate and count a customer’s change and provide a cash voucher or gift card in exchange for the coins. For many years, coin-counting companies have been responsible for recirculating more coins than the Mint issues in any given year. Moreover, coin-counting services are responsible for a majority of the coins recirculated every year through the Federal Reserve. The leading firm in the industry (Coinstar) processed and returned for recirculation 37 billion coins with a face value of \$2.55 billion in 2015, while the Mint circulated 16.2 billion coins worth \$1.1 billion. The coins recirculated by the largest coin-counting company in 2015, therefore, accounted for 66.2 percent of the 55.9 billion non-new coins that the Federal Reserve’s regional banks received in that year from all sources, and for 47.2 percent of their \$5.4 billion combined face value (Figure 1, below). As noted previously, the Federal Reserve also circulated 16.2 billion new coins in 2015, so the leading coin-counting company accounted for 51.3 percent of all coins, new and old, received by the Federal Reserve for circulation to the U.S. economy in that year.

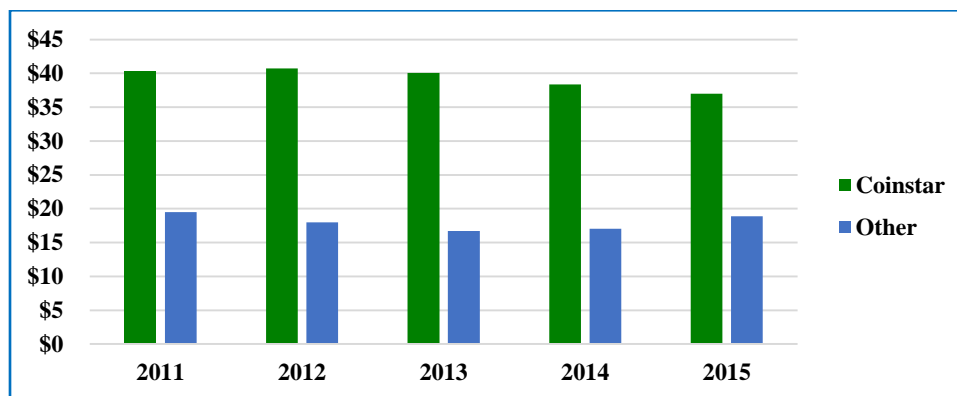
**Figure 1: The Volume of Non-New Coins Received and Recirculated
By the Federal Reserve from Coin-Counting Services and Others (in billions)**

¹⁰ Board of Governors of the Federal Reserve System (2016).

¹¹ United States Department of Treasury (2016).

¹² Board of Governors of the Federal Reserve System (2016-A).

¹³ U.S. Government Accountability Office (2008).



These arrangements for recirculating U.S. coins sharply reduce the need to produce new coins. Coins that otherwise might have remained stored in boxes and jars gain additional useful life through the exchanges conducted by independent coin-counting companies. More generally, the coins recirculated by those companies, as well as by financial institutions and the Federal Reserve, preclude the need for the Mint to produce more new coins. Some of the coins processed by coin-counting services would make their way back into circulation without those services, and some of the coins processed by them, once transferred to the Federal Reserve, are worn too badly to remain in circulation. Nevertheless, along with the Federal Reserve, independent coin-counting services have come to play a dominant role in the American economy's system for circulating cash. It is, as the president of the Royal Canadian Mint recently described it, "a cost-effective and efficient way to provide coins to the marketplace."¹⁴

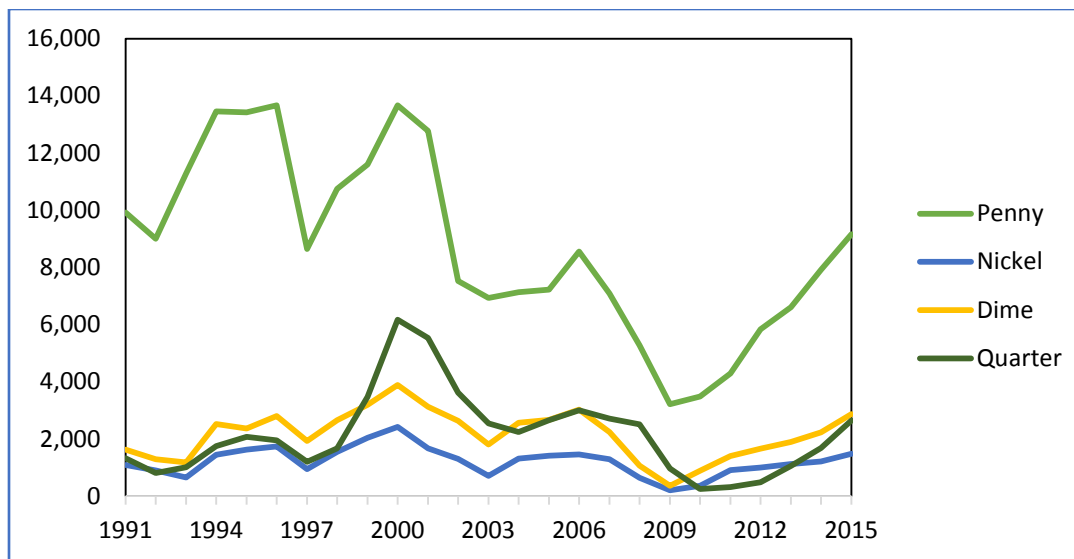
The Government's Costs to Produce New Coins

In 2015, the U.S. Mint produced nearly 17 billion new coins, including 9.4 billion pennies, 1.6 billion nickels, 3 billion dimes and 2.9 billion quarters, most of which were put into circulation through the Federal Reserve (Figure 2, below). The Mint also produced three other coins for circulation that have much lower consumer demand – 4.6 million half dollars, 5 million Native American dollars, and 40.3 million presidential dollars.

Figure 2: New Coins Introduced into Circulation, 1991-2015 (in millions)¹⁵

¹⁴ Aquino, Christine (2007).

¹⁵ U.S. Mint (2016).



Over the past 25 years, the production of each of the four common U.S. coins has risen and fallen based on fluctuating demand. In 1991, for instance, the Mint circulated 9.9 billion new pennies, 1.1 billion new nickels, 1.6 billion new dimes and 1.3 billion new quarters. By 2000, the Mint had increased the production and circulation of new pennies by some 38 percent to 13.7 billion, while the number of new nickels rose 118 percent to 2.4 billion; the number of new dimes more than doubled to 3.9 billion; and the number of new quarters increased nearly five-fold to 6.2 billion. By 2015, the number of new coins circulated had fallen to 9.2 billion pennies, 1.5 billion nickels, 2.9 billion dimes and 2.6 billion quarters. The Mint also produces gold, silver and platinum bullion coins for investors, which are not circulating tender, as well as specialty products for collectors such as commemorative coins and medals.¹⁶

In recent years, the government's costs to produce and distribute new pennies and nickels have exceeded their face values, while the costs to produce and distribute new dimes and quarters have remained less than their face values. In 2015, it cost the U.S. Mint \$130.1 million to produce new pennies with a total face value of \$91.6 million and \$109.7 million to produce new nickels with a total face value of \$73.8 million. The face value of new pennies equaled 70.4 percent of their total cost of production and shipment, and the face value of new nickels equaled 67.2 percent of their total costs. In contrast, the cost of new dimes with a total face value of \$287.3 million came to \$101.6 million, and the cost of new quarters with a total face value of \$661.3 million came to \$223.2 million. Most of these costs represent materials and production (Table 1, below).

Table 1: Numbers and Costs of New Pennies, Nickels, Dimes and Quarters, 2015 (in millions)¹⁷

	Coins	Coins	Face Value	Total Cost	Unit Cost of	Unit Cost of
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¹⁶ *Ibid.* In 2015, the Mint sold more than 1 million ounces of gold bullion coins, 48.7 million ounces of silver bullion coins, and 3 thousand ounces of platinum bullion coins. In that year, the Mint also sold 5.4 million specialty units for collectors, for a total of \$453.2 million and profits of \$66.8 million.

¹⁷ *Ibid.*

	Produced	Circulated			Production	Distribution
Penny	9,365	9,155	\$91.6	\$130.1	\$0.0140	\$0.0003
Nickel	1,600	1,477	\$73.8	\$109.7	\$0.0732	\$0.0012
Dime	3,041	2,874	\$287.3	\$101.6	\$0.0348	\$0.0006
Quarter	2,991	2,645	\$661.3	\$223.2	\$0.0831	\$0.0013

The gaps between the face value and the costs of producing coins recall traditional notions of “seigniorage,” under which governments secured “gains” when the face value of a coin exceeded the value of its precious metal content and “losses” when a coin’s precious metal content was worth more than its face value. In those antiquated terms, the current gaps imply that the U.S. government “loses” \$0.0043 per penny and \$0.0244 per nickel and “gains” \$0.0654 per dime and \$0.1669 per quarter. In practice, the Federal Reserve buys the new coins at their face value from the Mint and circulates them, and the Treasury Department pays or pockets the difference between the price the Federal Reserve pays for the coins and the costs the Mint bears to produce them. So, the cost and price differences for pennies and nickels do not represent seigniorage “losses” for the Mint and seigniorage “gains” for the Federal Reserve; nor do the costs and price differences for dimes and quarters represent seigniorage “gains” for the Mint and “losses” for the Federal Reserve. Rather, in modern currency systems, here and in every country in the world, these gains and losses are simply matters of government transfers and accounting. As such, they demonstrate that a seigniorage-based perspective focused on the costs to produce a coin compared to its face value is irrelevant to issues involving modern coins and notes.

The Value Proposition of U.S. Coins as Mediums of Exchange

U.S. coins, properly understood, are purely mediums of exchange. As such, their economic value is based not on the ratio of their face values to their costs of production and circulation, but rather on their face values times the number of times each coin is used, relative to their costs of production and distribution. Coins circulate between consumers and retailers, and coin-counting services and other institutions with excess coins return them to a regional Federal Reserve Bank or sanctioned coin terminal, which then recirculates them to financial institutions or, if they’re badly damaged, returns them to the Mint. Each time a coin is used, it offsets the need for a new coin; and as noted previously, U.S. coins are used for an average of about 25 years before being melted down.¹⁸ At the same time, the Mint has to produce large numbers of new coins every year, because the economy grows larger, and because substantial percentages of all “circulating” coins at any given time are held in Federal Reserve regional banks and commercial banks, as well as in private caches in households and business establishments, and are thus unavailable for cash transactions.

The economic value of a penny as a medium of exchange depends on how many times it is used in cash transactions over the coin’s lifespan. There are no economic studies on how many times each year an average coin is used – or, in economic terms, the “monetary velocity” of coins. However, we can estimate the number of times an average penny is used by dividing the total number of pennies spent in cash transactions over one year by the number of pennies in

¹⁸ U.S. Mint (2016)

active circulation, multiplied by the average penny's lifespan of 25 years. The Federal Reserve reports that in 2012, consumers participated in 122.4 billion non-cash transactions (paying by credit card, debit card, checks and electronic transfers),¹⁹ and that cash transactions accounted for 40 percent of all transactions.²⁰ Therefore, there were 204 billion consumer transactions in 2012, including 81.6 billion cash transactions.²¹ In any given cash transaction, consumers could use or receive in change zero pennies, one penny, two pennies, three pennies or four pennies; therefore, the average cash transaction involves two pennies. Consequently, we estimate that the 81.6 billion cash transactions in 2012 involved the exchange of 163.2 billion pennies.

As noted above, a majority of pennies and other coins at any given time are held by Federal Reserve regional banks, commercial banks and thrifts, sanctioned coin terminals, cash-counting services and the private caches of individuals and businesses. The Director of the U.S. Mint estimated in 1999 that just one-third of all pennies in use at that time were in active circulation at any moment.²² The Mint produced 224.7 billion pennies in the 25 years leading up to 2012,²³ and based on the Director's estimate, we calculate that at any given time in 2012, 74.9 billion pennies were in active circulation. Since we found that cash transactions in 2012 involved the exchange of 163.2 billion pennies, we can estimate that the average penny in circulation in 2012 was used 2.18 times in that year, and 54.5 times over its useful lifespan. The economic value of an average penny as a medium of exchange, therefore, is about \$0.55, or more than 38 times the current cost to produce and distribute a penny. Adjusting for inflation over 25 years (1990-2015), the economic value of each penny produced by the U.S. Mint, as a medium of exchange, is \$0.303, compared to its inflation-adjusted production and distribution costs in 1990 of less than eight-tenths of one cent (\$0.0077).

Contrary to a seigniorage framework, this analysis, based on the current character of coins as mediums of exchange, shows that the U.S. economy gains substantially from the production of pennies and all other common coins. Table 2, below, presents these calculations for the penny, again assuming 2.18 turnovers per year and a 25-year lifespan.

Table 2: The Economic Value of the U.S. Penny as a Medium of Exchange Over 25 Years

	Total Cost Per Unit	Value in Use Over 25 Years Per Unit	Value Per Unit Adjusted for Inflation	Cost Per Unit Adjusted for Inflation
Penny	\$0.0143	\$0.55	\$0.30	\$0.0077

The 25-year useful lifespan of U.S. coins also produces large savings for the U.S. government and economy, compared to the roughly six-year useful lifespan of a U.S. one-dollar bill. If coins had the durability of the one-dollar bill, the Mint would have to replace each coin more than four times over 25 years. Using the production costs of new coins in 2015, we can

¹⁹ Gerdes, Liu, Berkenpas, Chen *et al.* (2013).

²⁰ Bennett, Conover, O'Brien, and Advincula (2014).

²¹ This is consistent with an academic estimate of between 54 billion and 88 billion cash transactions in 2000. Lombra, Raymond (2007).

²² Tierney, John (1999).

²³ The public data on penny production begin in 1990, so we impute penny production in 1989 and 1988 based on the average from 1990 to 2012.

calculate the savings derived from the 25-year useful lifespan of coins, compared to the costs if each coin had the six-year useful lifespan of the U.S. dollar. Table 3, below, presents those calculations.

Table 3: Savings from the 25-Year Useful Lifespan of U.S. Coins, Compared to the Six-Year Useful Lifespan of U.S. Paper Currency

	Number of Coins over 25 Years (billions)	Total Costs Over 25 Years (millions)	Costs Over 25 Years if Coins Lasted Six Years (millions)	Savings Over 25 Years (billions)	Annual Savings (millions)
Penny	224.72	\$3,146.10	\$13,330.95	\$10,184.85	\$407.39
Nickel	30.57	\$2,237.97	\$9,482.93	\$7,244.96	\$289.80
Dime	53.11	\$1,848.32	\$7,831.84	\$5,983.53	\$239.34
Quarter	54.18	\$4,501.98	\$19,076.18	\$14,574.20	\$582.97

As noted above, in 2015 it cost the U.S. Mint \$130.1 million to produce and distribute new pennies, \$109.7 million to produce and distribute new nickels, \$101.6 million to produce and distribute new dimes and \$223.2 million to produce and distribute new quarters. Therefore, the annual production and distribution savings from the 25-year useful lifespan of pennies, compared to the six-year useful lifespan of paper currency, is \$407.4 million, or 3.1 times the cost to produce and distribute all new pennies in 2015. The ratios for the three other common coins are somewhat smaller. The annual savings from the long useful lifespan of nickels is \$289.8 million, nearly 2.6 times the cost of new nickels in 2015; the annual savings for dimes is \$239.3 million, or 2.4 times the cost to produce dimes in 2015; and the annual savings for quarters is \$583 million, or 2.6 times the cost to produce new quarters in 2015.

This analysis is consistent with studies by the Congressional Budget Office (CBO), the General Accountability Office (GAO) and the Federal Reserve on the potential savings from shifting from the dollar note to a dollar coin.²⁴ All three studies concluded that the longevity of coins produced large savings. Our turnover analyses and the government studies also all establish that seigniorage is an outdated metric for measuring the value of and gains or losses from producing and using modern forms of money that are not stores of value but purely mediums of exchange.

IV. The Debate Over the Metal Composition of U.S. Coins

Total coin production costs are based on metal prices, production costs, overhead costs and production volume. In 2010, Congress enacted the “Coin Modernization, Oversight, and Continuity Act,” which directed the U.S. Mint to evaluate the costs to produce U.S. coins, based

²⁴ The three government studies produced varying conclusions, based on differing assumptions. The GAO and CBO analyses concluded that shifting to a one-dollar coin would produce significant savings, while the Federal Reserve study took a broader view of economic costs and found that shifting to a dollar coin could increase costs to the economy. See Blum, James (2011); Lambert, Ferrar, and Wajert (2013); and U.S. Government Accountability Office (2014).

on commodity metal prices and the costs and benefits of shifting to alternative metals.²⁵ Currently, the penny is composed of 97.5 percent zinc and 2.5 percent copper, while the nickel is composed of 75 percent copper and 25 percent nickel; the dime and quarter are both clad coins that contain about 92 percent copper and 8 percent nickel. In response to the 2010 Act, the Mint established first that there is no alternative metal composition that would significantly reduce the costs of producing the penny while preserving its usefulness as a medium of exchange. The Mint also considered 29 different metal compositions for nickels, dimes and quarters (Phase I) and identified six of these new metal compositions for further analysis (Phase II). The new metal compositions for Phase II tests were evaluated on various criteria including hardness, conductivity, recyclability, toxicity, ability to handle “wear and tear” and ability to be used efficiently by coin sorters.²⁶

The Mint found that six new metal compositions could reduce the costs of producing dimes, nickels and quarters, but that none of them represented practical alternatives. Only one of the tested new compositions, the 80/20 copper-nickel alternative, was found to be a “seamless material” that would have little impact on industries that rely on coin-operated technologies, such as vending machines. The other five new compositions were “co-circulate materials,” which, while possibly suitable as circulating mediums of exchange, had different weights and/or electromagnetic signatures (EMS) from current coins. As such, they could not be used in currently configured coin-operated equipment that validates the unique weight and EMS of coins to determine whether they are authentic or counterfeit. (The Mint estimated that shifting to the co-circulate materials would cost industries that rely on coin-accepting technologies \$2.4 billion to \$6 billion.)²⁷ Finally, the Mint found that the only seamless alternative would produce very small annual production savings of just \$3.2 million for nickels, less than \$800,000 for dimes and less than \$1.3 million for quarters. In 2015, the GAO published a report that raised some questions about the Mint’s estimates. The GAO noted that all vending machines might not have to be updated if only the metal composition of nickels and dimes changed, and questioned the Mint’s estimates of the number of coin-operated technologies. The GAO did not dispute the small savings from changing the composition of the coins to the only seamless alternative.²⁸

The Impact of Commodity Prices on the Costs of Producing U.S. Coins

Given the Mint’s findings, it seems certain that the metal composition of the penny will not change and highly unlikely that the composition of the other three common coins will change. Nevertheless, a number of commentators continue to argue that continuation of the penny, given its composition, imposes unacceptable costs on U.S. taxpayers. In practice, the costs to produce the penny and the three other common coins fluctuate substantially, based primarily on the prices of metals set by global commodity markets.

²⁵ U.S. Mint (2014), Appendix A.

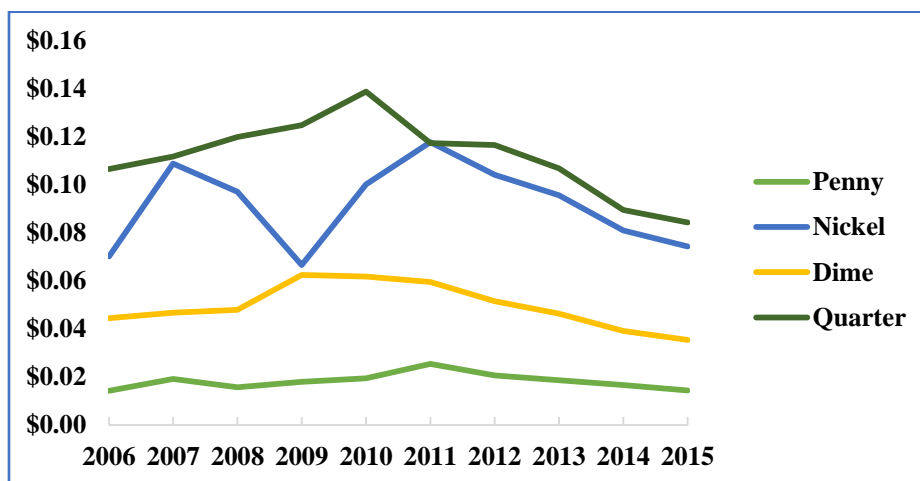
²⁶ *Ibid.*

²⁷ The Mint further found that two of the co-circulate materials failed other Phase II tests. The remaining three co-circulate materials (nickel-plated steel, multi-ply plated steel and stainless steel) produced annual savings equal to less than one percent of the costs to industries using coin-based technologies. *Ibid.*

²⁸ U.S. Government Accountability Office (2015).

The cost of producing a penny has varied from about \$0.014 per unit in 2006 to \$0.025 per unit in 2011. However, a decision to phase out the use of pennies would also involve increased production of nickels, and the cost to produce nickels has varied from \$0.067 in 2009 to \$0.118 in 2011 (Figure 3, below). Meanwhile, the cost of producing the dime has varied from \$0.062 in 2009 to \$0.035 in 2015, and the cost of producing the quarter has varied from \$0.139 in 2010 to \$0.084 in 2015. Based on production costs, therefore, the approach used by critics of the penny implies that the United States should abandon both nickels and pennies and move to cash transactions based solely on dimes, quarters and paper currency.

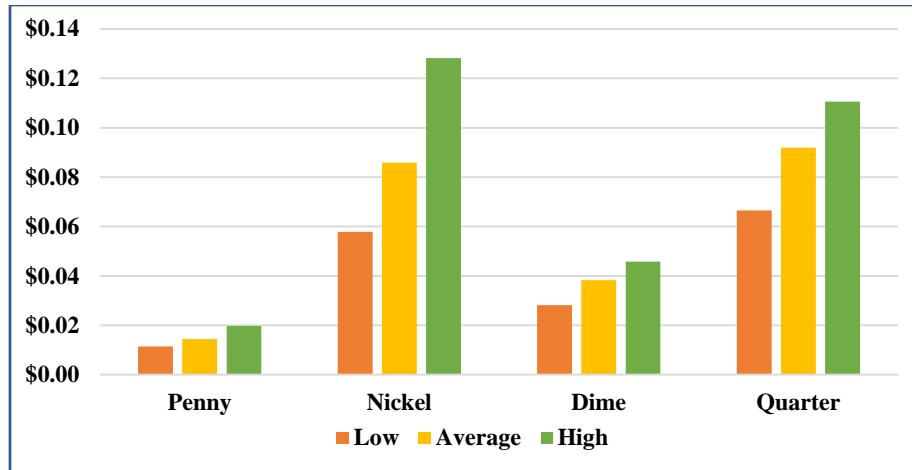
Figure 3: Unit Costs to Produce Common U.S. Coins, 2006-2015



If we consider proposals to eliminate only the penny, that change also would impose substantial costs on the government and the economy. For example, the production of nickels, and perhaps dimes and quarters as well, would have to increase, and the cost of cash transactions would have to be set or rounded up or down to the nearest nickel. To evaluate these costs, we begin with the rising and falling of global commodity prices for the metals used to produce U.S. coins. (The costs to produce and distribute U.S. coins, apart from the prices of their constituent metals, are unlikely to change significantly in the foreseeable future.) Figure 4, below, graphs the costs to produce the four common U.S. coins based on the lowest, average and highest commodity prices for the metals comprising those coins over the last 10 years.

Figure 4: Lowest, Average and Highest Unit Costs to Produce U.S. Coins, Based on Global Commodity Metal Prices, 2006-2015²⁹

²⁹ The World Bank (2016); and U.S. Mint (2016).



Based on the lowest, average and highest metal prices over the last decade, and assuming that other production and distribution costs remain the same as in 2015, the cost to produce a penny in the future would range from \$0.011 (lowest) to \$0.014 (average) to \$0.02 (highest), a range of 81.8 percent. The cost to produce the nickel in the future would range from \$0.058 (lowest) to \$0.085 (average) to \$0.128 (highest), a range of 120.7 percent. Dimes and quarters have the same metal composition, so their ranges are comparable: the cost to produce a dime in the future would range from \$0.028 (lowest) to \$0.038 (average) to \$0.046 (highest), or a range of 64.3 percent, while the cost to produce a quarter in the future would range from \$0.066 (lowest) to \$0.092 (average) to \$0.111 (highest), or a range of 68.2 percent.

Based on these ranges, the production costs for new coins can and do vary substantially. Using the quantity of new pennies, nickels, dimes and quarters produced in 2015, the costs to produce pennies in the future could range from \$107 million to \$184.5 million (Table 4, below). Similarly, the costs to produce new nickels in the future could range from \$92.5 million to \$205.1 million. As expected, the range is less for producing new dimes and quarters in the future, from \$85.6 million to \$139.3 million for dimes, and from \$198.9 million to \$330.7 million for quarters.

Table 4: Range of Total Production Costs for New Coins, Based on Varying Global Metal Commodity Prices and 2015 Production Levels (in millions)³⁰

Penny	<i>Lowest</i>	\$106.96
	<i>Average</i>	\$135.17
	<i>Highest</i>	\$184.52
Nickel	<i>Lowest</i>	\$92.51
	<i>Average</i>	\$137.34
	<i>Highest</i>	\$205.12

³⁰ The World Bank (2016); and U.S. Mint (2016).

Dime	<i>Lowest</i>	\$85.62
	<i>Average</i>	\$116.55
	<i>Highest</i>	\$139.25
Quarter	<i>Lowest</i>	\$198.85
	<i>Average</i>	\$274.91
	<i>Highest</i>	\$330.72

The Net Costs and Savings of Eliminating the Penny, Based on Metal Prices

As noted above, commentators who call for elimination of the penny, writing in outlets from the *Wall Street Journal* to the website *Slate*, argue that since the Treasury “loses” money on producing pennies, the government should eliminate the coin.³¹ To begin, eliminating the penny, as noted earlier, will require increased production costs for other coins, especially nickels. To analyze the net costs, we begin with 2015 commodity metal prices and the coin’s production costs. In 2015, the Mint produced 91,550,000,000 pennies with a combined face value of \$91.55 million. If the Mint eliminated new pennies and replaced their combined face value with nickels – an additional 1,831,000,000 nickels with a combined face value of \$91.55 million – it would save \$130.92 million in penny production costs but cost an additional \$136.23 million in expanded nickel production costs. This shift, therefore, would produce a *net loss* of \$5.31 million (Table 5, below).

To generate a net gain while eliminating the penny, the Mint would have to shift production of pennies to dimes. The production of an additional 915,500,000 dimes with a total face value of \$91.55 million would save \$130.92 million in penny production costs, while the production of the additional dimes would cost \$32.41 million, resulting in a net gain of \$98.5 million. However, this shift also would lead to a shortage of nickels for change in cash transactions, forcing the Mint to produce more nickels at an additional cost, and imposing significant consumer costs from rounding up to the nearest dime.

**Table 5: Annual Costs or Savings from Eliminating the Penny,
Based on 2015 Production Costs³²**

	Value	Nickels	Dimes	Total Cost	Savings
Shift to Nickels	\$91,550,000	1,831,000,000	-	\$136,226,400	-\$5,309,900
Shift to Dimes	\$91,550,000	-	915,500,000	\$32,408,700	\$98,507,800

We also applied the lowest, average and highest metal prices over the last decade to the analysis of the costs of eliminating the penny. Under a scenario in which the production of

³¹ McGinty (2014); and Yglesias (2012).

³² *Ibid.*

pennies is replaced by increased production of nickels with the same combined face value, the net costs range from \$1.3 million at the lowest metal prices, to \$25.1 million at average metal prices and \$54.4 million at the highest metal prices (Table 6 below). In short, all reasonable scenarios for replacing pennies with nickels would cost the Mint more than it would to retain the penny. Again, the only way to save production costs would be to shift the total face value of all new pennies to new dimes. The net gains in that case would range from \$78.8 million (at the lowest metal prices) to \$97 million (at average metal prices) and \$138.5 million (at the highest metal prices). However, as noted above, a shift from pennies to dimes would produce a nickel shortage for cash transactions and substantial consumer costs from rounding up or down to the nearest dime.

**Table 6: Annual Costs or Savings from Eliminating the Penny,
Based on Lowest, Average and Highest Metal Commodity Prices, 2006-2015³³**

	2015 Prices	Highest Prices	Lowest Prices	Average Prices
Shift to Nickels	-\$5,309,900	-\$54,424,393	-\$1,329,662	-\$25,072,705
Shift to Dimes	\$98,507,800	\$138,450,250	\$78,786,302	\$97,046,602

V. The Impact of Eliminating the Penny on Coin Recirculation through the Economy

The analysis above does not consider how the elimination of the penny would affect the rate at which nickels, dimes and quarters recirculate through the economy. As noted earlier, coin-counting services play a major role in the recirculation of U.S. coins. Coins channeled through the leading coin-counting service alone account for nearly two-thirds of all non-new coins and more than half of all coins, new and old, circulated and recirculated by the Federal Reserve System. Measures that adversely affect these arrangements for the recirculation of coins through the U.S. economy would also generate additional costs, by requiring the minting of more new coins.

The elimination of pennies would almost certainly impair the current system for recirculating coins through its impact on coin-counting services. As the most common U.S. coin, pennies account for the largest share of the coins recirculated through independent coin-counting companies. Consider the individuals and businesses that use coin-counting services to carry out exchanges when their receptacles for spare coins reach a certain level. Since that process is driven by pennies as the most common coin, withdrawing the penny from circulation would likely reduce the frequency with which individuals and businesses recirculate their coins through coin-counting services, which in turn would reduce the volume of coins recirculating through the cash economy.

The potential dimensions of this effect were demonstrated when the Royal Canadian Mint ended production of the Canadian penny in 2013 and began the process of removing them from the economy. As expected, the volume of coins handled by independent coin-counting services fell substantially, including the volume of nickels, dimes and quarters, as well as pennies. Based on the Canadian experience, the elimination of the U.S. penny could reduce the volume of

³³ The World Bank (2016); U.S. Mint (2016).

nickels and dimes recirculated through coin-counting services by 35 percent each, and the volume of quarters handled by those services by 25 percent.³⁴ To maintain the current availability of coins, such large reductions in the coins recirculated through coin-counting arrangements would have to be offset by increased coin production by the Mint.

The Mint would not have to offset all of the coins held back if the penny were eliminated and people and businesses turned in their accumulated change less frequently. Some of those “missing” coins would be used in other cash transactions, and the volume of nickels, dimes and quarters returned in each less-frequent coin-counting exercise would likely increase. On balance, however, eliminating the penny would increase the volume of coins held back at any given time and hence make them unavailable for recirculation; and ultimately, the Mint would have to respond to these implied shortages of nickels, dimes and quarters. Table 7, below, presents estimates of the volume of nickels, dimes and quarters held back from circulation by a slowdown in coin-counting associated with the elimination of the penny. These estimates are based on the impact of the elimination of the Canadian penny on the volume of other coins handled by independent coin-counting services, and the assumption that 75 percent, 50 percent or 25 percent of these reduced volumes of coins are held back from circulation at any given moment.

Table 7: Estimated Number of Nickels, Dimes and Quarters Held Back from Circulation By a Slowdown in Coin-Counting Arising from the Elimination of the U.S. Penny (in millions)

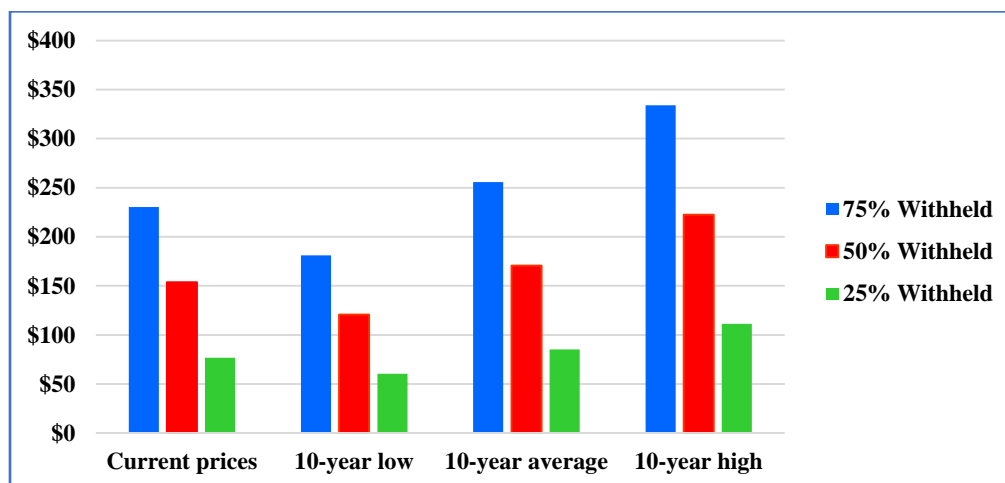
	Coins Recirculated by Coinstar, 2015	Number of Coins “Missing” from Circulation		
		75% Withheld	50% Withheld	25% Withheld
Nickels	4,079.9	1,071.0	714.0	357.0
Dimes	6,146.3	1,613.4	1,075.6	537.8
Quarters	5,916.7	1,109.4	739.6	369.8
Total	16,142.9	3,256.0	2,529.2	1,264.6

This analysis shows that eliminating the U.S. penny would likely affect the recirculation of nickels, dimes and quarters through the economy by reducing the use of independent coin-counting services. The estimated reductions in the volume of coins recirculated from coin-counting services to the Federal Reserve and then through to the economy range from 357 million to 1.07 billion nickels, 538 million to 1.61 billion dimes and 370 million to 1.11 billion quarters (Table 7 above).

These substantial reductions in recirculating coins would force the Mint to produce additional coins at additional costs. At current metal prices, the Mint would have to spend \$230 million to produce additional new coins if 75 percent of the reduction in coins recirculated through independent coin-counting services remained out of circulation at any given time. Similarly, the Mint would have to spend \$154 million if 50 percent of this reduced recirculation of coins remained out of circulation and \$77 million if 25 percent of this reduced recirculation of coins remained out of circulation (Figure 5, below). The impact of eliminating the penny on the volume of coins recirculating through the economy, therefore, would impose large additional costs.

³⁴ Coinstar (2015).

Figure 5: Costs for the U.S. Mint to Produce Additional Coins If the Elimination of the Penny Slows the Recirculation of Coins by Reducing the Use of Independent Coin-Counting Services



We also conducted this analysis using the lowest, average and highest global metal commodity prices from the last decade. Table 8, below, depicts the range of costs to produce the additional coins needed if, as expected, the elimination of the penny reduces coin recirculation through the coin-counting industry. For each price point, we present the range of estimated costs for the Mint, based on whether 75 percent, 50 percent or 25 percent of the expected reduction in coin recirculation by coin-counting services remained out of circulation. These costs range from \$60 million (25 percent of the reduced recirculation remains out of circulation, based on the lowest metal prices of the last decade) to \$334 million (75 percent of the reduced recirculation remains out of circulation, based on the highest metal prices of the last decade). There is no scenario in which eliminating the penny produces net savings.

Table 8: Costs to the Mint to Produce Additional Coins to Offset the Impact On Coin Recirculation From the Reduced Use of Coin-Counting Services (in millions)

Share Remaining Out of Recirculation	Commodity Prices for Metals Used to Produce U.S. Coins			
	Current	10-Year Low	10-Year Average	10-Year High
75 Percent	\$230	\$181	\$256	\$334
50 Percent	\$154	\$121	\$171	\$223
25 Percent	\$77	\$60	\$85	\$111

VI. The Costs to Consumers of Rounding Cash Transactions to the Nearest Nickel

When Congressman Jim Kolbe proposed the “Currency Overhaul for an Industrious Nation (COIN) Act” in 2006, it directed not only that the Mint stop producing new pennies, but also that all cash transactions would be rounded up or down to the nearest nickel.³⁵ This approach was also adopted in the program enacted in Canada in 2012. Under The Canadian

³⁵ Zappone (2006).

Economic Action Plan, the Royal Canadian Mint stopped the production and distribution of new pennies on February 4, 2013. While the Canadian penny remained legal tender, merchants were encouraged to round all final cash transactions up or down to the nearest \$0.05.³⁶ This approach was based on the view that Canada could reduce its coin production costs by eliminating new pennies and, since the penny would remain a pricing unit, there would be no negative effects on consumers or the economy. In practice, this approach entails significant, unintended costs.

Congressman Kolbe and the authors of Canada's program were correct in one respect: retaining the penny for pricing purposes while eliminating it from circulation involves large-scale rounding up or rounding down to the nearest nickel on billions of cash transactions. Economists have analyzed the likely distribution of such rounding adjustments, between those rounded up and those rounded down. The leading study examined pricing by a major convenience store chain in 1999 and 2000. Using actual prices, the researcher simulated 1,000, 5,000 and 10,000 different transactions involving purchases of one, two or three items, and found that between 60 percent and 93 percent of those transactions would involve rounding up to the next nickel.³⁷ As a result, the author concluded that the rounding up and rounding down of all cash transactions to the nearest nickel would create additional costs for U.S. consumers totaling \$318 million to \$818 million in 2000, or in 2015 dollars, consumer losses of \$438 million to \$1.13 billion. Even the low estimate of \$438 million is more than three times the total cost of producing all new pennies in 2015 (\$130.1 million) and more than four times the theoretical production savings from eliminating the penny and shifting the equivalent total face value to dimes.³⁸

Moreover, this analysis almost certainly understates the additional costs to American consumers from eliminating the penny, because many firms would engage in strategic pricing to increase their revenues by ensuring that more transactions would be rounded up. Economic theory and evidence establish that firms set prices to maximize their profits, and we should expect that merchants dealing with large volumes of cash transactions would approach the elimination of the penny as an opportunity to do that, especially in high-volume, low-margin industries. For example, gasoline stations often price their products in denominations of fractions of one cent and round up the final charge; one study estimated that gasoline providers earn an additional \$200 million to \$400 million per year from this process.³⁹

These consumer costs from rounding up to the nearest nickel would also fall disproportionately on lower-income households. When Canada eliminated its penny, electronic payments with credit cards, debit cards and checks continued to be denominated in pennies, without rounding to the nearest nickel. A study from the Federal Reserve Bank of San Francisco found that 55 percent of people living in households with annual incomes of less than \$25,000 prefer cash to other forms of payment, compared to 10 percent of those living in households with

³⁶ Royal Canadian Mint (2012).

³⁷ Lombra (2001).

³⁸ One researcher criticized Lombra's study for failing to take account of sales taxes and argued that his own analysis of transactions in seven states with sales taxes found little evidence of net rounding up or rounding down (Whaples 2007). In Lombra's response, he noted that many states, including the ten largest states, do not charge sales tax on food, the most common cash item. Lombra further found that after applying sales taxes of 3 percent, 5 percent and 7 percent, consumers were still subject to a rounding tax (Lombra 2007).

³⁹ Gephard (2015).

annual incomes of more than \$200,000.⁴⁰ The study further found that lower-income people use cash for about 57 percent of their purchases, compared to 33 percent of transactions by high-income people. The cost of rounding up is at most \$0.02 per transaction, but those costs would accumulate much faster among lower-income people least able to afford it.

This dynamic would also disproportionately affect younger people, as they are more likely to use cash for their purchases as well. The San Francisco Federal Reserve Bank study found that 40 percent of people ages 18 to 24 prefer using cash to other payment methods, compared to 25 percent of those ages 55 to 64 and 65 and older. Furthermore, people ages 18 to 24 use cash for about 48 percent of their purchases, compared to 40 percent of the purchases made by people ages 55 to 64 and 36 percent of purchases made by people ages 65 and older.⁴¹

Given these dynamics, it is also likely that some merchants would restrict electronic payments, especially in high-volume, low-margin businesses. Under current law and regulation, merchants can set a \$10 minimum for credit card transactions, but minimums are not permitted for debit card transactions. In practice, many merchants do apply minimums to debit card purchases: a survey by the Federal Reserve Bank of Richmond of 420 merchants across 26 different sectors found that 29 percent of them used debit card minimums.⁴² Since eliminating the penny would increase the potential profits from cash transactions, it also would likely increase merchants' use of restrictions on electronic payments to avoid cash, and thereby reduce the economic benefits associated with such payments.⁴³

VII. The Value of the Penny in the American Economy

Apart from cost issues, advocates of eliminating the penny often claim that the coin is virtually worthless as a unit of exchange. The home page of “Citizens to Retire the Penny,” an organization devoted to “educating the public on the advantages of retiring the penny from general circulation,” is entitled, “What can you buy with a penny?”⁴⁴ The best evidence for the value of the penny as a medium of exchange comes from its actual use. To begin, surveys find that most Americans value the penny. A 2012 poll by the Opinion Research Corporation found that 67 percent of respondents favored keeping the penny in circulation and 66 percent opposed eliminating it and establishing a price rounding system.⁴⁵ These findings echoed those from a 2006 Gallup survey, which also found broad support for the penny especially among lower- and moderate-income Americans: 65 percent of those earning less than \$30,000 per year saw the penny as useful, compared to 44 percent of those earning more than \$75,000 per year.⁴⁶ Since access to electronic forms of payment such as credit and debit cards increases with income, the survey showed that those who depend most on the cash economy also view the penny as most useful and valuable.⁴⁷

⁴⁰ Federal Reserve Bank of San Francisco (2014).

⁴¹ *Ibid.*

⁴² Wang, Schwartz, and Mitchell (2014).

⁴³ Chakravorti, Sujit (2003).

⁴⁴ Citizens to Retire the Penny (2016).

⁴⁵ Americans for Common Cents (2012).

⁴⁶ Gallup Organization (2006).

⁴⁷ The value of pennies also is evident in the practices of many charities. For example, Habitat for Humanity branches throughout the United States use penny drives to raise funds for affordable housing, as do many schools

More compelling evidence for the value of the penny as a medium of exchange comes from how frequently consumers and businesses use the coin. Earlier, we estimated that an average penny is used in cash transactions some 55 times over its lifespan. Furthermore, the U.S. continues to produce billions of new pennies year after year, even as most monetary transactions have migrated to electronic forms. In fact, the Mint produces far more pennies than any other coin. From 2001 to 2015, the Mint produced 6.4 times as many pennies as nickels, 3.4 times as many pennies as dimes and 3.2 times as many pennies as quarters (Table 9, below). As a result, 56.7 percent of all new coins produced by the Mint in this period were pennies, compared to nickels (8.9 percent), dimes (16.8 percent) and quarters (17.7 percent). If businesses and consumers did not find pennies useful, the Mint would not have produced nearly 103 billion of them over the last 15 years.

Table 9: Annual Production of New Coins by the U.S. Mint, 2001-2015 (in millions)

	Penny	Nickel	Dime	Quarter	Penny's Share
2001	12,773	1,668	3,123	5,531	55.3%
2002	7,520	1,302	2,633	3,616	49.9%
2003	6,926	714	1,808	2,550	57.7%
2004	7,130	1,314	2,569	2,242	53.8%
2005	7,220	1,418	2,669	2,656	51.7%
2006	8,553	1,461	3,023	3,007	53.3%
2007	7,084	1,289	2,247	2,711	53.1%
2008	5,272	647	1,070	2,510	55.5%
2009	3,218	207	358	965	67.8%
2010	3,487	359	887	252	69.9%
2011	4,289	914	1,403	323	61.9%
2012	5,835	1,006	1,658	486	64.9%
2013	6,610	1,123	1,901	1,062	61.8%
2014	7,920	1,211	2,233	1,683	60.7%
2015	9,155	1,477	2,874	2,645	56.7%
Total	102,992	16,110	30,456	32,238	56.7%

The Federal Reserve System does not publish comparable data on the distribution of coins, by type of coin, recirculated every year through Federal Reserve regional banks, coin-counting services, sanctioned coin terminals and commercial banks and thrifts. Given the steady production of the penny, averaging 6.87 billion new pennies per year from 2001 to 2015, it is certain that pennies also account for a majority of the coins recirculated, and therefore a majority of all coins in circulation through the U.S. economy at any given time. If American businesses and consumers found pennies to be “worthless” or simply “more trouble than they’re worth,” the penny would gradually decline as a circulating medium of exchange. The evidence, however, refutes that claim and demonstrates that within the U.S. cash economy, consumers and

trying to fund their extracurricular activities (Habitat for Humanity (2012). Similarly, the Leukemia and Lymphoma Society has collected more than \$150 million in pennies (15 billion) through its “Pennies for Patients” campaign (Americans for Common Cents (2016), and Panda International’s efforts to ensure the survival of giant pandas includes a “Pennies 4 Pandas” program to enlist the participation of children (Pandas International 2016).

businesses find value in the U.S. penny and their ability to conduct exchanges in units of a hundredth of a dollar.

A Response to the Latest Call to Phase-Out the Penny

In March 2017, the “Coin Dollar Alliance” a coalition of trade associations and other groups, issued a study claiming that taxpayers could save billions of dollars (over 30 years) by switching from the dollar note to the dollar coin, ending the production of the penny, and changing the metal composition of the nickel.⁴⁸ The authors’ arguments, especially regarding the penny, seem skewed and methodologically flawed. For example, the authors use international comparisons only when it serves their conclusions: They note that other major countries have replaced or supplemented their lowest denomination paper note with a corresponding coin; yet they fail to mention that the same countries continue to use small denomination coins akin to our penny -- from the Euro’s one-cent piece worth about one U.S. penny, and Japan’s one Yen coin worth about nine-tenths of our penny, to China’s one-Fen coin worth one-tenth of the Chinese one-Jiao coin, which in turn is worth about 1.6 U.S. cents. Every major economy continues to find economic value in producing and using small denomination coins.

When the study’s authors turn to the penny, they note that the U.S. Mint increased its production of pennies by 58 percent from 2012 to 2016 and ask, incredulously, “Do you, or anyone you know, want 58% more pennies than four years ago?” The authors know the answer but chose not to share it: The U.S. Mint produces the numbers of pennies, nickels, dimes, quarters and paper notes it does, based on demand from financial institutions tracked by the Federal Reserve.

The study’s most glaring methodological flaws involve its curious treatment of costs and inflation. “It is important to remember,” the authors assert, that “the cost of [producing and distributing] money increases over time, but the value of that money stays constant.” That is simply false. The costs of producing pennies, nickels, dimes and quarters are very sensitive to shifts in the prices of the metals used to produce them; and the price of zinc, the main component of pennies, varied over the last 10 years from a high of \$1.61 per pound to a low of 50.5-cents per pound, and ended June 2017 at \$1.17 per pound.⁴⁹ Despite the regular and substantial fluctuations in zinc prices, the study pumps up its undocumented estimate of \$1 billion in “losses to taxpayers” from producing pennies over the next decade by starting with a per-penny cost of 1.64-cents that reflected high zinc prices, rather than the latest cost reported by the Mint of 1.4-cent. The authors compound that error by assuming that those costs will only go higher, year after year – to be precise, by 3 percent per-year for a decade. In fact, an analysis of the monthly changes in actual spot zinc prices from June 2007 to June 2017 finds that the average monthly change was not an average increase of 0.25 percent (3 percent / 12 months) but an average decline of 0.11 percent.⁵⁰

They further compound their mistakes by ignoring the fact that if the Mint ends penny production, demand will increase for nickels as the smallest denomination coin widely available

⁴⁸ Klein and Hoagland (2017).

⁴⁹ Index Mundi (2017). “Zinc Prices.”

⁵⁰ *Ibid.*

– and so they omit the additional cost of producing more nickels. As we saw, replacing pennies with nickels with the same combined face value – so the Mint would produce one additional nickel for every five pennies it no longer produced – yields a net loss whether we use the low, average or high metal commodity prices of the last decade. The ten-year net cost would range from \$13.3 million (low) to \$250.7 million (average) to \$544.2 million (high). (See Table 6, above)

To be sure, the authors also embrace an option discussed by the Mint to reduce the cost of producing new nickels by changing its metal composition to 80 percent copper and 20 percent nickel alloy.⁵¹ The Mint also noted that this change would produce very marginal gains estimated at \$3.2 million per-year, based on the nickel’s current production levels. However, the authors still fail to acknowledge that their plan require substantial additional costs from increasing the numbers of new nickels produced.

The study also fails to acknowledge or discuss how ending the production of pennies would lead to large-scale rounding-up or rounding-down to the nearest nickel the prices that consumers pay retailers. As noted earlier, researchers have found that retailers already price 60 percent to 93 percent of all goods sold at a penny price-point in the top half of a ten-cent range – that is, at prices ending in 6, 7, 8 or 9-cents. The Coin Dollar Alliance study omits this issue entirely, because the expected rounding-up and rounding-down process would cost U.S. consumers a net \$200 million to \$400 million per-year, most of that borne by lower and moderate-income households. Moreover, if the penny were phased out, “strategic pricing” by retailers would only increase the share of purchases rounded up to the nearest nickel, rather than rounded down, and the consequent costs to consumers.

The study suffers from other conceptual problems. It casts the difference between the cost of producing a penny and its face value as a “seigniorage” loss to taxpayers, when it is a government accounting issue registering as a loss for the Mint and a corresponding gain for the Federal Reserve. The study ignores the penny’s economic value, as a medium of exchange. We calculated that each penny is used an average of some 55 times during its time in circulation; so on an inflation-adjusted basis over 25 years, it costs less than eight-tenths of a cent to produce a penny that provides 30-cents in transactional value as a medium of exchange. Finally, the authors ignore the most basic economic evidence that consumers and businesses demonstrate the value of the penny by using it. The simple fact that Americans use more pennies, per-year, than any other coin is dispositive evidence of its economic value. When people and businesses stop using pennies, we will know that its value as a medium of exchange has ended.

VIII. The Costs to U.S. Investors of Eliminating the Penny as a Pricing Unit

Finally, phasing out the U.S. penny also would have a substantial adverse impact on U.S. financial markets and individual or retail investors. As noted earlier, when Canada recently withdrew its penny from circulation, it preserved the coin’s use as a pricing unit. Some Canadian commentators have urged Ottawa to eliminate the penny from pricing, and historical precedent favors ending a coin’s use in pricing once it is withdrawn from circulation. When the United States withdrew the half cent from circulation in 1857, U.S. prices moved quickly to a penny

⁵¹ It is only fair to note that the Coin Dollar Alliance, which financed the study, is itself supported financially by the Copper and Brass Fabricators Council, the Copper Development Association, Global Brass and Copper, the Arizona Mining Association, and the National Mining Association.

basis. More recently, Great Britain created a half-penny coin when it moved to the decimalization of the British pound in 1971 and then withdrew the half penny from circulation starting in 1984 – and British prices quickly adopted the British penny as the base, despite the wide use of electronic payments.⁵² Some current advocates of eliminating the U.S. penny would retain its use in pricing, while others would end it. If American consumers react negatively when merchants routinely round up their charges to the nearest nickel, economy-wide pricing based on the nickel could be the natural response.

U.S. financial markets adopted penny-based pricing only recently, but the benefits suggest that moving to nickel-based pricing would reverse those benefits. From 1817 to 1997, the New York Stock Exchange (NYSE) and other U.S. equity markets used a system based on Spanish base-eight pricing, such that all stock prices were quoted in increments of \$0.125 (one-eighth of a dollar). Economists long argued that a system based on a smaller denomination would enhance the liquidity of equity markets and narrow the spreads between asks and bids, saving investors money. Accordingly, U.S. stock markets moved to a base-16 system in 1997, with prices set in increments of \$0.0625; and in April 2001, the SEC directed all U.S. equity markets to quote their prices in pennies, the smallest available denomination.

This shift to a more refined, penny-based pricing structure for stocks was a test of the claimed advantages of decimalization, especially regarding liquidity and spreads in financial markets. Liquidity here refers to a stock's availability in a market, or how easily an investor can buy or sell it without affecting its price. One study found that the new decimalization for pricing stocks reduced the spread between the highest price a buyer will pay (the "bid") and the lowest price a seller will accept (the "ask") by an average of \$0.022, thereby reducing investors' transaction costs.⁵³ The researchers also found, however, that decimalization appeared to reduce another aspect of liquidity: the number of "buy" and "sell" orders for a stock, or its "depth." Another study of decimalization from the Federal Reserve Bank of Chicago examined 1,339 NYSE stocks, based on how frequently they were traded.⁵⁴ Like the other researchers, the study found that after decimalization, spreads narrowed, but depth decreased. Its author also created an overall measure for liquidity using both spreads and depth and concluded that liquidity increased substantially after decimalization.⁵⁵

Similarly, a study by the GAO found that decimalization reduced bid-ask spreads, trading costs and the average volatility of stock returns across both the NYSE and NASDAQ exchanges;⁵⁶ and other researchers confirmed the GAO's findings on trading costs and volatility.⁵⁷ Decimalization also aligned American equity markets with those in other financial centers, as U.S. stock markets had been alone among the world's top 20 financial centers in not using a base-ten system. This alignment also enhanced liquidity in U.S. equity markets: a study of stocks cross-listed on U.S. and Canadian exchanges found that after decimalization, the trading and dollar volume of Canadian stocks on U.S. exchanges increased more than the trading

⁵² Barford (2014).

⁵³ Chakravarty, Wood and Van Ness (2004).

⁵⁴ Furfine (2003).

⁵⁵ *Ibid.*

⁵⁶ Hillman (2005).

⁵⁷ Bessembinder, Hendrik (2003).

and dollar volume of other stocks on those exchanges, without reducing trading or dollar volume on the Canadian exchange.⁵⁸

Based on all of these studies, if the United States eliminated the penny and moved to nickel-based arrangements for pricing, it would adversely affect U.S. equity markets and their investors. To estimate the dimensions of those effects, we return to the GAO study. Its author found that after decimalization, quoted spreads narrowed by 73 percent for NYSE stocks (from \$0.154 to \$0.042) and by 68 percent for NASDAQ stocks (from \$0.17 to \$0.054). Further, “effective spreads” based on actual transaction prices rather than the quoted best prices declined 62 percent for NYSE stocks and 59 percent for NASDAQ stocks.⁵⁹ To be sure, a number of factors in addition to decimalization contributed to these cost reductions, including the spread of electronic trading, algorithmic trading and SEC reforms to improve the operations of equity exchanges.

To estimate the potential effects for American retail or individual investors if the United States moved from decimalization to nickel-based equity trading, we focus first on the volume of shares traded by those investors. A 2010 study estimated that retail investors account for 11 percent of all shares traded, compared to institutional investors (e.g. pension funds, hedge funds, insurance companies, etc.). Based on current daily trading volumes of 3.5 billion shares on the NYSE and 1.8 billion shares on the NASDAQ, individual investors trade an average of 385 million shares per day on the NYSE and 198 million shares per day on the NASDAQ. Economists estimate that the execution costs of a stock trade are equal to half the bid-ask spread.⁶⁰ A recent study found that from 2008 to 2013, effective spreads averaged between \$0.01 and \$0.02 per share for stocks traded on the NYSE (for an average of \$0.015) and between \$0.02 and \$0.03 per share for stocks traded on the NASDAQ (for an average of \$0.025).⁶¹ Based on these findings, we estimate that under the current decimal-based arrangements, trading by retail investors in NYSE stocks involves execution costs of approximately \$2.9 million per day, and trading by retail investors in NASDAQ stocks involves execution costs of nearly \$2.5 million per day (Table 9, below).

The issue here is this: how would the elimination of the penny for pricing stocks affect the execution costs of retail investors? Again, we know that spreads became smaller as a result of not only decimalization but also the advent of electronic trading, algorithmic trading, and new SEC rules. However, the SEC conducted a pilot program that tracked trading costs before and after the 2001 shift to decimalization, and analysis of that data indicates that decimalization alone reduced trading costs for retail investors by 24.2 percent.⁶² This implies that moving to a nickel-based system, or one close to the 16-base system preceding decimalization, would increase spreads by 31.9 percent ($1/1-0.242 = 1.3193$). Based on the finding that effective

⁵⁸ Oppenheimer and Sabherwal (2003).

⁵⁹ Hillman (2005).

⁶⁰ Bessembinder and Venkataraman (2010).

⁶¹ Angel, Harris, and Spatt (2013).

⁶² Chakravarty, Wood, and Van Ness (2004). The authors estimated that decimalization reduced effective spreads by 27.4 percent for trades of less than 500 shares, by 24.2 percent for trades of 500 to 999 shares, by 24.3 percent for trades of 1,000 to 4,999 shares, by 23.5 percent for trades of 5,000 to 9,999 shares and by 0.5 percent for trades of 10,000 shares or more. According to a 2008 study, the executed orders of retail investors average 770.9 shares. Kaniel, Sarr, and Titman (2008).

spreads today average about \$0.015 per share for NYSE trades and \$0.025 per share for NASDAQ trades,⁶³ a shift from penny-based arrangements to nickel-based arrangements would increase those spreads to \$0.019 and \$0.033, respectively. This analysis suggests that a shift to nickel-based pricing for stocks would increase the trading costs of retail investors by more than \$1.7 million per day, or \$410 million per year (Table 9, below). Moreover, these estimates are conservative, because they do not take into account how shifting from decimal-based trading to nickel-based trading might interact with other factors that also lowered spreads.⁶⁴

Table 10: Execution Costs for Retail Equity Trades, With and Without Decimalization

	Total Daily Volume	Retail Investors	Effective Spread	Execution Costs	Alternative Spread	Alternative Costs	Additional Costs
NYSE	3,500,000,000	385,000,000	\$0.015	\$2,887,500	\$0.0198	\$3,809,367	\$921,867
NASDAQ	1,800,000,000	198,000,000	\$0.025	\$2,475,000	\$0.0330	\$3,265,172	\$790,172
Total	5,300,000,000	583,000,000	-	\$5,362,500	-	\$7,074,538	\$1,712,038

IX. Conclusions

Calls to eliminate the U.S. penny are commonplace, and proposals to do so invariably claim that the government and taxpayers would save substantial sums. This study analyzed the actual fiscal and economic effects of eliminating the penny. We found that the most common approach, shifting from penny-based transactions to a nickel-based system, would impose large costs on American consumers and taxpayers. Eliminating the penny and producing additional nickels with the equivalent combined face value would cost the government, on a net basis, an additional \$5.3 million per year at 2015 prices. Since much of the cost of producing new coins depends on global commodity metal prices, we also analyzed the losses and gains from this shift, using the lowest, average and highest metal prices from the last decade. This analysis found that the shift would produce net costs of \$1.3 million per year using the lowest metal prices, net costs of \$25.1 million per year using average metal prices and net costs of \$54.4 million per year using the highest metal prices.

Moreover, the economic value of the penny and other coins is not based on the metals used to produce it, as it was in the 18th and 19th centuries, when coins were made of silver and gold, but rather on its use as a medium of exchange. As such, the value of a coin is expressed every time it is exchanged, and we found that the average penny turns over 2.18 times per year. Since the penny's average lifespan is 25 years, its economic value as a medium of exchange is \$0.55, compared to its 2015 cost of production of \$0.014. Adjusting for 25 years of inflation

⁶³ Angel, Harris, and Spatt (2013).

⁶⁴ The impact for institutional investors is more ambiguous, based on studies showing that decimalization was followed by a decline in the depth of trades by institutional investors. Nevertheless, the empirical evidence suggests that transaction costs for institutional investors also declined following decimalization. The GAO reported that data from three equity analytics firms indicated that after decimalization, the transaction costs of institutional investors fell by 30 percent, 40 percent and 53 percent for NYSE stocks and by 44 percent, 46 percent and 53 percent for NASDAQ stocks (Hilman, 2005). Academic studies confirm the direction of the effect reported by GAO. One analysis used data for 80,000 orders for NYSE stocks by institutional investors and found that their trading costs declined by about 11 percent. Another study found that transaction costs for institutional investors on NASDAQ trades declined 49 percent on orders of more than 10,000 shares (Werner 2003).

(1990-2015), the economic value of an average penny as a medium of exchange is \$0.303, compared to the inflation-adjusted cost of \$0.008 to produce it.

There is also no acceptable way to reduce those costs of production. The Mint reports that there are no alternative metal combinations that could lower the costs of producing pennies while preserving their usefulness as a medium of exchange. The Mint did identify one acceptable alternative for nickels, dimes and quarters, but the projected savings were minimal.

Most coins in use in the United States are not new coins from the Mint but used coins recirculating through the economy. Independent coin-counting services are a principal force in the recirculation process, since two-thirds of all coins recirculated through the Federal Reserve System and commercial banks and thrifts come from coin-counting services. Since pennies comprise a majority of the coins recirculated through this process, eliminating the penny could disrupt the current system for recirculating all coins. When Canada eliminated its penny in 2013, the volume of Canadian nickels and dimes recirculated through these services fell by 35 percent. So if the U.S. penny were eliminated, and the Mint offset just 25 percent of the reduced volume of recirculated coins with new nickels, dimes and quarters, produced at 2015 metal prices, it would cost the Mint an additional \$77 million. The net costs rise or fall with metal prices. Using the lowest metal prices over the last decade, the Mint would have to spend an additional \$60 million per year to maintain adequate coin recirculation; applying the highest metals price of the last decade, the Mint would have to spend an additional \$181 million per year to maintain adequate coin recirculation. The net costs would also rise if the Mint has to offset 50 percent or 75 percent of the reduced volume of recirculated coins.

Eliminating the penny while retaining its use as a pricing unit would also impose new costs on American consumers, since billions of cash transactions would have to be rounded up or down to the nearest nickel. Based on studies of consumer cash transactions, 60 percent to 93 percent of cash transactions would involve rounding up the final charges, and we found that this process would cost consumers \$438 million to \$1.13 billion per year.

Furthermore, if pennies were eliminated and their role in pricing ended as well, U.S. investors would also bear additional costs. Since 2001, all U.S. stock prices have been quoted in pennies, and the change from the former regime of selling and buying stocks for prices quoted in eighths or sixteenths of a dollar lowered trading costs for individual or retail investors. We found that reversing course by shifting to nickel-based stock quotes would raise those trading costs by at least \$410 million per year.

Based on public demand, the U.S. Mint produces almost 6.9 billion new pennies every year, and pennies account for a majority of all U.S. coins circulating through the economy. However loudly the penny's critics complain, it is clear from the use of the coin by consumers and businesses that Americans value the penny as a medium of exchange. All told, our analysis found that eliminating the penny as a medium of exchange would result in substantial net costs totaling some \$909 million to \$1.9 billion per year for the government, the economy, businesses, consumers and investors. Ultimately, the campaign to phase out the U.S. penny lacks any economic foundation or justification.

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