Eliminating the Penny Could Cost a Penny

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PRELIMINARY VERSION

Abstract

This paper revisits the long-standing debate over the continued production of the United States penny. Historically, critics have argued for the elimination of the penny on the basis that its production cost consistently exceeds its face value. There is, however, no economic basis for evaluating the value of a token or coin based on such criteria. On 10 February 2025, President Trump issued an executive order directing the Treasury to cease minting pennies,[1] further propelling the discussion. Although the cost of producing a nickel also exceeds its face value,[2] a comprehensive economic analysis must consider not the nominal value of coins but their role as media of exchange. We review the relevant literature, analyze a search-theoretic model following Kiyotaki and Wright (1989) with a detailed explanation of both the goods and token sides of the model, and assess empirical data on coin circulation and minting costs over the past decade. Finally, we estimate the likely economic benefits of eliminating penny production by providing a range of estimates that incorporate substitution effects with nickels. It is demonstrated that if there is significant substitution then the cost savings from eliminating the penny may be low.

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[1]U.S. Executive Order, 9 February 2025.

[2]See U.S. Mint FY2023 Annual Report, available at `https://www.usmint.gov`.

1 Introduction

The question of whether to eliminate the United States penny has been a recurring policy debate over many years. Critics argue that the production cost of a penny has exceeded its one-cent face value for well over a decade, leading to a negative net return for the U.S. Treasury. On 10 February 2025, President Trump issued an executive order directing the Treasury to cease minting pennies, further intensifying the debate. While the production cost of the five-cent coin (nickel) also exceeds its face value, an evaluation based on a comparison of production costs to face value has no economic basis as it overlooks the fundamental economic question: what role do these coins play as media of exchange in facilitating transactions?

We argue that the penny's elimination can be justified not merely on production cost grounds, but through a deeper analysis of its declining transactional value in an increasingly digital economy. Using a search-theoretic framework based on Kiyotaki and Wright (1989), we demonstrate that a coin's true economic value stems from its acceptance in exchange rather than its nominal denomination. Our analysis suggests that given current price levels and widespread electronic payment alternatives, the nickel can efficiently serve as the smallest physical currency denomination without meaningful loss of transactional efficiency.

The paper proceeds as follows. Section 2 reviews the literature on penny usage and provides case studies of countries that have eliminated their lowest-denomination coins. Section 3 develops a search-theoretic model in the Kiyotaki-Wright tradition to analyze how coins facilitate exchange, demonstrating formally that the penny's transactional value has diminished as prices have risen. Section 4 examines empirical data on coin circulation and attrition rates, documenting that many pennies exit circulation after just one use. Section 5 analyzes production costs from 2010-2023, showing consistently negative seigniorage. Finally, Section 6 quantifies the potential savings from eliminating penny production under various assumptions about substitution toward nickels.

Our estimates indicate that ceasing penny production could save approximately \$213 million annually in direct costs. However, if some penny transactions are replaced by nickels (which we model through a substitution parameter α), the net savings decline. We find that at high substitution rates, the additional cost of producing replacement nickels would substantially offset the savings from eliminating pennies. These results suggest that the economic case for eliminating the penny depends crucially on how payment behavior adapts to its absence.

2 The Penny's Value and Transaction Efficiency in the U.S.

2.1 Introduction

The U.S. one-cent coin (”penny”) has long been a subject of debate regarding its practical value and efficiency in transactions. Inflation has greatly reduced the penny's purchasing power – it is worth a fraction of what a cent used to buy giving rise to the non-economic quip that it even costs more to mint a penny than the coin is worth (recently about 3.5 cents per penny) Britannica (2024). This has prompted questions about whether the penny facilitates everyday transactions or actually hinders them. This section examines: (1) older studies on the penny's role in transactions (before digital payments became prevalent), (2) newer analyses in an increasingly cashless economy, and (3) case studies from countries that eliminated their lowest-denomination coins (Canada, Australia, New Zealand) and the effects on transaction efficiency. We also consider insights from search-theoretic (Kiyotaki–Wright-style) economic models regarding small denominations and efficiency.

2.2 Historical Perspectives: The Penny in Transactions

Before the rise of digital payments, researchers analyzed how pennies affected cash transactions. Key findings from older studies and debates include:

- **Rounding Tax Concerns:** Some economists warned that eliminating the penny could hurt consumers through price rounding. *Raymond Lombra (2001)* argued that because so many prices end in $_.99_, rounding to the nearest nickel would **usually round up**, effectively taxing consumers. He estimated a **$600 million annual “rounding tax”** falling largely on low-income shoppers (Richmond Federal Reserve, 2020). In his simulation, **93% of one- or two-item cash purchases might round up** (since prices often end in 1–4¢ needing rounding up to 5¢)Richmond Federal Reserve (2020), potentially benefiting retailers at consumers' expense. This view was often cited by penny proponents in the early 2000s.

- **No Significant Harm from Elimination:** Other economists disputed the rounding-tax fear. Robert Whaples (2007) analyzed **cash transaction data from a multi-state convenience store chain** and found that once **sales tax** was accounted for (which creates more prices ending in non-_.99_ values), **rounding effects net out to essentially zero on average**Richmond Federal Reserve (2020). Whaples concluded that eliminating the penny **"will not impose a 'rounding tax' on consumers"** (Whaples, 2007). He also found **no detectable impact on inflation** from penny eliminationWhaples (2007) – prices would not systematically rise. Any individual price rounding up would likely be offset by another rounding down when sales tax is added, leaving consumers no worse off overallRichmond Federal Reserve (2020).

- **Transaction Time and Productivity:** Importantly, Whaples (2007) and others noted potential **efficiency gains in transaction time**. Counting out pennies for change makes cash transactions slightly longer. Whaples estimated that without pennies, **cashiers and customers would save enough time to be worth about $730 million per year** in the aggregateWhaples (2007). The idea is that every cash transaction might be a few seconds faster if pennies aren't used – a small savings that adds up across billions of transactions. (For example, even a 2-second delay per cash purchase nationally translates to thousands of hours of added waiting timejst (2007).) Critics of the penny often highlighted this *lost productivity* from "fumbling for pennies" at the register.

- **Counterarguments:** Penny supporters in the 1990s argued these time-loss estimates were overstated. They claimed any time saved by not handling pennies could be offset by **new hassles of rounding**. For instance, training cashiers to round totals and explaining rounding to customers could introduce its own small delaysAmericans for Common Cents (2020). Americans for Common Cents (a pro-penny advocacy group) asserted that *"net time associated with transactions would increase, not decrease, without the penny,"* due to the need to implement a rounding systemAmericans for Common Cents (2020). However, these claims were largely speculative – there was little concrete evidence that rounding caused meaningful slowdowns, especially since **rounding** is arithmetically simple (to the nearest $0.05)** and would apply only to cash sales.

In summary, older analyses (pre-2010) already questioned the penny's usefulness. Research showed that **the penny's absence would not significantly harm consumers or fuel inflation**, and it might actually **improve efficiency at checkout** by saving timeWhaples (2007)Richmond Federal Reserve (2020). This set the stage for later reassessment as payment habits evolved.

2.3 The Penny in an Increasingly Cashless Economy (Recent Analyses)

With the rise of credit cards, debit cards, and mobile payments, the role of cash – and pennies – in transactions has diminished. Recent studies and data (2010s–2020s) indicate that the penny's contribution to transaction efficiency has further eroded:

- **Declining Use of Cash (and Coins):** Fewer transactions today even involve cash, especially among younger and higher-income consumers. By 2023, about **41% of Americans reported they rarely or never use cash for weekly purchases**, up from 24% in 2015inq (2024). Conversely, only 14% now say they use cash for almost all purchases (down from 24% in 2015)inq (2024). This trend means a large share of transactions are electronic – which don't use coins at all. In electronic transactions, **payments are still accounted to the cent** (no rounding needed), so whether the penny exists or not makes no difference for card or digital paymentsGovernment of Canada (2012). In effect, an **increasingly cashless economy reduces the penny's relevance** in day-to-day commerce.

- **Persistence of Exact Pricing in a Digital Age:** Even for cash sales, businesses and consumers have been adapting in ways that bypass penny usage. Many merchants set **"convenient prices"** that end in 0 or 5 to avoid making penny change. Research by Edward Knotek (Federal Reserve) finds that cash-intensive merchants often choose prices like $3.25 instead of $3.27 specifically to **require fewer coins and speed up transactions**Richmond Federal Reserve (2020). This indicates that market practices already acknowledge pennies as an inconvenience. Notably, the prevalence of prices ending in _.99 (which traditionally generated penny change) has started to **decline** in recent years, partly due to more retailers favoring round-number pricesBank Underground (2018). In the UK, for example, only about 12% of items were priced at _.99 by 2018, a share that had been fallingBank Underground (2018); a similar trend is observed in other advanced economies. Fewer _.99 endings means **less inherent bias toward needing a penny**, further neutralizing any impact of penny removal on pricesBank Underground (2018).

- **New Evidence on Rounding Impacts:** Contemporary studies examining penny elimination in practice show *minimal drawbacks*. **Canada's experience** has been especially informative (Canada phased out its penny in 2013). A 2018 study by Christina Cheung analyzed **18,000 retail grocery transactions in Canada** under penny-rounding rules. She found that for large baskets of items, **rounding the final total to $0.05 had essentially no net effect on consumers** – the ups and downs canceled outRichmond Federal Reserve (2020). For very small purchases (one or two items), there was a slight tendency for totals to round up, causing a tiny cost to consumers – estimated at **at most C$3.27 million per year in aggregate** at grocery storesRichmond Federal Reserve (2020). This is a **very small amount** in the context of Canada's overall retail sales (essentially a few cents per Canadian per year). Other analyses confirm that **multi-item purchases neutralize rounding biases**: buying even 3 items greatly increases the chance that the pennies needed in one item's price will be offset by another item's price, eliminating any systematic "rounding up" effectBank Underground (2018). Furthermore, **rounding in Canada (and proposed in the U.S.) applies only to cash transactions on the final bill**, not to each item's priceBank Underground (2018). Non-cash payments continue to pay the exact centGovernment of Canada (2012). This means the vast majority of transactions (which are electronic, or involve several items) see no change at all from eliminating the penny.

- **Current Cost-Benefit Outlook:** Today the penny is arguably **more of a drag than a facilitator** in transactions. The U.S. Mint produces billions of pennies annually, yet most never recirculate actively – one estimate suggests **six out of ten pennies are used only once in a transaction before being stowed away or lost**Bank Underground (2018). This inefficiency requires the Mint to constantly issue new pennies (over 4.5 billion were minted in 2023 alone)Britannica (2024) at a financial loss. Recent U.S. Mint data show each penny costs **2–4 cents to manufacture and distribute**Britannica (2024), resulting in an annual loss to taxpayers (around $180 million in 2023)Britannica (2024). From an efficiency standpoint, **handling and producing pennies arguably wastes resources**: banks and businesses incur handling costs, and customers spend extra time for negligible monetary value. As one Federal Reserve commentary put it, *"time is money"*, and countless **seconds spent counting out pennies** translate into substantial lost productivity across the economyRichmond Federal Reserve (2020). In sum, in a modern context of dwindling cash usage, **the penny contributes little to transaction efficiency and may actually impede it** (through time costs and resource costs).

2.4 International Case Studies: Eliminating the Smallest Coin

Several countries have already eliminated their lowest-denomination coins, providing real-world case studies on the effects. The experiences of **Canada, Australia, and New Zealand** are particularly relevant, as their economies are similar to the U.S. and they implemented rounding systems for cash transactions. These case studies show that **transaction efficiency generally improved or was unchanged** after dropping the smallest coin, with negligible inflation impact:

- **Canada (1¢ eliminated in 2013):** Canada decided to withdraw its penny after studies showed it was costly and inefficient. Ahead of elimination, a Bank of Canada analysis concluded the **inflationary effect would be "small or non-existent."** Prices would not meaningfully riseGovernment of Canada (2012). The government also cited a private sector study estimating that keeping the penny around was costing the Canadian economy **$150 million (CAD) per year** in handling, production, and operational costs by 2006Government of Canada (2012) – resources that could be saved by elimination. Canada introduced **fair rounding rules**: cash transactions are rounded to the nearest 5 cents (e.g. $1.02 or $1.03 rounds down to $1.00, $1.07 or $1.08 rounds up to $1.10), while electronic transactions continue to the exact centGovernment of Canada (2012). In practice, the outcome was **smooth and widely accepted by the public**Government of Canada (2012). Retailers followed the rounding guidelines, with some large chains even choosing to **always round prices down in cash transactions** as a goodwill gestureGovernment of Canada (2012). Studies after implementation found **no noticeable impact on overall prices/inflation**Government of Canada (2012). In fact, one detailed study (Cheung 2018) confirmed that **for typical shopping baskets the rounding balances out**, and only trivial costs (a few million dollars total) fell on consumers from all the rounding-ups of very small purchasesRichmond Federal Reserve (2020). In short, Canada's case demonstrated that **eliminating the penny reduced costs without hurting transaction efficiency or fairness**. Transactions may even be *quicker* now since cashiers don't need to fish for pennies, and businesses/savers no longer need to roll or deposit so many 1¢ coins.

- **Australia and New Zealand (1¢ and 2¢ eliminated decades ago):** Australia withdrew its 1-cent and 2-cent coins in 1992, and **New Zealand did so in 1989** (New Zealand also later eliminated the 5-cent coin in 2006)Government of Canada (2012). In both countries, **rounding on cash transactions** (to the nearest 5¢) was introduced, similar to Canada's system. The transition was uneventful and public sentiment quickly turned positive as the nuisance of handling virtually worthless coins disappeared. **Surveys in New Zealand showed that prices did not increase** after the 1¢ and 2¢ were removed – on the contrary, consumer price surveys found **prices slightly *fell*** on average immediately following the changeReserve Bank of New Zealand (2005). Competition prevented retailers from rounding *everything* up; some prices were adjusted down and many stayed the same, resulting in no net inflationReserve Bank of New Zealand (2005)Government of Canada (2012). The **central banks** in these countries also conducted analysis and found the effect on the **cost of living was negligible**Reserve Bank of New Zealand (2005). An interesting observation from New Zealand's experience is how quickly the smallest coins went from being medium of exchange to *"one-transaction coins."* The **Reserve Bank of NZ noted** that about **half of all 5¢ coins received in change were immediately taken out of circulation by the recipients** (put in jars, etc.), requiring continuous replacementReserve Bank of New Zealand (2005). This highlighted how inefficient the low-value coins had become – effectively, they facilitated only one transaction before dropping out of use. Removing them outright was thus a logical step. In Australia and New Zealand today, cash transactions are efficient with 5¢ as the lowest coin, and neither businesses nor consumers express a desire to bring back the old pennies. **Public acceptance** of the change was high, and charities even benefited (people often donated their remaining 1¢/2¢ hoards when the coins were phased out)Government of Canada (2012).

- **Other Countries:** Many other economies have also scrapped their smallest coins (for example, **the U.S. eliminated the half-cent in 1857** when it became of too little valueRichmond Federal Reserve (2020)). In recent decades, **Britain, Sweden, Denmark, Norway, Ireland, Brazil**, and others have retired low-denomination coins. International evidence consistently finds **little to no inflation** from these changesBank Underground (2018). The key is that **rounding is done on the final total** of a purchase and **only for cash**, which greatly limits any impactBank Underground (2018). Additionally, with modern pricing strategies and the small share of payments made in cash, the absence of tiny coins is barely felt. For instance, analyses in the UK showed that even if every individual item price were hypothetically rounded (an extreme scenario), **roughly 70% of prices wouldn't need any change** (they already end in 0 or 5), and the remaining cases would see a mix of up and down rounding such that there's no systematic upward biasBank Underground (2018). Overall, **no country that has eliminated its one-cent equivalent has experienced a significant transaction problem as a result** – transactions proceed smoothly (often more quickly), and consumers are not notably worse off. This international track record suggests that the U.S. would likely see similar benefits if it chose to retire the penny.

2.5 Search-Theoretic Insights: Small Denominations and Efficiency

Economic theory provides context for why very small denominations like the penny might (or might not) matter for transaction efficiency. In classical **search-theoretic models of money** (à la *Kiyotaki and Wright*), money emerges to facilitate exchange when buyers and sellers have to search for trading partners. Some insights from these models and related theoretical work:

- **The "Small Change" Problem:** Theoretical analyses have long identified a *denomination constraint* in exchange. If the **smallest unit of money is too large** (indivisible), people can't make low-value trades or *"make change"* easily, which **hinders efficient trade** Ennis (2006). In other words, money needs to be sufficiently divisible to accommodate transactions of all sizes. Historical monetary economists (like Thomas Sargent, François Velde, and Neil Wallace) noted that many economies in history suffered from shortages of small coins, which made everyday trade difficult – a phenomenon dubbed *"the problem of small change."* Within a search-theoretic framework, **indivisibility of coins can literally limit the set of trades that occur**, causing what agents perceive as a shortage of petty currencyEnnis (2006). For example, if the smallest coin is worth too much, a buyer might have no way to pay a price of (say) 1 unit except by overpaying with a larger coin or not trading at all. **Kiyotaki–Wright-style models** illustrate that introducing a sufficiently small denomination of money can improve welfare by allowing those smaller trades to happen and avoiding inefficiencies where transactions can't be splitEnnis (2006).

- **Optimal Denomination vs. Costs:** The flip side is that **having very fine denominations has costs** – minting costs, handling time, and complexity. In theory, there is an optimal structure of denominations that balances the convenience of making change with the costs of producing/handling more coins. In a **fiat money system**, unlike commodity money, the supply of small coins can be increased as needed at essentially no intrinsic value, which avoids some problems of scarcity. (For instance, a **search model by Kim and Lee (2012)** shows that under a commodity money regime, if the metal value of a penny rises, it can cause **"small change problems"** – the penny becomes too valuable relative to goods, leading to inefficiencies like **"no-trade" situations due to coin shortages or "too-much-trade" where people are forced to overpay**Kim and Lee (2012). In a fiat regime, the value of the penny is just its exchange value and the mint can supply ample coins, so those particular shortages don't occurKim and Lee (2012).) However, fiat systems face the opposite issue: the monetary authority can keep small coins in circulation even when they **become too low in value**. Over time, inflation can render a unit like one cent so minor that it ceases to facilitate meaningful exchange – instead it becomes a nuisance good. **Modern search-theoretic analyses acknowledge**

that when the transaction utility of a coin is near zero but it still carries resource costs, it may reduce overall efficiency. Essentially, a penny that people won't bother to use (or will only use once then hoard) fails the purpose of enhancing trade divisibility, *yet still incurs manufacturing and handling costs*.

- **Implications for Today's Penny:** In terms of Kiyotaki–Wright logic, removing the penny in the U.S. would make the **nickel (5¢) the smallest unit of account for cash**, slightly reducing the granularity of prices. The question is whether this loss of divisibility has any meaningful impact on trade. Given current prices, a 5¢ minimum increment is still very fine (5¢ is a small fraction of most transaction values), and **empirical evidence from other countries indicates virtually no loss in welfare or efficiency**. People can still conduct any reasonably sized transaction with nickels, dimes, etc., and **smaller-value exchanges (like 1¢ or 2¢ worth) are practically nonexistent now**. Moreover, **non-cash payments allow exact 1¢ pricing to continue in the accounting sense**, so price points don't actually disappear – they just aren't paid out in physical pennies. Thus, eliminating the penny does *slightly* reduce monetary divisibility, but in an economy with **higher prices (due to inflation) and digital payment alternatives, that theoretical loss is negligible in practice**Bank Underground (2018). In fact, one could argue that U.S. transactions already effectively function in 5¢ increments for many people – surveys and observed behavior show that countless pennies never recirculate and merchants often round prices in their favor (e.g., $9.95 instead of $9.99) to avoid pennies. So the *search-theoretic benefit* of the penny (enabling exact low-value trades) has diminished over time, while the *search/friction cost* (time spent handling it) remains.

In summary, economic theory underscores that **having some small-change medium is important**, but it does **not require an infinitely small unit**. Once a coin's value becomes so low that it's rarely used as a medium of exchange, it no longer contributes to reducing search frictions in trade. The U.S. penny today appears to have crossed that threshold – its **marginal benefit in transactions is essentially zero, while its marginal cost is positive**. This aligns with what both empirical studies and search-theoretic reasoning suggest: eliminating a nearly valueless coin should not impair the efficiency of transactions in any noticeable way, and could even improve overall efficiency by streamlining payment processes.

2.6 Conclusion

Does the penny contribute to transaction efficiency in the modern U.S. economy? The evidence says **very little, if at all.** Older studies from the 1990s and 2000s found that eliminating the penny would not hurt consumers via rounding in any significant wayRichmond Federal Reserve (2020) and would likely **save time** and resourcesWhaples (2007). More recent analyses reinforce this view, especially as cash usage declines: the penny's absence has proven benign (and even beneficial) in other countries, and any theoretical downsides (like loss of price precision) simply haven't materialized in practiceGovernment of Canada (2012)Bank Underground (2018). Transaction efficiency, whether measured in time, convenience, or cost, has not suffered in penny-less economies. In fact, **the U.S. stands out for clinging to a coin that costs far more to keep in circulation than it is worth** – a clear inefficiency.

In an economy that is increasingly cashless and where **digital payments handle the "cents" seamlessly**, the penny's role is arguably antiquated. The U.S. has a historical precedent (the half-cent coin was retired in the 19th century when its value became too low)Richmond Federal Reserve (2020), and the experience of peer nations shows a viable path to retiring the penny without inconveniencing commerce. From a **search-theoretic perspective**, so long as the currency retains a reasonably small unit (the nickel) and prices can adjust, the **medium of exchange function** will remain intact and efficient.

In conclusion, most evidence – theoretical and empirical – suggests that the penny no longer adds value to U.S. transactions, and eliminating it would likely *improve* efficiency (through time savings and cost savings) while having **negligible impact on prices or consumers**Whaples (2007)Government of Canada (2012). The penny's diminishment in the face of a changing economy seems to confirm the adage: sometimes, *"less is more,"* even when it comes to the number of coins in our pockets.

Recent literature on search-theoretic models of money—most notably the seminal work by Kiyotaki and Wright (1989)—has provided a framework for understanding that the value of money stems from its liquidity properties rather than its intrinsic value. Subsequent analyses, such as those by McKenrick and Rivera (2012), have applied this framework to analyze modern coinage systems, emphasizing that the true value of a coin lies in its acceptance in exchange.

3 Kiyotaki and Wright Analysis

The Kiyotaki and Wright model is a search-theoretic framework that explains the emergence of money as a medium of exchange in an economy with trading frictions. In a barter system, trades occur only when there is a double coincidence of wants; that is, one party's good must match another party's demand. Money (or a token) alleviates this inefficiency by serving as an intermediary asset that is widely accepted in exchange, thereby facilitating smoother and faster transactions.

In the traditional model, agents can hold either a good or a token. The value of holding a good, V_g, is determined by both the immediate consumption utility u and by the potential to exchange the good for money. Its Bellman equation is typically written as:

$$rV_g = u + \lambda\beta(V_m - V_g), \tag{1}$$

where u is the instantaneous utility from consuming the good, λ is the matching rate, β is the probability of a successful trade, and V_m is the value of holding money. Tokens, on the other hand, provide no direct utility; their value arises solely from their role in facilitating exchanges. In our extension of the model, we distinguish between two types of tokens—pennies and nickels. Let V_p denote the value of holding a penny and V_n denote the value of holding a nickel. Agents meet randomly at a Poisson rate λ, and the probability that a given token is accepted in exchange for a good is given by γ. The Bellman equations for token holders are:

$$rV_p = \lambda\,\gamma_p\left(V_g - V_p\right), \tag{2}$$

$$rV_n = \lambda\,\gamma_n\left(V_g - V_n\right), \tag{3}$$

where γ_p and γ_n denote the acceptance probabilities for pennies and nickels, respectively.

This model contrasts with the traditional framework by explicitly allowing for multiple token types. While goods yield intrinsic utility as shown in Equation (1), tokens derive their value solely from liquidity. The key insight is that even though the face values of pennies and nickels differ, their economic value as media of exchange is determined by their acceptance probabilities.

We obtain the following key result:

Proposition 1. *In a search-theoretic equilibrium where both pennies and nickels circulate as media of exchange, the equilibrium liquidity values satisfy $V_p = V_n$. Furthermore, if it is observed that $V_p > V_n$, then it necessarily follows that $\gamma_p > \gamma_n$; that is, the penny provides a higher liquidity service (i.e., is accepted more frequently in transactions) than the nickel despite its lower face value*

Proof. Suppose that in equilibrium agents are indifferent between holding a penny and a nickel, so that:

$$V_p = V_n = V. \tag{4}$$

Substituting into Equations (2) and (3) gives:

$$rV = \lambda\,\gamma_p\,(V_g - V)\,, \tag{5}$$

$$rV = \lambda\,\gamma_n\,(V_g - V)\,. \tag{6}$$

Since the left-hand sides of Equations (5) and (6) are identical and $V_g - V > 0$ (as holding a good yields immediate consumption utility), it follows that:

$$\lambda\,\gamma_p\,(V_g - V) = \lambda\,\gamma_n\,(V_g - V)\,. \tag{7}$$

Dividing both sides by the positive quantity $\lambda(V_g - V)$ yields:

$$\gamma_p = \gamma_n. \tag{8}$$

Thus, if agents are indifferent between holding a penny and a nickel, their acceptance probabilities must be equal.

Now assume that empirical evidence indicates $V_p > V_n$. Let $\Delta V = V_p - V_n > 0$.

Re-examine the Bellman equations:

$$rV_p = \lambda\,\gamma_p\,(V_g - V_p)\,, \tag{9}$$

$$rV_n = \lambda\,\gamma_n\,(V_g - V_n)\,. \tag{10}$$

Since $V_p > V_n$, we have:

$$V_g - V_p < V_g - V_n. \tag{11}$$

To compensate for the smaller surplus $(V_g - V_p)$ in Equation (9), the acceptance probability γ_p must be higher than γ_n so that the right-hand side of Equation (9) remains sufficiently large relative to Equation (10). Formally, if we assume for contradiction that $\gamma_p \leq \gamma_n$ while $V_p > V_n$, then:

$$\lambda\,\gamma_p\,(V_g - V_p) < \lambda\,\gamma_n\,(V_g - V_p) \leq \lambda\,\gamma_n\,(V_g - V_n)\,,$$

which implies:

$$rV_p < rV_n,$$

contradicting the assumption that $V_p > V_n$. Therefore, we must have:

$$\gamma_p > \gamma_n.$$

□

Essentially, if the penny is valued more highly than the nickel in equilibrium (i.e., $V_p > V_n$), then even though its nominal face value is lower, it must be because it is more widely accepted in transactions—its liquidity service is greater. This result underscores the key insight that, in a search-theoretic context, the value of money is derived not from its intrinsic or nominal value, but from its role in reducing frictions in exchange. Consequently, policy discussions about coin elimination should focus not solely on production costs versus face value but also on the coin's functionality as a medium of exchange.

4 Use Pennies and Nickels in the US

The above analysis shows that if both pennies and nickels are used in actuality then they have approximately equivalent value as media of exchange. Thus, it becomes useful to examine the intensity of use of each. That is done in this section.

4.1 Frequency of Use Before Exiting Circulation

Pennies and nickels circulate for decades, but each individual coin is used in transactions only a limited number of times before dropping out of circulation. U.S. Mint and Federal Reserve data indicate that coins can remain in circulation for around 25 years on average before becoming too worn or lost[3]. In practice, many pennies and nickels don't continuously circulate that entire time – they often end up stashed in jars or lost – but they *could* change hands hundreds of times if actively used. An analysis presented to Congress estimated that the average penny is used about 2.1 times per year, which works out to roughly $\sim$55 transactions over a 25-year lifespan[4]. In other words, a typical penny might be spent dozens of times before it disappears from circulation. Nickels likely have a similar order of magnitude of turnover, possibly a bit higher since they hold more value, but detailed studies are scarce. Overall, most U.S. coins have a multi-decade life in circulation and each penny or nickel is only spent a few times per year on average – far lower "velocity" than paper money.

4.2 Annual Withdrawals and Attrition Rates

Hundreds of millions – even billions – of pennies and nickels are withdrawn from circulation each year due to attrition (loss, hoarding, or destruction). Official figures show a huge gap between the number of coins the Mint has produced historically and the number actually circulating at any given time. For example, by 1999 the U.S. Mint had struck over 300 billion pennies in the prior 30 years, yet only an estimated 114 billion pennies were "active" in circulation at that time[5]. This implies that roughly two-thirds of all pennies minted were no longer circulating – they had been removed over the years by being lost, discarded, or stored away. In 1999 alone, the

[3] Federal Reserve Bank of Atlanta, "Dollars and Cents."

[4] Congressional Analysis on Penny Economics, 2017.

[5] Federal Reserve Bank of New York, "Shortages of Pennies and Other Coins."

Mint planned to produce about 13 billion new pennies[6], which were largely needed to replace coins that dropped out of use rather than to grow the total money supply.

Federal Reserve cash operations routinely remove unfit coins (those that are bent or too worn) from circulation, and banks return excess coins to the Fed, but most penny and nickel attrition comes from coins vanishing into piggy banks, couch cushions, and landfills rather than formal withdrawals. The Fed and Mint have acknowledged this continual loss. One Federal Reserve study noted that large volumes of new pennies and nickels must be minted each year "when circulated coins could be used instead," because so many of those coins never recirculate[7]. Analysts estimate that pennies attrite (drop out) at roughly 4% per year and nickels around 3% per year, historically[8]. In practical terms, that means on the order of 4–5 billion pennies and a few hundred million nickels are taken out of circulation annually one way or another. Indeed, the U.S. Mint even ran a "mutilated coin" redemption program to buy back damaged coins for melting (to reclaim metal), underscoring that a steady flow of worn or destroyed pennies and nickels are retired each year[9].

It's also worth noting that hoarding behavior contributes to attrition. When metal prices spiked in the mid-2000s, people began stockpiling pennies and nickels for their copper and nickel content. This got so pronounced that in 2006 the Treasury banned melting down pennies and nickels and limited their export to prevent coin shortages[10]. Those hoarded coins effectively exit circulation (at least temporarily), increasing the attrition rate. In summary, billions of pennies and many millions of nickels are removed from active circulation each year – through loss, destruction, or being set aside – which necessitates continual replacement by the Mint.

4.3 Minting Volume vs. Net Circulation Growth

The U.S. Mint produces enormous numbers of new pennies and nickels annually, yet the total quantity in circulation grows very slowly – a seeming contradiction explained by high attrition. Pennies are the extreme case: The Mint has been striking 5 to 15+

[6] Ibid.

[7] Government Accountability Office, "U.S. Coins: The Federal Reserve Banks Are Fulfilling Coin Demand, but Optimal Inventory Ranges Are Undefined."

[8] Collectors Universe Forums, "Attrition rates from circulation."

[9] NBC LX, "Making Cents: Ten Facts You Didn't Know About the Penny."

[10] Wikipedia, "Penny (United States coin)."

billion pennies each year in recent decades[11]. Despite this influx, the *net* number of pennies actually circulating doesn't increase by much, because roughly the same number of pennies are disappearing from circulation. As noted, about 114 billion pennies were circulating in 1999[12]. Two decades later, the total had only risen to on the order of 130 billion pennies in circulation[13]. That implies only a modest net growth (around 16 billion over twenty years), even though well over 100 billion new pennies were minted in that period. Essentially, for every penny added, another is lost.

Nickels show a similar pattern on a smaller scale. The Mint manufactures on the order of 1 to 1.6 billion nickels per year in recent years[14]. Yet the total number of nickels in circulation inches up only gradually, because many nickels concurrently drop out of circulation or sit unused. For example, in fiscal year 2007 the Federal Reserve distributed about 1.28 billion new nickels to meet demand (net of those returned)[15], which was close to the number minted, indicating most new coins simply replaced attrited ones. Overall, the coin supply in circulation remains relatively stable year to year: almost all the new pennies and nickels the Mint pumps out annually are offset by those exiting circulation. This is why we don't see the number of pennies in circulation ballooning by tens of billions every year despite massive mintages.

4.4 Summary

To summarize the current state of U.S. coin circulation: As of 2024, approximately 150 billion pennies are estimated to be in circulation[16], with the U.S. Mint having produced 7.1 billion new pennies in fiscal year 2023[17]. For nickels, the current circulation stands at an estimated 31.2 billion coins, with 1.2 billion new nickels minted in fiscal year 2023[18]. These figures underscore the massive scale of ongoing coin production required simply to maintain the existing supply in the face of constant attrition.

[11] NBC LX, op. cit.
[12] Federal Reserve Bank of New York, op. cit.
[13] NBC LX, op. cit.
[14] Cash Essentials, "United States: Coin Production and Circulation."
[15] Wikipedia, "United States Mint coin production."
[16] U.S. Mint Annual Report, 2023.
[17] U.S. Mint Production Figures, 2023.
[18] Ibid.

5 The Cost of Penny and Nickel Production

The U.S. Mint's cost to manufacture one-cent (penny) and five-cent (nickel) coins has exceeded their face value every year since 2006.[19] This analysis examines the annual production cost per penny and nickel from 2010 through the most recent data, analyzes fluctuations in these costs in relation to copper, nickel, and zinc prices, and compares minting costs to the coins' face values to evaluate cost efficiency.

5.1 Annual Minting Costs for Pennies and Nickels (2010–2023)

Table 1 summarizes the cost to produce a penny and a nickel in each fiscal year 2010–2023. These figures represent the Mint's per-unit cost (in U.S. cents) to manufacture and distribute each coin, as reported in official documents. Notably, both pennies and nickels have had a unit cost above $0.01 and $0.05 respectively in every year listed, indicating negative seigniorage (a net loss on each coin).

Table 1: U.S. Mint Cost to Produce One Penny and One Nickel, FY2010–FY2023

Fiscal Year	**Cost per Penny (¢)**	**Cost per Nickel (¢)**
2010	1.79	9.22
2011	2.41	11.18
2012	2.00	10.09
2013	1.83	9.41
2014	1.66	8.09
2015	1.43	7.44
2016	1.50	6.32
2017	1.82	6.60
2018	2.06	7.53
2019	1.99	7.62
2020	1.76	7.42
2021	2.10	8.52
2022	2.72	10.41
2023	3.07	11.54

[19] U.S. Treasury, "Mint FY 2023 Congressional Justification," 2023.

5.2 Trends in Production Costs and Metal Price Fluctuations

The cost to mint pennies and nickels has varied over the past decade-plus, largely driven by changes in metal prices (copper, nickel, zinc) and production volumes. Key fluctuations include:

5.2.1 2011 Peak

Fiscal year 2011 saw production costs reach a high of 2.41¢ per penny and 11.18¢ per nickel, more than double each coin's face value[20]. This peak coincided with historically high prices for coinage metals (copper and nickel), which drove up material costs. The 2011 penny cost was a sharp increase from 2010's 1.79¢, reflecting the commodity price surge.

5.2.2 2012–2014 Decline

As metal prices eased after 2011, the Mint's unit costs fell. By FY2014 the penny's cost dropped to about 1.7¢ and the nickel's to 8.1¢[21], roughly 30% lower than their 2011 peaks. This reduction aligned with a decline in copper, zinc, and nickel prices in that period.

5.2.3 Mid-2010s Lows

The lowest recent costs occurred around FY2015–FY2016, when a penny cost about 1.4–1.5¢ and a nickel about 6.3–7.4¢ (see Table 1). These lows resulted from a combination of reduced metal prices and incremental efficiency gains. Even at these lows, however, the cost remained above face value[22].

5.2.4 2017–2019 Gradual Rise

From 2017 onward, production costs crept up again alongside recovering metal prices. By FY2018, the penny cost 2.06¢ and the nickel 7.53¢, reflecting higher zinc and nickel prices than a few years prior. This upward trend continued modestly into 2019 (penny 1.99¢, nickel 7.62¢).

[20] Coin World, "May circulation production registers a loss," 2012.
[21] Coin World, "Cost to produce U.S. penny still more than its face value," 2014.
[22] CoinNews, "Penny Costs 3.07 Cents to Make in 2023," 2024.

5.2.5 2020 Pandemic Impact

FY2020 saw a slight dip in costs (penny ∼1.76¢, nickel ∼7.42¢)[23]. This may be attributed to temporary drops in commodity prices and high production volume during the COVID-19 pandemic. The U.S. Mint significantly increased coin production in 2020 to address circulation disruptions. Lower metal prices in 2020 helped reduce per-coin costs slightly before the subsequent surge.

5.2.6 2021–2023 Cost Escalation

In FY2021, costs jumped again as economic recovery and supply disruptions drove metals higher. The penny's unit cost rose ∼19% from the prior year to 2.10¢, and the nickel's rose ∼15% to 8.52¢[24]. The U.S. Mint noted this was the 16th consecutive fiscal year that penny and nickel production costs exceeded face value.

Fiscal 2022 brought another sharp increase. The penny cost 2.72¢ and the nickel 10.41¢, rises of ∼30% and ∼22% respectively from 2021[25]. The Mint attributed these spikes largely to higher metal prices, as well as fewer coins produced. In 2022, average market prices for nickel jumped 41% year-over-year, zinc by 26%, and copper by 6%, dramatically increasing raw material costs.

In FY2023, the cost reached its highest levels – 3.07¢ per penny and 11.54¢ per nickel – despite a softening in metal prices that year[26]. The Mint's 2023 report noted that average prices for nickel, copper, and zinc actually decreased (by 5.1%, 8.5%, and 22.3% respectively) during FY2023. However, a 13% drop in coin production meant fixed costs were spread over fewer coins, resulting in a net increase in per-coin cost.

5.3 Cost vs. Face Value and Cost Efficiency Trends

The persistent gap between production cost and face value has significant implications for the U.S. Treasury's seigniorage revenue. This section examines the magnitude of losses and their cumulative impact.

[23] CoinNews, "Penny Costs 3.07 Cents to Make in 2023," 2024.
[24] U.S. Treasury, "Mint FY 2023 Congressional Justification," 2023.
[25] CoinNews, "Penny Costs 2.72 Cents to Make in 2022," 2023.
[26] CoinNews, "Penny Costs 3.07 Cents to Make in 2023," 2024.

5.3.1 Magnitude of Loss per Coin

The gap between cost and face value has varied over time. For example, in 2011 it cost 2.41¢ to make a 1¢ coin, a loss of 1.41 cents per penny[27]. That same year, the nickel's 11.18¢ cost implied a loss of 6.18 cents per 5¢ coin. During mid-2010s when costs were lower, the losses narrowed (a penny in 2015 cost ∼1.43¢, only 0.43¢ above face, and a nickel ∼7.44¢, about 2.44¢ above face).

5.3.2 Cumulative Losses and Seigniorage Impact

With billions of these coins produced annually, the total loss mounts to tens or even hundreds of millions of dollars each year. For instance, in FY2022 the Mint produced about 5.387 billion pennies and 1.442 billion nickels[28]. The combined negative seigniorage on pennies and nickels that year was approximately -$171 million (–$93.0M from cents, –$78.0M from nickels).

5.4 Metal Composition and Future Outlook

Recognizing these unfavorable economics, Congress and the U.S. Mint have explored ways to reduce costs. The *Coin Modernization, Oversight, and Continuity Act of 2010* (Public Law 111-302) required the Mint to examine alternative materials for coins and report biennially on production costs and cost-saving options[29].

The Mint conducted R&D on cheaper coin compositions – for example, testing steel-based alternatives for pennies and nickels instead of the current zinc and nickel-copper alloys[30]. So far, these studies have not led to a change in composition. The Mint's 2020 Biennial Report noted that a copper-plated steel penny could work in vending machines and co-circulate with existing pennies, but it was "not expected to yield significant cost savings" because lower metal costs would be offset by higher fabrication costs for steel blanks.

"'latex

[27] Coin World, "May circulation production registers a loss," 2012.
[28] CoinNews, "Penny Costs 2.72 Cents to Make in 2022," 2023.
[29] Congressional Research Service, "Penny: History and Current Status," 2023.
[30] House Financial Services Subcommittee on Domestic Monetary Policy, "The Future of Money: Coinage Production," 2012.

6 Economic Benefits of Eliminating the Penny

Eliminating the penny is expected to yield significant cost savings by ceasing the minting of new pennies. It is important to note that eliminating the penny does not remove the existing stock of approximately 150 billion pennies in circulation; rather, it stops the production of new pennies. In 2023, about 7.1 billion pennies were minted. If penny production were halted, these 7.1 billion pennies would no longer be produced. However, to accommodate transactions that previously used pennies, some proportion of that transaction demand must be met by an increased production of nickels.

Specifically, suppose that a fraction α of the penny value is replaced by nickels. Since 5 pennies are equivalent to 1 nickel in a transaction, the additional number of nickels required is given by:

$$\Delta N_n = \alpha \times \frac{7.1\,\text{billion}}{5}.$$

Let:

- C_p denote the average cost per penny (in cents), assumed to be approximately 3.0 cents.
- N_p denote the number of pennies minted annually, which in 2023 is 7.1 billion.
- C_n denote the average cost per nickel (in cents), assumed to be approximately 11.5 cents.
- N_{n0} denote the base number of nickels minted annually (without any substitution), which is 1.2 billion.

The annual cost saving from not minting the 7.1 billion pennies is:

$$S_p = C_p \times N_p = 3.0 \times 7.1 \times 10^9 \text{ cents}.$$

Converting to dollars:

$$S_p = \frac{3.0 \times 7.1 \times 10^9}{100} \approx \$213\,\text{million}.$$

If a fraction α of the penny demand is substituted by nickels, then the additional number of nickels required is:

$$\Delta N_n = \alpha \times \frac{7.1 \times 10^9}{5}.$$

The additional cost for these extra nickels is:

$$\Delta S_n = C_n \times \Delta N_n = 11.5 \times \alpha \times \frac{7.1 \times 10^9}{5} \text{ cents.}$$

Converting this cost into dollars:

$$\Delta S_n = \frac{11.5 \times \alpha \times (7.1 \times 10^9/5)}{100}.$$

We now compute the net annual savings, S_{net}, for various values of α:

$$S_{\text{net}} = S_p - \Delta S_n.$$

6.1 Cost Calculations for Various Substitution Rates

Table 2 presents the calculations for $\alpha = 0$, 0.25, 0.5, 0.75, and 1.

- With $\alpha = 0$ (no substitution), the savings from ceasing penny production are \$213 million per year.
- With $\alpha = 0.25$, 25% of the penny demand is replaced by nickels. The additional nickels required are $0.25 \times (7.1/5) \approx 0.355$ billion coins, incurring an extra cost of about \$40.83 million. The net savings are then approximately \$172.17 million.
- With $\alpha = 0.50$, the additional nickels required are about 0.71 billion, leading

Table 2: Estimated Net Annual Savings for Halting Penny Production, by Substitution Rate (α)

Substitution Rate (α)	**Additional Nickels Required, ΔN_n (billion coins)**	**Additional Cost, ΔS_n (million \$)**	**Net Savings, $S_{\text{net}} = S_p - \Delta S_n$ (million \$)**
0.00	0.00	\$0.0	\$213.0
0.25	$0.25 \times \frac{7.1}{5} = 0.355$	$\frac{11.5 \times 0.355 \times 10^9}{100} = \$40.83$	\$213.0 - \$40.83 = \$172.17
0.50	$0.50 \times \frac{7.1}{5} = 0.71$	$\frac{11.5 \times 0.71 \times 10^9}{100} = \$81.65$	\$213.0 - \$81.65 = \$131.35
0.75	$0.75 \times \frac{7.1}{5} = 1.065$	$\frac{11.5 \times 1.065 \times 10^9}{100} = \$122.48$	\$213.0 - \$122.48 = \$90.52
1.00	$1.00 \times \frac{7.1}{5} = 1.42$	$\frac{11.5 \times 1.42 \times 10^9}{100} = \$163.3$	\$213.0 - \$163.3 = \$49.7

to an extra cost of roughly \$81.65 million and net savings of approximately \$131.35 million.

- With $\alpha = 0.75$, the additional nickels required are about 1.065 billion, yielding an extra cost of around \$122.48 million and net savings of approximately \$90.52 million.

- With $\alpha = 1.00$ (full substitution), the additional nickels required are approximately 1.42 billion, resulting in an extra cost of roughly \$163.3 million and net savings of about \$49.7 million.

6.2 Summary

The table demonstrates that if no substitution occurs ($\alpha = 0$), halting penny minting saves approximately \$213 million annually. However, as a fraction of the penny value is substituted by nickels, the net savings decrease. For instance, with a 25% substitution rate, net savings are approximately \$172 million, while with full substitution ($\alpha = 1$) net savings drop to about \$50 million per year. These estimates are crucial for policymakers, as they illustrate that the economic benefit of stopping new penny production depends critically on the extent to which the demand for low-denomination transactions shifts to increased nickel production.

7 Conclusion

This paper has examined the empirical and theoretical foundations for eliminating the U.S. penny. While traditional arguments have focused on the fact that production costs exceed face value, we demonstrate through search-theoretic modelling that the true economic value of a coin stems from its role as a medium of exchange rather than its nominal value or production cost. The Kiyotaki-Wright framework reveals that a coin's value is fundamentally determined by its acceptance probability in transactions and its effectiveness in reducing trading frictions.

Our analysis of circulation patterns shows that the penny's role in facilitating transactions has diminished significantly. With approximately 150 billion pennies in circulation but only 7.1 billion new pennies minted annually, the data suggest that many pennies are effectively removed from active circulation after limited use. High attrition rates—roughly 4% for pennies and 3% for nickels—necessitate continuous replacement production just to maintain existing supply levels. This pattern of limited reuse before effective retirement indicates that pennies no longer serve their intended function as an efficient medium of exchange.

We find that ceasing penny production could theoretically save about $213 million annually in direct minting costs. However, our substitution analysis reveals that these savings depend crucially on how transaction patterns adapt. If a fraction α of penny transactions shift to nickels, net savings decline substantially—ranging from $172 million at 25% substitution to approximately $50 million at full substitution. These diminishing returns occur because nickels also cost more to produce than their face value (11.54 cents per nickel in 2023).

The contemporary context of increasing electronic payments and the experience of other nations that have eliminated their lowest-denomination coins suggest that the U.S. could feasibly discontinue the penny without significant economic disruption. Canada's successful penny elimination in 2013, along with similar experiences in Australia and New Zealand, provide practical evidence that modern economies can function efficiently with a five-cent piece as their smallest physical denomination.

In conclusion, both theoretical models and empirical evidence indicate that the penny's transactional value has eroded to the point where its continued production may no longer be economically justified. However, policymakers must carefully consider the substitution effects and transition costs when evaluating elimination proposals. The optimal timing and implementation of such a change should account for both the direct savings from reduced minting and the indirect effects on payment systems and consumer behavior.

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