Is Paper Money Just Paper Money? Experimentation and Variation in the Paper Monies Issued by the American Colonies from 1690 to 1775

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The British North American colonies were the first western economies to rely on legislature-issued paper monies as an important internal media of exchange. This system arose piecemeal. In the absence of banks and treasuries that exchanged paper monies at face value for specie monies on demand, colonial governments experimented with other ways to anchor their paper monies to real values in the economy. These mechanisms included tax-redemption, land-backed loans, sinking funds, interest-bearing notes, and legal tender laws. I assess and explain the structure and performance of these mechanisms. This was monetary experimentation on a grand scale.

[The colonies] cannot keep Gold and Silver among them sufficient for the Purposes of their internal Commerce... Paper Bills called Bills of Credit or Paper Money have therefore in the colonies long been substituted for real Money. Various Ways of issuing these and on different Foundations, have at different Times been thought of and practised.... On the whole no Method has been found to give any Degree of fixed, steady, uniform Value to Bills of Credit in America,...

Benjamin Franklin, 13 February 1767[1]

The British North American colonies were the first western economies to experiment with sizable emissions of paper monies—called *bills of credit*.[2] These bills were emitted by their respective colonial legislatures. No banks issuing paper banknotes exchangeable for their face value in specie on demand existed in North America in this era.[3] These colony-specific legislature-issued paper monies formed an important part of the circulating medium of exchange in many colonies (Brock 1975, Newman 2008). These colonial paper-money experiments were neither uniform nor coordinated across the colonies. They were instituted piecemeal—at different times with different motivations and goals. Their institutional structures and relative performances varied. While not consciously intended to be so, either by the colonies or the British government, this was monetary experimentation on a grand scale.

Explaining how colonial paper money regimes performed has proven controversial.

Economists have found that the statistical relationships between the face-value quantities of paper monies in circulation, prices, and exchange rates are weak to non-existent in the colonies south of New England. These findings challenge the applicability of the classical quantity theory of money. Alternative hypotheses to account for these findings have been difficult to empirically test. These hypotheses include possible changes in the non-price components of the equation of exchange and potential currency substitutions between paper and specie monies. When empirical confirmation is lacking, hypotheses proliferate and views calcify. As a result, scholars have debated heatedly over how to characterize colonial monetary behavior.[4]

Economists have typically assumed that colonial paper monies were fiat currencies in fully monetized economies. They have largely ignored the extensive efforts to legislate the structure of money—something easy to ignore if all paper monies are assumed to be fiat currencies. These assumptions and lapses of consideration have permeated past modeling, regardless of monetary ideology.[5] Poor modeling performance in past studies may be due to the non-applicability of these assumptions and failures to address the structure of money.

I address these lapses and assumptions. I deconstruct, analyze, and assess the experiments in monetary structure engaged in by colonial legislatures to see how far such considerations can succeed in yielding a viable alternative understanding of colonial paper money performance. I encourage the reader to set aside prior monetary modeling ideologies applied to colonial America and consider whether this alternative approach can yield new and valuable insights.

I proceed as follows: First, I show that bills of credit were actually used as a paper-money medium of exchange. Second, I present the institutional constraints that circumscribed what colonies could do in terms of creating a money "thing" to explain why paper money took the form of bills of credit. Given that paper money was in the form of bills of credit, I also establish

why monetary structure matters and define the limiting range of those structures. Third, I document variations across colonial paper money emissions to show that paper monies are not just paper monies. Not only did the structure of paper money differ between colonies, it differed from emission to emission within a colony. These findings indicate that the face values of paper monies cannot be compared within, or summed across, emissions to measure the amount of value in circulation. This observation makes most past studies of colonial monetary performance meaningless—thus perhaps explaining the poor modeling performance in those studies.

Fourth, I identify and analyze the legal tools colonists had to achieve their monetary goals. These tools included creating bond-like redemption structures for their paper money, making their paper money a legal tender, and having their paper money pay interest. Redemption entailed removing paper money from circulation, with it being subsequently destroyed, via exchanging it for its face value in specie equivalents at the established redemption date. Redemption mechanisms included accepting paper money in payment of taxes imposed; emitting paper money through loans to subjects and requiring loan repayments to be in that paper money, or its face-value specie equivalents, on a fixed schedule; and creating sinking funds in specie to execute redemption at legislatively determined future dates. I assess the potential success of the various monetary structures crafted by the colonists with these legal tools.

I assume that achieving a sound monetary policy is the primary goal influencing how colonial legislatures structured their paper money emissions. A sound monetary policy entailed creating a paper instrument that could serve as an inside money for executing domestic transactions within the colony, with that paper instrument trading at a predictably stable or constant trend value over time relative to its face value in specie. Stable and predictable values reduced the costs of transacting internal trade and so enhanced economic performance. Ideally,

those values would be equal to the paper instrument's specie-equivalent face value. If this ideal was not feasible, could the colonists produce a paper instrument that would trade at a constant value *relative* to its specie-equivalent face value? If they could not produce that outcome, could they produce a paper instrument with a predictable trend value relative to the paper instrument's specie-equivalent face value? I assess how the legal tools at the colonists' disposal worked, and how successful they were at achieving this monetary goal, in the second half of the essay.

WERE BILLS OF CREDIT USED AS A MEDIUM OF EXCHANGE?

Absent a time machine and a video camera, we cannot definitively know what colonists used as a medium of exchange to execute domestic transactions. Most bookkeeping accounts, both government and private, and most other surviving records, such as newspapers and probated wills, do not list the instrument used to execute each transaction. Typically, these records convert transaction values into a common local unit of account, such as New Jersey pounds, and then list the transacted values in that unit. This habit made for easy bookkeeping, summing of account values, and value comparisons. However, it leaves future scholars in doubt as to the actual instruments used as the means of payment. The common local units of account, i.e. the "pounds" of each colony, were imaginary monies used as units of account before physical bills of credit, denominated in these units, were created. Prices in these units do not change precipitously from immediately before to immediately after bills of credit were first issued in a given colony (Grubb 2012). Surviving records identifying the actual instruments or monies used to execute domestic transactions are rare and unusual. Selectivity in their recording and survival makes them unreliable for determining the typical medium of exchange.

As a result, scholars have principally relied on literary statements as their primary source to judge the medium of exchange used in the colonies. This evidence overwhelmingly insists that

1) specie monies were scarce, and 2) barter was the common mode of executing domestic transactions before colonists issued bills of credit. Grubb (2012) documents how ubiquitous these statements were relative to contrary statements. Examples include Franklin's observation quoted above, and the preambles to paper money acts passed by colonial legislatures. For example, the preamble to colonial New Jersey's paper money act of 1723 stated,

> Whereas Many Petitions and Applications have been made to his Excellency the Governour of this Province, by the Free-holders, Merchants and Inhabitants of the same, setting forth That the Silver and Gold formerly Current in this Province, is almost entirely Exported to *Great Britain* and elsewhere, and thereby the many Hardships which his Majesty's good subjects, within this Colony, lie under, for want of a Currency of Money... ...for want of a Medium of Trade or Currency of Money; And...to pay the small Taxes for Support of this Government they have been obliged to cut down and pay in their Plate, Ear-Rings and other Jewels; And that many Law-Suits and Differences have arisen, and do daily arise amongst them, which will be the Ruin of a great Number of the said Inhabitants, if some Method be not found out for their Relief. And this Assembly... by a *Paper Currency*,…finding no other Way to Remedy the Grievances aforesaid, of his Majesty's good Subjects here. (Bush 1977, p. 301, italics in the original).

In addition, Franklin's early tour de force pamphlet on Pennsylvania paper money, *A Modest Enquiry into the Nature and Necessity of a Paper-Currency* (1729), makes clear that before bills of credit were emitted, barter was the primary medium for executing domestic transactions, and if legislatures removed bills of credit from circulation, barter would return as the primary transacting medium for executing domestic trades (Labaree 1959, v. 1, pp. 139-57). Similarly, when Maryland was debating its first paper money emission, London merchants advised them that "it is now time to leave off the old way of barter" and have "debts contracted in money" (*Maryland Gazette* 15 April 1729).[6]

The literary evidence claiming that specie monies were not scarce, besides being relatively rare, comes either from anti-paper-money polemicists or involves domestic transactions that were required by law to be in specie monies.[7] As such, this evidence is both unrepresentative and biased. Colonial proprietors required by law that their quit rents be paid in

specie (Grubb 2006a, pp. 57-8). This specie was then exported from the colonies to the proprietors in England. As such, these payments cannot be used to infer that other domestic transactions were executed in specie. In fact, evidence on quit-rent collection indicates that specie was scarce even for this small subset of legally-required domestic specie transactions.

For example, in 1737, Maryland's proprietor complained that, while his quit rents were required to be paid in sterling, he was being paid in foreign gold coins that were "Cut into Small pieces." Because a gold coin was worth more than the sum of its bits, he was being underpaid. Therefore, he directed his agents to measure payments by weight rather than by the tail of the coin. Even so, he complained that he was still being defrauded by his renters "passing Bitts of Brass for Gold" (*Archives of Maryland* v. 40, pp. 47-8).

In the 1750s, Thomas Penn was the proprietor of Pennsylvania. Richard Hockley was the agent collecting his quit rents. Hockley admitted to Penn on 10 October 1751 that "money [meaning specie for paying quit rents] is become scarce..." and again on 11 May 1753 advised that "in answer to your orders of making seizures for neglect of payment of your quit rents...[I] thought it not so prudent at a time when the country was clamoring for more money..." (*Penn Manuscripts* v. 5, p. 183; v. 6, pp. 17, 59, 67).

Contemporary anti-paper-money polemicists typically did not present direct evidence of specie plentitude. Instead, and to the extent that they offered any arguments at all, they relied on a Hume-type specie-flow mechanism to deduce that specie could not be scarce (Rotwein 1970, p. 69). If specie was scarce, then local prices would fall drawing specie into the economy. If specie was plentiful, then local prices would rise drawing specie out of the economy. As such, specie could never be scarce. Specie could be absent only if displaced by some other money. Thus, specie could only be made scarce in colonial America by being displaced by bills of credit. If

bills of credit were removed, then specie would return and not be scarce. These conclusions are deductions, not observations.

Embedded in this Hume-type specie-flow mechanism are two implicit assumptions that do not apply to colonial America—assumptions that scholars seldom discuss. First, the mechanism assumes that colonial economies are fully monetized. In other words, barter is assumed to be so costly and inefficient that no one would execute a local transaction with barter. Second, the mechanism assumes that the opportunity cost of using specie to execute a domestic transaction is zero. In other words, the mechanism assumes costless import substitution.

Grubb (2012) shows both these assumptions are unlikely to hold for colonial America. When these assumptions are relaxed, chronic specie scarcity is possible as a rational maximizing outcome, given no barriers to trade. Colonial Americans could not easily produce goods that could replace imported goods. Given that imports could only be purchased with specie, the opportunity cost of not using specie to purchase these imported goods was positive. Colonists developed relatively efficient barter systems which placed a price floor below which the prices of domestically produced goods could not fall in the face of specie money scarcity. These conditions, namely a positive opportunity cost to using specie coupled with the transaction costs of using barter being only moderately above that of using specie for executing domestic transactions, short-circuited the standard Hume-type specie-flow mechanism. Grubb (2012) provides the modeling details of this outcome. Basically, rational maximizing colonists used specie to buy imported goods, thus sending the specie out of the colony and making it unavailable to execute further domestic transactions. Then they resorted to efficient barter systems to execute their domestic transactions. Chronic specie scarcity was the result.

The colonists developed relatively efficient barter systems. Efficient barter entailed

exchange organized around shop-notes, store book-credit accounts, tobacco credits, promissory notes, individual bonds, and so on, with local goods priced in a common unit of account which allowed easy pricing and account clearing across multiple trades and traders.[8] Efficient barter is illustrated by Henry Callister, a merchant storekeeper in Townside [Crumpton], Maryland. Callister was shipping wheat to Philadelphia sold to him by local planters, and importing goods from Philadelphia to sell back to these same planters. In 1762, Callister's store manager, Nathan Wright, asked what Callister would accept in payment from local customers to clear their store credit accounts. Callister said he would accept almost anything, i.e. any monies, bills, or goods (*Callister Papers*, material just prior to 18 January 1762; Tyler 1978). The clearing of store accounts was flexible with relative indifference between the means used.

Crude barter entails the contemporaneous exchange of goods in the presence of a double coincidence of wants. It is prohibitively costly. Efficient barter extends beyond crude barter. It allows for the time mismatch of demands as well as some limited geographic and individual mismatch of demands. Efficient barter allows the trading of goods in a credit-debt account-based exchange structure. Set-offs and net settlements are used to clear accounts between traders and even among a limited set of traders, without using a store-of-value instrument or money "thing" whose value is independent of the personal reputation of the debtor party to the transaction (Kahn and Roberds 2009). These transactions are still barter exchanges *per se* in that goods are directly canceling goods in the transaction process without the use an intervening money "thing." Because of the credit dimension and use of set-offs and net settlement structures, efficient barter reduces the transaction costs of exchange substantially over crude barter.

A "medium" of exchange necessarily implies a credit dimension in trade, as the store-of-value instrument or money "thing" is moved from the seller in the initial transaction to being

used by that sellers when he turns buyer in the next transaction. Efficient barter is able to capture a limited amount of this valuable credit dimension to trade, as well as some net settlement and set-offs among third parties, without using a money "thing" or non-personal store-of-value instrument. Efficient barter is typically limited to geographically established exchange circuits where repeat transactions and personal reputations are manifest. Efficient barter structures, such as a store book-credit accounts, tobacco credits, bills of exchange, promissory notes, etc., are all individual-reputation dependent for their value. They typically cannot trade, like third-party checks, far afield without significant loss of value. An inside money "thing" that depends only on the government, rather than on each individual user, for its value, if managed well, could lower transaction costs over using efficient barter.

When colonial legislatures emitted bills of credit, these bills displaced efficient barter for executing domestic transactions, not specie monies. Efficient barter had already displaced specie monies for executing domestic transactions before bills of credit were ever issued.[9] In 1767, Franklin explained as much (Labaree 1970, v. 14, pp. 77-9),

> In Report of the [British] Board of Trade, dated February 9, 1764, the following Reasons are given for restraining the Emission of Paper Bills of Credit in America, as a Legal Tender....
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> To consider these Reasons in their Order. The first is, *That Paper Money carries the Gold and Silver out of the Province, and so ruins the Country, as Experience has shewn in every Colony where it has been practised in any great Degree*. This seems to be mere speculative Opinion, not founded on Fact in any of the Colonies. The Truth is, that the Balance of Their Trade with Britain being generally against them, the Gold and Silver is drawn out to pay that Balance; and then the Necessity of some Medium of Trade has induced the making of Paper Money, which could not be carried away. Thus, if carrying out all the Gold and Silver ruins a Country, every Colony was ruined before it made Paper Money.

This margin of displacement occurred because the opportunity cost of using bills of credit to execute domestic transactions was zero, i.e. bills were an inside money with no exportable value. Bills were simply a marginally better transacting instrument than the other barter methods

at hand for executing domestic trades. They had colony-wide acceptance, beyond that of most geographically and personal-reputation constrained efficient barter structures. But even after bills were emitted, the colonies remained under-monetized (Grubb 2012; Rousseau 2006, pp. 98-110). Under-monetization, coupled with the margin of currency substitution being bills displacing other barter methods for executing domestic transactions, explains why economists have failed to find a strong statistical relationship between changes in the amount of bills in circulation and changes in prices. Because bills of credit, compared with using the next best barter alternative, created some marginal improvement in transacting efficiencies for executing domestic trades explains why economists have occasionally found small positive relationships between changes in the amount of bills in circulation and changes in output.[10]

Finally, three pieces of direct evidence point to bills of credit circulating as a local medium of exchange. First, Hanson (1979, 1980) shows that bills throughout the colonies were issued in relatively small denominations with the apparent intent to facilitate the making of change in domestic transactions. The relatively small denomination of the bills would be consist with substantial hand-to-hand circulation. Second, a substantial proportion of bills were emitted through land-bank loans (explained below), see Appendix Table A1. These bills only went into circulation if subjects voluntarily chose to borrow them from their respective colonial treasuries, agreeing to pay at least 4 percent interest per annum on the loaned amount. The possibility that subjects borrowed these bills and just held them, only to have to repay the principal and interest to the treasury later, stretches credulity. It would be an irrational act. Not only must subjects have used the bills borrowed to execute local trades, but they must have expected to gain from such transactions compared with the next best borrowing and transacting alternative.

Third, paper money acts included a reserve sum of bills to be printed for the sole purpose

of replacing worn, torn, and ragged bills that were no longer fit to remain in circulation. Subjects would bring these unfit bills to the issuing treasury and receive new replacements, with the unfit bills being destroyed by the treasury. The size of these reserve funds provides a gauge of how extensively these bills were expected to circulate as a medium of exchange.

For example, the New Jersey emissions of 1733, 1737, and 1769 (the 1769 emission being disallowed by the Crown) each set aside enough extra bills to replace 25 percent of the amount authorized, see Appendix Table A1. These emissions had a 16- to 20-year circulation life (Bush 1977, pp. 427-8, 474-87; 1982, pp. 523-47). The New Jersey emission of June 1756 set aside enough extra bills to replace 20 percent of the amount authorized. This emission had a seven-year circulation life (Bush 1980, pp. 413-25). Finally, the New Jersey emission of 1746 set aside enough extra bills to replace 60 percent of the amount authorized (Bush 1980, pp. 21-8).

Maryland provides a similar example. The Maryland emission of 1733 initially set aside enough extra bills to replace 12.2 percent of the amount authorized (*Archives of Maryland* v. 40, pp. 28-31, 266-9). The Maryland emission of 1770 set aside enough extra bills to replace 6 percent of the amount authorized. This emission had a 12-year circulation life. The Maryland treasury reported that 3.4 percent of this emission had been replaced within the first three years of being placed in circulation. This rate of replacement, if it continued, would exhaust the amount of extra bills set aside for that purpose well before the circulation life of that emission came to an end. As a result, Maryland increased the amount of replacement bills in its next paper money act. The Maryland emission of 1774 set aside enough extra bills to replace 27.8 percent of the amount authorized. This emission also had a 12-year circulation life (Celia and Grubb 2014). Given these three pieces of evidence, it is hard to deny that bills of credit experienced extensive hand-to-hand usage as a medium of exchange.

INSTITUTIONAL CONSTRAINTS: WHY BILLS OF CREDIT?

Colonial governments could not create money *per se*. That was the exclusive prerogative of the sovereign, namely the British Crown. As such, even if the colonies possessed gold and silver bullion—either mined or imported—they were prohibited from minting their own coins. What colonial governments could do was create tradable debt in the form of bills of credit (Newman 2008, p.10). Most colonial bills were non-interest-bearing.

In a speech to the New Jersey assembly on 16 January 1717, Jeremiah Bass, assemblyman from Salem County, argued that colonial paper money was a debt that had to be repaid, but that no interest should be paid on that debt (1717, p. 19),

> To lay a Tax to be paid immediately is impractical and impossible. shall we then borrow Money at Interest, and pass an Act for the Re-payment as the Taxes come in? This would be like the Ass laden with Wool, that lay down in the River to alleviate his Burthen. What then remains but that we borrow of our selves without interest? I mean, that we establish a proper credit, strike so many Bills as will pay the Arrearage, and change the out-standing Bills, and provide an Indubitable Fund for the annual sinking of them. Of all Expedients, I am sure, this will be the most sure, facile and acceptable to the Province. It will furnish us with a current Stock of Money for carrying on our Trade, and payment of our Taxes, give the People Time to make the best Market of their Provisions; and that will render the payment of these Debts of the Province less Injurious to the People.

Bass argued that because paper money was a borrowing from themselves, paying interest was unnecessary. Paying interest also produced an unattractive tax burden. Most bills of credit were structured as zero-coupon bonds (Smith 1937, pp. 310-2).

Oversight by the British government and by the proprietors of some colonies constrained paper money creation. Paper money acts could be disallowed. The debates with a colony's proprietor were often not about paper money *per se*, but about political rights and prerogatives. Typically, proprietors wanted to be exempt from having to accept their colony's bills in payment of the quit rents owed them, and proprietors also wanted a say in how bills could be spent. Colonial assemblies typically wanted the opposite. Wrangling over these issues often delayed

and shaped paper money acts (Brock 1975, pp. 354-62; Grubb 2008).

Colonial paper money legislation was also constrained by the British Parliament. In 1741, Parliament extended the 1720 Bubble Act to the colonies. This made joint-stock corporations, except those chartered by the Crown, illegal (Harris 1994; Newell 1998, pp. 228-30; Priest 2001, p. 1379; Smith 1937, p. 304). Thus, banking operations in the colonies were made prohibitively costly in terms of being unable to adequately raise capital and spread risk among bank stockholders. Banking structures successfully emitting paper banknotes backed by fractional specie reserves, with banknote exchangeable for their face value in specie on demand at the issuing bank, would not appear until near the end of the American Revolution. Colonists saw specie-based fractional-reserve banking as the preferred way to emit a paper instrument that would always trade, except in liquidity crises, at its face value in specie.[11] They were, however, effectively barred from this line of monetary development by British regulation.

Problems with New England's paper money led Parliament to pass the Currency Act of 1751 (Newell 1998, pp. 231-3; Officer 2005; Priest 2001, pp. 1383-4). This Act applied only to New England. It outlawed making bills of credit a legal tender in private transactions. It also restricted the emission-to-final-redemption interval to be a maximum of two years in peacetime and five years during wartime. Problems with Virginia's bills in the early 1760s led Parliament to pass the Currency Act of 1764. This Act applied to all the colonies and outlawed making bills of credit a legal tender for any transaction. It did not restrict the emission-to-final-redemption interval as was done to New England by the Currency Act of 1751. After colonial protests, Parliament in 1773 amended the Currency Act of 1764 to allow bills to be made a *de jure* legal tender for public debts (Ernst 1973, pp. 77-88, 282-311).

The prior literature fails to explain why these Acts took the form they did. The Acts did

not prohibit paper money as is often erroneously stated in the literature. Given that legal tender laws did not determine the market value of paper money (established below), why were these Acts primarily about legal tender laws? By treating bills of credit as zero-coupon bonds and legal tender laws as a tort law problem, I make consistent and coherent sense of these Acts.

Lastly, the British government did not allow the colonies to implement capital-trade controls that would restrict the exportation of specie monies from the colonies. By contrast, the British government restricted the free exportation of specie monies from Britain. Colonists constantly complained that as fast as specie monies were imported they were exported to England to cover the colonies' trade deficits with the mother country. The conditions necessary for chronic specie scarcity were present in colonial America (Grubb 2012). Colonial treasuries never held specie reserves in meaningful quantities. Colonial treasuries functioned only as an intermediary between tax inflows and colonial assembly spending outflows.

HOW COLONIAL PAPER MONIES DIFFERED

Appendix Table A1 documents the individual paper money emissions in British North America by colony in sequence from the first emission through 1774. This information was taken from original legislation, i.e. from primary sources, for New York through Virginia, and from secondary sources for New England, North and South Carolina, and Georgia. In addition, information was taken from what was printed on surviving bills as compiled by Newman (2008). While this information is a substantial improvement over the prior literature, future researchers still need to fill information gaps indicated in the table.

Paper money emissions began in 1690 in Massachusetts; 1703 in South Carolina; 1709 in Connecticut, New Hampshire, New Jersey, and New York; 1710 in Rhode Island; 1712 in North Carolina; 1723 in Pennsylvania and Delaware; 1733 in Maryland; and 1755 in Virginia and

Georgia. Once initiated, colonial legislatures, with irregular frequency, continued to enact new emissions. Appendix Table A1 shows considerable variation in the size, structure, and characteristics of the paper money authorized, both across colonies and over time within a given colony. Some emissions paid an interest, and some did not. Some emissions were made a legal tender, and some were not. Emissions had differing redemption intervals specified in their authorizing legislation. Some emissions had portions set aside as land-backed loans for the colony's subjects, and some did not. Some emissions had future redemptions linked to an accumulating sinking fund comprised of specie-denominated assets. Most emissions, however, linked future redemptions to explicit taxes or land-backed loans that could be paid in those emissions or their specie equivalents.

Appendix Table A1 shows that most emissions had legislated redemption periods. These periods varied by emission both across colonies and across emissions within a given colony. The typical redemption window had bills removed at a rate of 1/N per year over an N year redemption span which typically ran from the year after initial emission to the last year (N) of the legislated redemption window. Different emissions had different N-year spans. Some redemption legislation imposed slight variations on the 1/N method, with 1/N not being exactly the same in all years or with redemptions not starting until some years after the bills were first emitted. Redemption structures were occasionally altered by legislatures given emergency circumstances or to correct past failures to execute redemptions as legislated. Some emissions, e.g. in Maryland, were legislated to be redeemed only in year N.

Because most emissions did not pay interest and had explicitly legislated redemption dates, they can be characterized as zero-coupon bonds with various maturities. Given the variation in maturity dates, the present value of the bills when treated purely as bonds would

experience substantial differences both across colonies and across emissions within a given colony. This observation implies that summing the face of value of bills from different emissions, or even from the same emission at different points in time, is a meaningless exercise. The present value of a bill was contingent on its uniquely legislated redemption structure, on its timing and location within that redemption structure, and on the discount rate.

Interest bearing bills only appear in New England after the passage of the 1751 Currency Act, in Virginia from 1755-6, and in North Carolina from 1756-8. A few colonies had de facto interest payments attached to their first emissions in the form of payment discounts when using their bills, e.g. see Massachusetts, Connecticut, New Hampshire, New York, New Jersey, North Carolina, and South Carolina. After these initial emissions, these colonies turned to a zero-coupon bond structure for subsequent new emissions. Lastly, most colonies made their bills legal tender within their colony until they were stopped either by the 1751 or 1764 Currency Acts. This behavior, however, was not universal. A few emissions in early New Hampshire, Rhode Island, North Carolina, and South Carolina were not designated a legal tender even though doing so would have been allowed.

Most emissions were injected into the economy via direct spending by the colony's legislature. This direct spending of emissions was concentrated in war periods, i.e. 1690-1 for King William's War, 1702-13 for Queen Anne's War, 1739-48 for the War of Jenkin's Ear and King George's War, and 1754-63 for the Seven Years and French and Indian War. Most of this direct spending was paying for war costs, e.g. soldiers' pay and war materials. These direct-spending emissions were also primarily linked to redemption via future tax payment obligations legislated concurrently with the paper money acts.

By contrast, land-bank emissions were more likely to occur during peacetime. When

there were not enough spending obligations to support the direct injection of bills into the economy, legislatures needed some other way to injects bills into the economy. Allowing subjects to borrow newly printed bills from the treasury at a below-market interest rate, with the borrower's lands pledged as collateral for the loan, was a popular peacetime bill-injection mechanism. A few other bill-injection mechanisms were used, such as Maryland using some of its first emission to pay planters to destroy trash tobacco in their possession.

Lastly, Appendix Table A1 shows that most emissions of a given colony, given their redemption time windows, overlapped in circulation with the circulation of immediately prior and immediately subsequent emissions. Overlapping emissions are phenomena that have not been previously addressed in the literature. I discuss their role below in stabilizing the value of representative bills over time.

Material printed on the face of the bills informed holders about each emission. Besides the monetary denomination, two additional pieces of information appeared on all bills, namely the date of emission and the colony emitting the bill. Thus, subjects could always distinguish emissions by the colony-date printed on the face of the bill. This information could then be matched to the dates of the authorizing legislation, thus providing subjects with complete information about how each emission was structured.

The material printed on the face of the bills also stated consistently whether interest would be paid. If a bill paid interest, that was stated with the interest rate on the face of the bill. By inference, when no interest rate was supplied, subjects could be certain that the bill paid no interest. By contrast, redemption dates for specific emissions were only irregularly printed on the face of the bills. In some colonies, redemption dates were often printed on the face of the bills, e.g. see Connecticut, New Hampshire, Rhode Island, North Carolina, Georgia and, after 1740,

South Carolina. In others, no redemption dates were printed on the bills even though redemption dates were so legislated, e.g. see New York, New Jersey, Pennsylvania, Maryland, and Virginia.

While the value terminology printed on bills varied across emissions, both across colonies and over time within a given colony, it had a common meaning. This information functioned as a unit-of-account reference for the numerical value printed on the bill. “Lawful money”, “current money”, “proclamation money”, or some specie statement on the face of the bill referred to the unit-of-account equivalence between pounds sterling, or the specie money named, and the pounds of particular colonies. These equivalences served unit-of-account and tax-receipt purposes only. No one, including colonial treasuries, stood ready, or were obligated, to exchange bills for specie on demand at the unit-of-account equivalences stated on the face of the bills. These unit-of-account equivalences fixed values at the point of redemption only.

Statements printed on some bills indicated how the bills could be redeemed. Early on in New England, New York, and New Jersey a subject could redeem a bill at the treasury of the respective colony for any “stock” or “fund” in the treasury. While such statements printed on the bills disappeared by mid-century, this redemption option continued to be legislated into each emission’s structure, for example see the paper money acts passed by Virginia between 1755 and 1771 (Hening 1969, v. 6, pp. 461-81, 521-30; v. 7, pp. 9-25, 26-33, 46-54, 69-87,163-9, 171-9, 255-65, 331-7, 347-58, 357-63, 493-502; v. 8, pp. 342-8, 493-503). Colonies employed this option to rebalance paper money final redemption requirements within their respective colonies.When a colony emitted paper money, it also set future taxes or loan principal repayments to redeem and remove that paper money from circulation. Colonial assemblies realized that at the point of final redemption the future tax and loan payment obligations used to retire the paper money and the possession of that paper money would not be perfectly

synchronized among its subjects. The transaction costs of trading paper money among a colony's subjects to perfectly realign each subject's possession of paper money with that subject's tax and loan payment obligations at the point of final redemption were burdensome and fraught with potential hold-ups of one subject against another.

Colonial assemblies solved this problem by allowing subjects to pay their tax and loan payment obligations either in the colony's paper money or in some other medium, such as in grain or specie, at a fixed rate to the colony's paper money. Subjects that did not have, or could not acquire in time, the colony's paper money, paid their taxes and loan payments in these other media. Subjects that had more paper money than they owed in taxes and loan payments could cash in their excess balances of paper money at the colony's treasury for the grain or specie at the bill's face value equivalent, i.e. for the "stock" or "fund" in the treasury, paid in by the subjects who did not have the paper money to pay their tax and loan payment obligations. Because final paper-money-redemption taxes and loan payments were set equal to the quantity of paper money emitted, this method rebalanced tax and loan payment obligations and paper money holdings among the colony's subject.[12] Prior to final redemption, this redemption option was rarely exercised, which explains why printing this redemption options on the face of the bills fell into disuse by mid-century. I explain why this redemption option was seldom exercised pre-final redemption, and the conditions under which it would be exercised, below.

Finally, information printed on some bills indicated that redemption would be in sterling bills of exchange. For example, after 1764 Maryland linked redemption of its paper money to a sizable fund it had accumulated in Britain of Bank-of-England stock. Maryland paper bills explicitly stated on their face that the bearer of the bills were entitled to "receive *Bills of Exchange* Payable in LONDON..." at the rate of four shilling, 6 pence per dollar of the said bill

(Newman 2008, pp. 171-3). This entitlement, however, was not for exchange on demand, but only for exchange at legislated maturity dates.

In summary, Appendix Table A1 shows considerable variation among the paper monies emitted across the colonies and within a given colony. Paper money was not just paper money. Monetary experimentation on a grand scale was afoot. I address next the structure and performance of the various mechanisms used by the colonies to anchor their paper monies to real values in their respective economies. First, some modeling guidance is provided:

The market exchange value (MEV) of bills of credit can be decomposed into their expected real-asset present value (APV), i.e. their value as just another non-money barter asset; minus a risk discount (RD) that captures any expected excess default risk connected with this asset; plus their liquidity premium (LP) that encompasses their "moneyness" value, i.e. their extra value as a transacting medium, see equation (1).[13] All components in equation (1) are calculated as a percentage of face value to be in a comparable metric. For a pure fiat currency MEV ≈ LP and its APV ≈ 0. For a pure commodity or asset money, produced in an open-access competitive market, arbitrage yields MEV ≈ APV, leaving its LP ≈ 0 in long-run equilibrium.

(1) $MEV_t = APV_t + (LP_t - RD_t)$

If $(LP_t - RD_t)$ is assumed to be relatively small, then most of MEV is determined by APV, which in turn is governed by the redemption structure legislated. For New Jersey and post-1764 Maryland, $(LP_t - RD_t)$ has been estimated to be relatively small (Celia and Grubb 2014, Grubb 2014). LP was not directly controlled by the legislature. It was determined by the next best alternative means of executing domestic trades in the colony, i.e. efficient barter. Only a small LP was needed to make paper money preferred to using efficient barter. RD was under the control of the legislature. They could keep it near zero by crafting a credible redemption

structure and following through on its execution. When colonies did that, it was likely that MEV ≈ APV. APV was directly controlled by the legislature. They set the parameters that determined the present value of the bond structure underlying their bills of credit, see equation (2).

(2) $APV_t = f(r, i, red_t, N)$
r = the discount rate, i = the interest rate paid on the bills held, N = the length of the redemption window or maturity, red_t = yearly redemption structure within the redemption window, with $\partial APV/\partial r < 0$, $\partial APV/\partial i > 0$, and $\partial APV/\partial N < 0$.

Calculating APV requires knowing the market interest (discount) rate r for low-risk assets. No quantitative interest rate data for any class of assets currently exists for colonial America. The typical or normal interest rate mentioned in the literature is used as this market rate. This rate is derived from legislative acts and literary evidence about what the normal rate was. This evidence overwhelmingly places that rate at 6 percent for eighteenth-century America. Early in the century, that rate may have been higher, e.g. around 8 percent.[14]

I assume bill holders used a 6 percent rate to discount future payments, and I use 6 percent in all APV calculation exercises presented below, in part because the issuing colonial government was the single guarantor of redemption. RD adds additional points to this normal discount rate to account for any added risk of default expected above the norm. This RD addition could vary by emission because it depends on the credibility of the redemption exercise created and executed by the legislature for each particular emission. If legislatures maintained credible redemption exercises for all emissions, then RD would add no discount variance across emissions. By contrast, the discount rates subjects applied to bills of exchange varied from bill to bill, because the guarantors of each bill-of-exchange's redemption were different individuals with different risks of non-redemption.

Given differing N, red_t, and i per emission, the APV_t, and hence MEV_t, of bills from a given emission, per given r, would differ across the circulation years of that emission, as well as

across emissions in the same colony and between emissions of different colonies. As such, comparing the face value of bills over the circulation history of an emission, summing the face value of bills across emissions in a given colony, and summing the face value of bills across colonies are meaningless exercises.[15] Paper money is not just paper money.

Given a market discount rate (r) and assuming (LP - RD) ≈ 0, colonial legislatures could control the market exchange value (MEV) of their paper money by controlling its APV through how they structured and executed N and red_t and by selecting an i. Using these tools, could colonial legislatures achieve their monetary goal of creating a stable paper money that always traded at its specie-equivalent face value or, barring that, always traded at a stable value *relative* to its specie-equivalent face value or, barring that, traded at a predictably stable trend value relative to its specie-equivalent face value? The following sections explore these potentialities.

REDEMPTION MECHANISMS FOR ZERO-COUPON BONDS

Bills of credit that paid no i and so functioned as zero-coupon bonds were the most typical emitted by colonial legislature. Three different redemption mechanisms were used, i.e. redemption through payment of future taxes, redemption through payment of loan principal, and redemption using an accumulated sinking fund. All three mechanisms produce a similar APV calculation, even though their administrative structures differ considerably.

The Tax-Redemption Mechanism

The tax-redemption mechanism was the most ubiquitous, in part because it was used to meet wartime emergency spending. Colonial governments faced standard budget constraints. Tax receipts had to match spending. When they didn't, colonial governments had to adjust their borrowing and asset positions. For the most part, colonial governments did not have asset positions, such as stocks of gold and land. In addition, external markets where colonial

governments could borrow and lend were not adequately developed or accessible. Thus, when current tax receipts did not match current spending, colonial governments moved tax receipts through time to balance current budgets.

They did this by issuing bills of credit (M), see equation (3). Local taxes could be paid in these bills or in specie at a legally fixed equivalence to bills for tax receipts. This rate would be the stated par or face value of the bills. Paper money creation was a credit-debt mechanism that matched budget deficits with budget surplus over a multi-year horizon. As such, the balanced budget requirement was cut loose from a strict time unit, such as always being balanced over the fiscal year. It still had to be balanced, but now it could be balanced over a multi-year horizon. To achieve this outcome, colonial paper money acts included concurrent tax legislation designed to remove the authorized bills emitted in the near future.

$$(3) \qquad 0 < (G_j - T_j) = M_j \leq \sum_{t=j+1}^{N} (T_t - G_t) > 0$$

M_j = face value of new emissions of M (bills of credit) in year j
T = taxes paid in M or its specie equivalent at face value
G = government spending

To maintain fiscal credibility, future taxes in excess of spending, $(T_t - G_t) > 0$, had to be spread over numerous years, especially when M_j was large such as from wartime emergency spending. This structure imparted a time-discounting dimension to the bills' APV. This time-discounting would typically vary with the size of M_j, which in turn depended on the size of the budgetary (wartime) emergency.

The typical method of tax-redemption was to set net new taxes to redeem M_j to be an equal amount per year ($₸_t$) over the N-year redemption window, i.e. $(T_t - G_t)/N = ₸_t$ for years j+1 through N. Under this condition, M_j is removed from circulation at a constant rate over the N-year redemption window. While setting redemption taxes at $₸_t$ was the most typical, it was not

universal. Often colonial governments enacted small variations in T_t over the N-year redemption window. Thus, calculating the APV of each emission requires a unique exercise depending on that emission's explicit T_t structure.

The Land-Bank Loan Redemption Mechanism

When colonial governments did not have enough emergency spending to serve as a basis for emitting new M, they typically turned to a land-bank loan mechanism to emit new M into the economy. Bills of credit were printed and placed in the colony's treasury and subjects could borrow bills on interest, pledging their lands as collateral (Celia and Grubb 2014, Grubb 2015, Thayer 1953). Loan principal would be repaid to the treasury on a fixed schedule, thus removing the bills from circulation. See equation (4).

$$(4) \qquad M_j = \sum_{t=j+1}^{N} L_t$$

L = loan principal paid (redeemed and so retire) each year

This land-bank redemption mechanism imparted the same time-discounting structure to the bills for calculating a bill's APV as did the tax-redemption mechanism. The N-year redemption window could vary across emissions, thus yielding variation in the APV of bills from different emissions regardless of whether those emissions employed land-bank or tax-redemption mechanisms. Tax-redemption and land-bank-loan redemption mechanisms, however, may have had differing effects on (LP - RD) in equation (1), see Grubb (2014).

The time structure of redemption was typically more varied across land-bank emissions than across tax-redemption emissions. Sometimes all the principal would be redeemed only in that last year of the loan period, i.e. $M_j = L_N$ with $L_t = 0$ for $t < N$. More typical, and similar to the tax redemption mechanism, L_t was set at a constant face value amount $Ł_t = L_t/N$. In this case, M_j was removed from circulation, and so the face value of the paper money supply shrank, at a

constant rate over the N-year loan redemption window. Often, however, colonial governments would re-loan the principal payments received during a designated portion of the loan period N. This action kept the amount of bills in circulation constant at M_j over that portion. Such patterns alter the time-discounting calculations needed to determine APV. Again, calculating the APV of each emission requires a unique exercise depending on how that emission's L_t was structured.

An additional issue affecting APV calculations for the land-bank loan mechanism is how the annual interest income earned (E_t) from the loans was used by the colonial government, see equation (5). The annual interest subjects had to pay on their loans was a percentage point or two below the typical market rate.[16] This incentivized subjects to borrow the bills and put them into circulation. Land-bank emissions always appear to be fully loaned out.

$$(5) \qquad i' * [\sum_{t}^{N} (L_t)] = E_t$$

E = interest earnings each year
i' = yearly interest charged on loans of M; with $i' < r$

Some colonial governments used the interest income (E_t) as current revenue and spent it on current salaries, etc. This revenue formed an important part of the spending revenue for some colonies, e.g. New Jersey, and allowed them to reduce current taxes (Grubb 2015). This action kept the bills paid in as annual interest in circulation. Thus, the money supply (M_j) left in circulation would strictly follow the L_t-redemption process.

Some colonial governments, however, loaned the annual interest earned back out, thus increasing the principal to be redeemed by year N to more than the initial M_j available to be loaned, e.g. Maryland after 1769 (Celia and Grubb 2014). This action did not alter the M_j left in circulation or the APV calculation process. The only difference was, for colonies following this method, they would collect more specie income in year N because more principal was now outstanding than there were bills in circulation to pay that principal.

Finally, some colonies used the annual interest income to retire bills from circulation, e.g. see New Jersey in the 1720s (Grubb 2015). This process altered the APV calculation from those methods outlined above as it altered the path of M_j left in circulation from that yielded by a strict L_t-redemption process. Again, calculating the APV of each emission requires a unique exercise depending on how that emission's E_t was used.

The Sinking Fund Redemption Mechanism

Using a sinking fund as a redemption mechanism was practiced primarily by Maryland. Given an amount of paper money (M_j) emitted by the colonial government, taxes were concurrently legislated that were payable in specie over a number of years j+1 to N, with the proceeds placed in an interest-bearing fund. At N, when the fund was expected to equal the amount of M_j initially emitted, M_j would be exchanged for the specie in the fund at M's face value in specie, see equation (6).

$$(6) \qquad M_j \leq S_N = \sum_{t=j+1}^{N} [\{(T_t - G_t) = S_t\} + r^* \sum_{t=j+1}^{N} S_{t+1}]$$

S = the sinking fund in specie-denominated assets
r = market interest rate (the discount rate)

Compared with the tax-redemption and land-backed loan mechanisms, the taxes filling the sinking fund could not be paid in bills (M_j). At maturity, however, the bills would be swapped at face value for specie-denominated assets, as opposed to being swapped at face value for specie-equivalent tax obligations or loan principal repayment obligations. This administrative difference, however, does not matter to the APV calculation given face value specie-equivalent redemption at maturity for each mechanism. As such, the sinking fund mechanism yields the same APV calculations as the special case of the tax-redemption and land-backed loan redemption mechanisms when all redemptions are structured to take place in year N and none in

the intermediate years between j+1 and N.

Calculating APV_t

If redemption takes place only in year N (year 0 in Figure 1), then the APV_t of a bill is simply $e^{-r(N-t)}$. In year N (t = N), namely at the point of redemption, $APV_N = 1$, i.e. its face value in specie. At five years before N, namely five years prior to redemption, with a 6 percent discount rate, $APV_5 = .74$, i.e. the bill is worth 74 percent of its face value in specie. Figure 1 shows the time-discounted path of a bill's APV_t, using a 6 percent discount, for a new bill that is redeemable 10 years later.[17] The bill's APV_t starts at 55 percent of face value when issued and slowly rises to face value 10 years later at the point of redemption. This is simply time-discounting, not depreciation. Under this method, the legislature cannot structure the redemption of bills to always have them trade at face value. They will only trade at face value at the point of redemption (maturity). The APV_t for this redemption structure is certain. There is no range of realized values around its solid-line path in Figure 1.

If bills are redeemed at some rate k_t over the redemption window j+1 to N, then APV_t is calculated as shown in equation (7). The outcome when k_t is a constant, namely 1/N, is shown in Figure 1 as the 1/N dotted line. This redemption structure pushes APV_t closer to trading at face value than when redemption is in year N only. However, it still cannot achieve bills trading at face value except in year N. Again, this below-face-value outcome is not depreciation, but simply time-discounting, i.e. rational bond pricing.

$$(7) \qquad APV_t = \sum_{t}^{N} k_t * e^{-r(N-t)}$$

k_t = share of M_t redeemed each year from t to N, with $\sum_{t}^{N} (k_t) = 1$

While pushing APV_t closer to face value than the redemption at N-only structure, this 1/N redemption mechanism comes with a cost. Paper money acts did not indicate which bill from

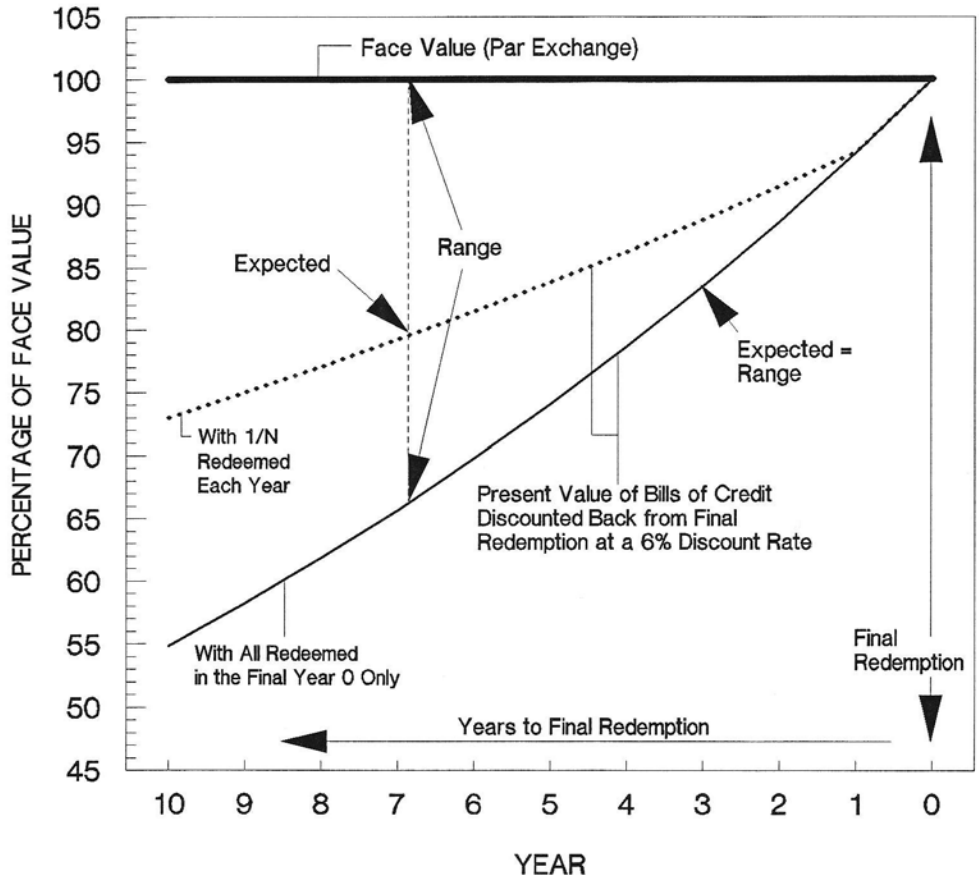

Figure 1. Present Value of Bills of Credit between Emission and Redemption

an emission would be redeemed in which year within its j+1 to N redemption window. Thus, the dotted line in Figure 1 showing the APV_t path for the 1/N redemption structure is only the *expected* present value or the APV_t of a representative bill currently outstanding in year t. The realized range around that expected present value, at any point in time, extends from face value to the solid line showing the APV_t for the N-only redemption structure. This range of realized values makes for a cumbersome medium of exchange.

Using an approximate 1/N per year redemption structure may have been necessary to achieve fiscal credibility. The 1/N structure is consistent with a fiscal obligation smoothing strategy, revealing a credible commitment to keeping taxes and loan principal repayments within historically acceptable and feasible yearly limits, thus keeping RD ≈ 0 as best they could. Most

colonies relied on a redemption mechanism close to the 1/N per year method.

Using an approximate 1/N per year redemption structure for each emission also explains why the specie redemption option was rarely exercised pre-final redemption. By law, subjects could pay their yearly tax and loan obligations to the government either in that government's bills or in the bill's face value specie equivalents. Prior to final redemption, i.e. in the years j+1 → N, a bill's expected value, namely its $APV_t \approx MEV_t$, was less than its face value in specie, see Figure 1. A subject who happened to possess specie but no bills, could come out ahead by exchanging his specie for bills with his neighbors at the current expected APV_t price. He would then pay his current government obligations in bills rather than directly with his specie. Only if the transaction costs (TC) of exchanging specie for bills in the local economy exceeded the current time-discounted value of the bills, i.e. only if $TC > (1 - APV_t)$, would a subject exercise the option to directly pay his current obligations to the government with his specie.

For example, suppose in 1724 I have a current payment obligation of $1.33£_{NJ}$ to the New Jersey government ($£_{NJ}$ = New Jersey paper pounds) which must be paid to my local county tax and loan-office collector. The specie equivalent at the bill's face value would be a $1£_{Sterling}$ payment (Grubb 2015, pp. 16, 18). But in 1724, the expected $APV_t \approx MEV_t$ of a $£_{NJ}$ was about 80 percent of its face value, roughly corresponding to year 7 in Figure 1 (Grubb 2014). Thus, if I had $1£_{Sterling}$ and no $£_{NJ}$, instead of using my $1£_{Sterling}$ to directly pay my obligation, I would trade my $1£_{Sterling}$ to my neighbors in exchange for $1.66£_{NJ}$. I would then pay my $1.33£_{NJ}$ obligation to my local county tax and loan-office collector in bills and have $0.33£_{NJ}$ left over, compared with directly paying my obligation using all my $1£_{Sterling}$.

Now suppose that I live in Vineland, New Jersey and most bills are circulating near the seats of government in Burlington and Perth Amboy, New Jersey, e.g. the bills issued to pay

government salaries. If the cost of getting from Vineland to Burlington or Perth Amboy is greater than 0.33$£_{NJ}$, then I would exercise my legal option to pay my obligation in specie, i.e. with my 1$£_{Sterling}$, rather than incur the expense of being forced to search out bills to buy in the colony. The specie redemption option protected subjects from those rare situations where the high transaction costs of currency exchange would impose an undue realized tax burden on them. The rarity of this condition, however, explains why colonial treasuries were seldom paid specie and so rarely had such "funds" on hand that could be claimed by bill holder prior to final redemption.

Did Colonists Understand the Necessity of Time-discounting Zero-coupon Bonds?

Subjects understood the necessity of time-discounting bills of credit that were structured as zero-coupon bonds. For example, in the New Jersey provincial council in 1758, Lewis M. Ashfield based his objection to paper money on the time-discounting properties of these bills and the effect that a lengthy redemption had on their present value. He said, "...as the whole Credit of a Paper Currency depends upon its Sinking [redemption], which by being put off to a long day will he Conceives greatly Contribute to Lessen it's Value..." (Ricord 1892, v. 17, p. 159).

In 1764, Benjamin Franklin, in the longest speech of his career (among his surviving texts), explained to the Pennsylvania Assembly exactly how bills of credit structured as zero-coupon bonds worked in terms of time-discounting and present value. In reference to an emission of 50,000$£_{PA}$ ($£_{PA}$ = Pennsylvania pounds) in bills of credit proposed in late 1763, Franklin pointed out "The true Way in my Opinion to preserve a Value in our Paper Bills nearly equal to the nominal Sums we stamp on them..." He argued that the method of tax-redemption at future dates could not achieve this outcome because of time-discounting. He stated,

> At present every Bill that I receive tells me a Lie, and would cheat me too if I was not too well Acquainted with it. Thirty Shillings in our Bills, according to the Account they give of themselves should be worth *five* Dollars; and we find them worth but *four*: They should be worth 22*s*. 6*d*. Sterling, and we find them worth scarce 17*s*. 2*d*. Sometimes

indeed more or less... When we sit here in Legislation, we have great Power, but we are not almighty. We cannot alter the Nature of Things. Values will be as they are valued or valuable, and not as we *call* them. We may stamp on a Piece of Paper, This is *Ten Shillings*, but if we do not make some other Provision that it always be worth *Ten Shillings*, the *Say-so* of our Law will signify little. Experience in other Colonies as well as in ours, have demonstrated this.

...we propose to found the Credit of these Bills on a Tax to be raised, which is to sink them as I understand in Six Years at one Sixth Part per Annum, for the due punctual Performance of which there is to be the Sanction of a Law. If this be the Case, and allowing the Security to be good, of which I make not the least Doubt, (tho' some Colonies have by subsequent Laws postpon'd the Payments they had engaged to make, for much longer Terms) I say, supposing the Law punctually executed, it is not difficult... to compute what real Value that Fund [the proposed tax redemption] gives the Bills. When you pay them out, it is instead of so much *real Money* which your owe and ought to pay immediately, but not having the Money to pay, these are your Promisory Notes, obliging you to pay the whole Sum, not upon Demand, but in Six Years by annual Quotas; they are therefore in the nature of things, and between honest Men, really worth no more than the Sum that remains, when Interest for the Time is deducted; and allowing that publick Security is something better than private, I shall state that Interest at 5 per Cent only; then

The Interest of £50,000 for the first Year is		£2500: 0:0
Do of 41,666: 13:4	2d Year is	2083: 6:8
Do of 33,333: 6:8	3d Year is	1666: 13:4
Do of 25,000: 0:0	4th Year is	1250: 0:0
Do of 16,666: 13:4	5th Year is	833: 6:8
Do of 8,333: 6:8	6th Year is	416: 13:4
	Total of Interest	£8750: 0:0

This Sum, £8750, taken from £50,000
8,750

leaves £41,250 for the *true Value* of the promisory Notes, or we call them, Bills of Credit, which is always 20 per Cent less than their nominal Value; and if People should compute the Interest at 6 per Cent instead of 5, and have withal any reason to doubt the Punctuality of the Government as to the Time of Payment, their Value would be proportionally lower. (Labaree 1967, v. 11, pp. 13-5).

While presented differently by Franklin, when his numbers are recalculated to be percentages of face value between emission and final redemption, they are the same as depicted in Figure 1.

In 1767, Franklin explained to the British how colonial bills of credit structured as zero-coupon bonds functioned as money. In a paper titled "The Legal Tender of Paper Money in America," presented to a Ministry in Britain on 13 February 1767, Franklin wrote,

> ...a Bill [of credit] promising Payment at Distant Periods of Time,...depending solely on such distant Payment for its Value, how good soever the Security that the Payment shall be punctually made, is not and cannot possibly be of Value equal to the Sum expressed in it [on its face], but must suffer a Discount in Proportion to the Time. Hence the Discount will be greatest soon after the Bills are issued, that is, as soon as the Nature of them begins to be understood; and, as the Term of Payment approaches, the Discount will gradually become less till it amounts to nothing worth Notice.
>
> But such a daily changing Medium is from that Circumstance inconvenient and unfit for the Purposes of Commerce, whose Measures ought to be as much as possible fixed and certain, and easily understood, the common People being incapable of nice Computations (Labaree 1970, v. 14, pp. 35-6).

Besides describing the APV_t time-path of a bill as shown in Figure 1, Franklin also noted how the necessity of time-discounting made for a cumbersome medium of exchange.

In 1776, Adam Smith, in the *Wealth of Nations*, made similar observations which, like Franklin's, are consistent with the model depicted in Figure 1. Smith wrote,

> The paper currencies of North America consisted, not of bank notes payable to the bearer on demand, but in a government paper, of which the payment was not exigible till several years after it was issued: And...the colony governments paid no interest to the holders of this paper,... But allowing the colony security to be perfectly good, a hundred pounds payable fifteen years hence, for example, in a country where interest is at six per cent. is worth little more than forty pounds ready money.... (Smith 1937, pp. 310-2).

Finally, bills of exchange were a familiar and commonly used private payment instrument within the transatlantic merchant community. The face value of a bill of exchange was its payment at some designated future date at some designated distant location. Bills of exchange were discounted, i.e. sold below their face value, with the difference between the face value and the sale price capturing the implicit interest, transaction, and risk costs of carrying the bill to execution. Everyone understood this. Bills of credit were structured the same way, and so the public would have been familiar with how to assess their present value.

OVERLAPPING ZERO-COUPON BOND REDEMPTION STRUCTURES

Monetary emissions were not one-off exercises. Once the redemption exercise had removed an emission from circulation, another would soon take its place. Typically, colonies

would authorize a new emission before the prior emission had been removed from circulation, thus operating overlapping emission-redemption structures. Figure 1 shows that bills of credit structured as zero-coupon bonds would never trade at face value except at the point of final redemption, nor would they ever trade at a constant value relative to their face value. Could overlapping emission structures improve this outcome?

Figures 2, 3, and 4 model the outcome of such sequential and overlapping emission-redemption structures. These models are ideally structured monetary policies used to illustrate what colonial legislatures could potentially achieve. Figures 2, 3, and 4 maintain the same assumptions used to construct Figure 1, and use the 1/N yearly redemption structure. Figures 2, 3, and 4 expand Figure 1 to make the process sequential and overlapping. The only differences are that Figure 2 assumes that the redemption interval for each emission is four years with 1/4th redeemed each year; Figure 3 assumes that the redemption interval is ten years with 1/10th redeemed each year, and Figure 4 assumes that the redemption interval is 16 years with $1/16^{th}$ redeemed each year. In addition, the horizontal scales of Figures 2, 3, and 4 are reoriented to be forward looking as opposed to retrospective as in Figure 1.

Sequential emissions impart an oscillating present value to the bills; the longer the emission-to-final-redemption time interval, the more amplified the oscillation. When emissions are perfectly sequential with no overlap, the four-year redemption window in Figure 2 has the present value of its bills cycling between 86 percent and 100 percent of face value, the ten-year redemption window in Figure 3 between 73 percent and 100 percent of face value, and the 16-year redemption window in Figure 4 between 62 percent and 100 percent of face value. Such volatility, even if perfectly predictable, is not a desirable feature for an easy-to-use medium of exchange. The above oscillation can be dampened by having emissions overlap.

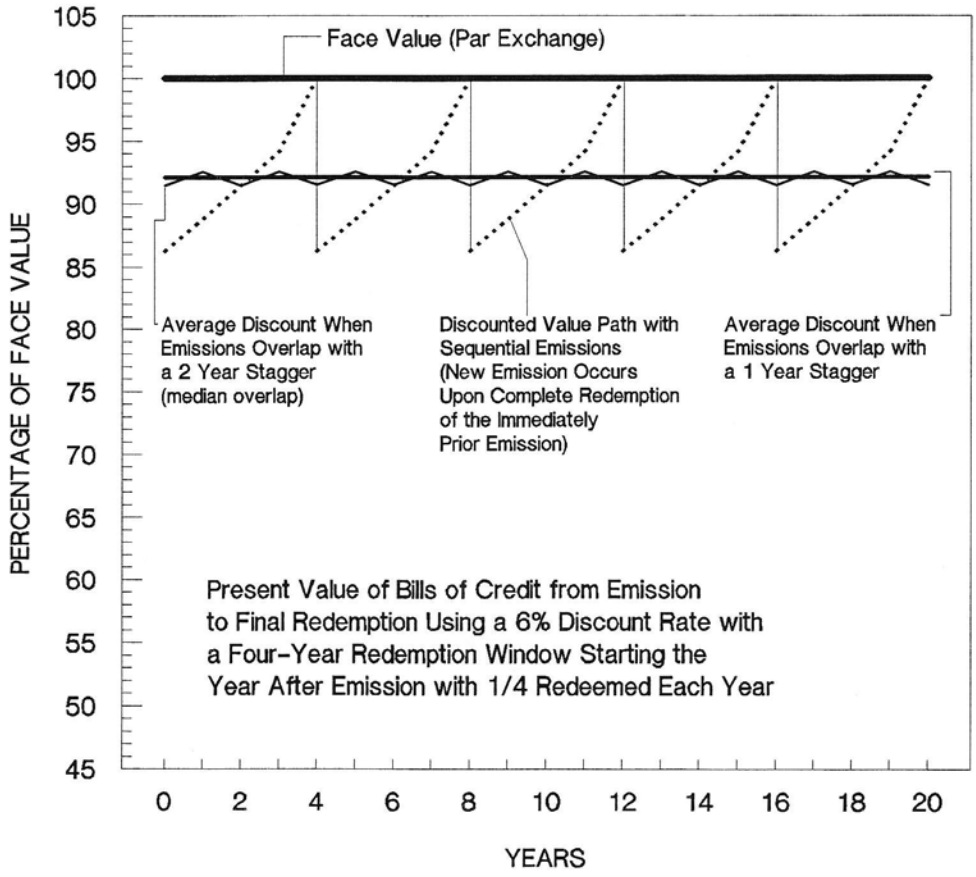

Figure 2. Present Value of Bills of Credit between Emission and Redemption with a Four-Year Emission Redemption Window, and with Sequential and Staggered Overlapping Emissions

Overlapping emissions with a one-year stagger perfectly stabilizes the present value of the average bill to a constant value over time, 92 percent of face value for emissions with a four year redemption window, 84 percent with a ten-year redemption window, and 77 percent with a 16-year redemption window. Even overlapping emission-redemption structures that are half the emission-redemption window, substantially reduces the oscillation from a no-overlap structure. In Figure 2, a median overlap stagger yields a cycle between 91 and 93 percent of face value for emissions with a four-year redemption window. In Figure 3, a median overlap stagger yields a cycle between 81 and 88 percent of face value for emissions with a ten-year redemption window. In Figure 4, a median overlap stagger yields a cycle between 70 and 84 percent of face value for

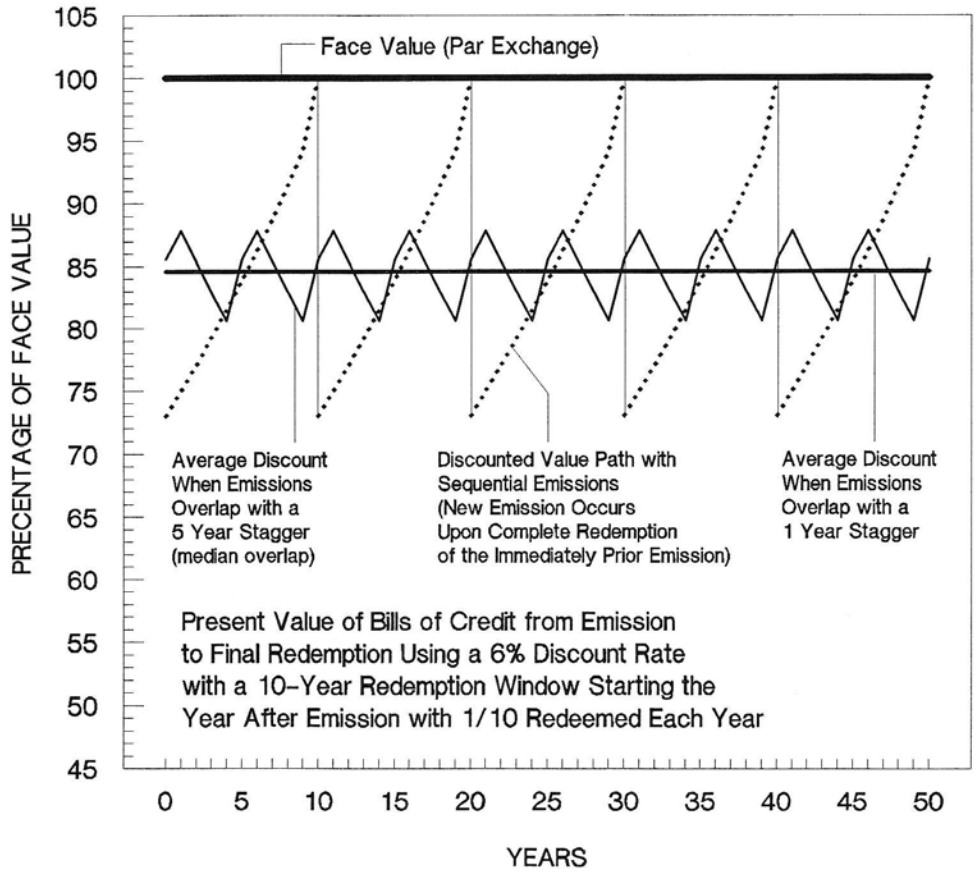

Figure 3. Present Value of Bills of Credit between Emission and Redemption with a Ten-Year Emission Redemption Window, and with Sequential and Staggered Overlapping Emissions

emissions with a 16-year redemption window.

The overlapping patterns in Figures 2, 3, and 4 are either perfectly constant or stationary with no trend and short half-lives. While Figures 2, 3, and 4 are stylized models, they can be used to gauge value patterns from alternative redemption windows and emission overlap staggers as shown in Appendix Table A1. Densely overlapping emission-redemption structures could produce predictable and relatively stable present value patterns for the average bill in circulation.

All bills had their emission date printed on their face. Therefore, subjects could identify bills by emission and thereby acquire the exact terms of each emission's redemption. As such, I assume subjects would calculate the expected APV time-path of each emission separately, e.g.

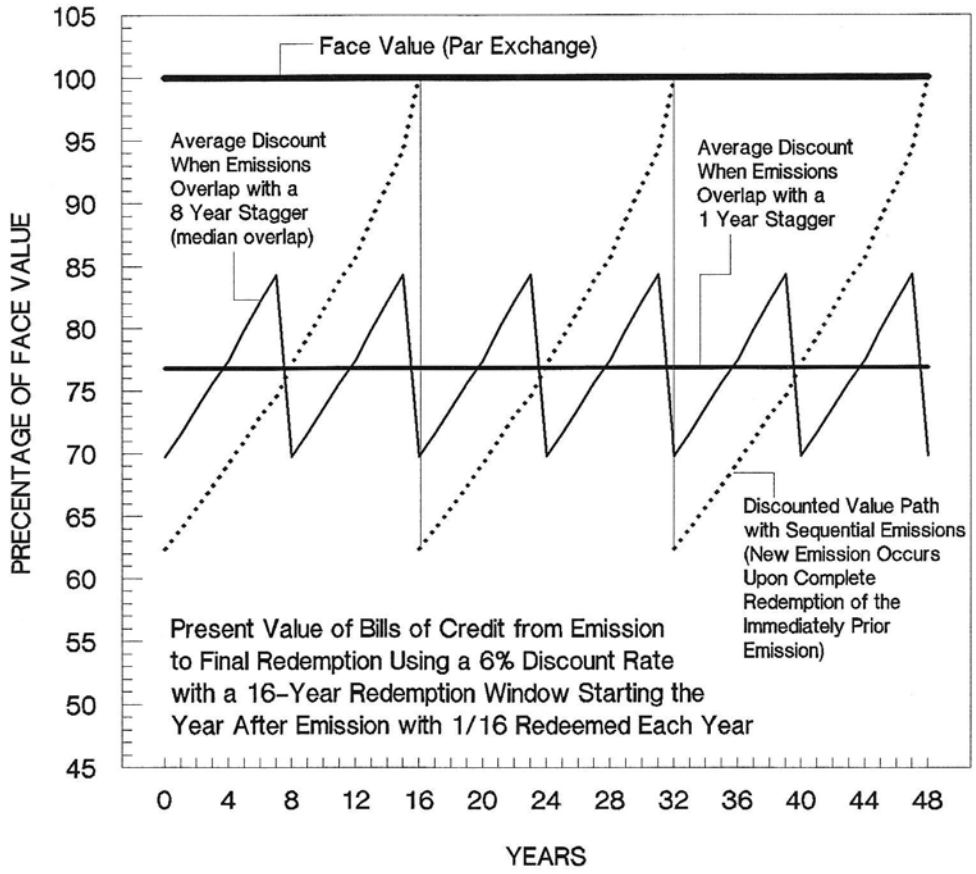

Figure 4. Present Value of Bills of Credit between Emission and Redemption with a 16-Year Emission Redemption Window, and with Sequential and Staggered Overlapping Emissions

see Figure 1. Under these conditions, colonial legislatures could not keep the market value of different emissions equal using overlapping structures. Overlapping emissions could only kept the expected value of the average bill currently outstanding equal over time. In other words, overlapping emissions could make random draws of bills at each point in time equal.

Overlapping emissions did not prevent the present value of bills from different emissions currently in circulation from being different. Variation in current present values across bills from different, but overlapping, emissions would make for a cumbersome medium of exchange. Colonial legislatures overcame this complication by making redemption requirements fungible across bills of different emissions that were concurrently in circulation. As long as the sequence

of total redemption requirements over time equaled the sequence of total emitted bills over time, which bills were used to pay which taxes or loan obligations in which years, among overlapping emissions, would not matter. In most cases, redemption structures in paper money acts did not specifically designate which bills currently outstanding could satisfy the redemption requirements for those emissions. As such, fungibility among bills from overlapping and currently outstanding emissions appears to have been the norm for redemption. Legal tender laws explicitly allowed this fungibility.

Finally, while the expected value of the average bill currently in circulation could be stabilized at a relatively constant value over time using an overlapping emission structure, the range of realized present values for particular bills in circulation, i.e. the variance around the expected value of the average bill, remained unaltered. That range is shown in Figure 1, and in Figures 2, 3, and 4 as the range of values spanned by the sequential emissions structure. The 1/N redemption structure for bills of credit created this variance in realized present values, and so made for a cumbersome medium of exchange. Whether legislatures could feasibly solve this problem, other than by making all redemptions in year N only, is unclear. I have found no attempted solutions.[18] It may have been the only practical way they had to maintain $RD \approx 0$.

In conclusion, colonial legislatures could not emit a bill of credit as a zero-coupon bond that would always trade at its face value. They could, however, create an overlapping emission-redemption structure for these bills that would cause the average bill currently in circulation to trade at or near a constant value relative to its specie-equivalent face value. Statistically, this pattern would be a stationary series with short half-lives to shocks.

THE EMPIRICAL VALUE OF ZERO-COUPON BILLS OF CREDIT

Appendix Table A1 shows that colonial legislatures frequently created overlapping

emission-redemption structures. The realities and exigencies of colonial politics, foreign wars, and disputes with proprietors (and the British Board of Trade) made achieving the stylized model outcomes in Figures 2, 3, and 4 unlikely. Despite these real-world impediments, were colonial legislatures able to produce, via overlapping emission-redemption structures, reasonably functioning paper money regimes? Could they cause the average bill outstanding to circulate at or near a constant expected value over time relative to their specie-equivalent face values?

The market exchange values (MEV in equation 1) of bills emitted by the middle colonies, from New York through Virginia, are used to judge whether value patterns are consistent with the stylized models in Figures 2, 3, and 4. These colonies are chosen because they primarily issued their bills as zero-coupon bonds and operated under the same legal tender regime.[19] The complete MEV histories of the respective paper money emissions for New York, New Jersey, Pennsylvania, Maryland, and Virginia are used.

Observed market exchange rates are taken primarily from merchant account books in the colonies. These rates are for exchanging colonies' bills of credit for bills of exchange paying pounds sterling in London. These rates are the most ubiquitous and the only ones that yield continuous time-series evidence for converting bills of credit into specie values in the colonial marketplace. The lack of evidence in these colonial merchant account books of the direct exchange of bills of credit for various gold and silver coins is consist with the general scarcity of specie coins in colonial America (Grubb 2014, McCusker 1978).

Colonial merchants used these transactions to pay for imports to America, or repay the debts incurred for acquiring and shipping such goods. Imports from Britain ultimately had to be paid for in specie (sterling) values. Colonial merchants who shipped goods, such as tobacco, to Britain accumulated sterling credits in London. They sold bills of exchange on those credits to

other colonial merchants who required such credits to pay for British imports to America.

These market exchange rates divided by the specie-equivalent face value of the bills yields a preliminary measure of MEV. Face value is 1.3275 colonial pounds equals $1£_{Sterling}$ (Queen Anne's Proclamation Rate) for New Jersey, New York, Pennsylvania, and Maryland pre-1766, and 1.25 colonial pounds equals $1£_{Sterling}$ for Virginia and Maryland post-1765 (Grubb 2014; Hening 1969, v. 6, pp. 478-83; McCusker 1978). These data are then adjusted to account for the time and transaction costs of getting a bill of exchange to London and having it liquidated into specie usable in the colonies. This cost is estimated to be approximately 7.09 percent.[20] Thus, the final MEV estimate divides the observed market exchange rates in Grubb (2014) and McCusker (1978) by the realized par exchange rate of $1.2334£_{colonial\ pounds} = 1£_{Sterling}$ rather than $1.3275£_{colonial\ pounds} = 1£_{Sterling}$, and $1.1614£_{colonial\ pounds} = 1£_{Sterling}$ rather than $1.25£_{colonial\ pounds} = 1£_{Sterling}$, respectively. These final MEV estimates by colony are presented in Figure 5.

The empirical patterns in Figure 5 have a general resemblance to the stylized models in Figures 2, 3, and 4 once the actual redemption structures in Appendix Table A1 are taken into account. New York, New Jersey, and Pennsylvania employed a mixture of moderate to longish redemption windows, using an approximate 1/N redemption method per emission, and with moderate degrees of overlap between emissions. The redemption pattern is a mixture of those in Figures 2, 3, and 4, with a general movement from a Figure 2 pattern to a Figure 3 pattern to a Figure 4 pattern over time. For these three colonies, MEV primarily bounces between 85 and 65 percent of face value, with a slight downward trend over time. This range is where the typical average redemption window length would place its APV given the inconstant overlap of emissions enacted by their legislatures. The downward trend is consistent with the increase in the average redemption window length that occurs over time, in part due to the excessive cost of the

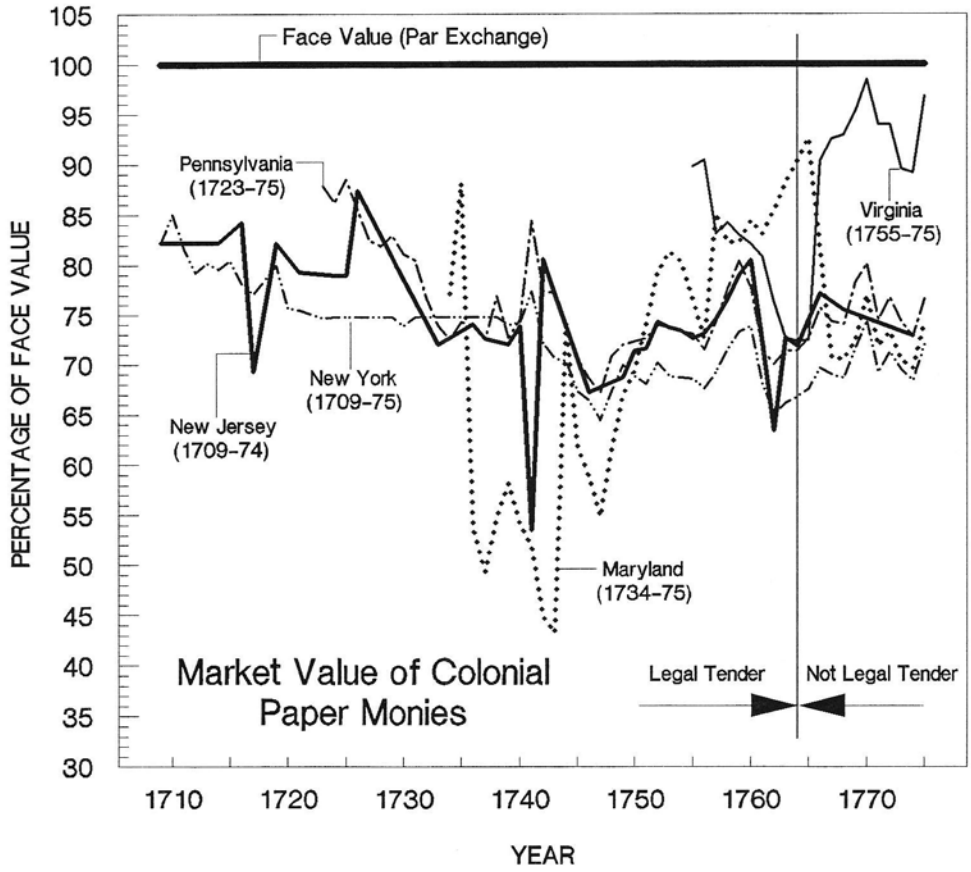

Figure 5. The Market Value of Bills of Credit Structured as Zero-Coupon Bonds as a Percentage of Specie-Equivalent Face Value Adjusted for Transaction Costs

Sources: Grubb (2015, 2014); McCusker (1978).
Notes: See text for construction. Linear interpolated values are used in place of missing observations.

Seven Years War. Large wartime emissions required longer redemption windows to keep yearly taxes within historically acceptable and feasible limits and so maintain fiscal credibility.

Maryland provides a sharp contrast in MEV pattern over time, but one that is still consistent with the stylized model in Figure 1. From 1733 to 1765, Maryland employed long redemption windows (31 years for most bills) with little emission overlap, and with most bills redeemed in the last year of the redemption window only. Once subjects learned of this structure, the MEV of Maryland bills fell to around 45 to 55 percent of face value and then more or less rose steadily toward face value by the final redemption year of 1765. This pattern is within the

general range of where the actual redemption structure would place its APV pattern over time, see Figure 1, Appendix Table A1, and Grubb (2008).

After 1765, Maryland switched to a shorter redemption window, but one that was still moderately long (12 years), with moderately overlapping emissions, i.e. between a Figure 3 and Figure 4 pattern. This change in redemption structure after 1765 made the MEV for Maryland bills look like that for New York, New Jersey, and Pennsylvania. The redemption structures for all four colonies after 1765 yields APVs in the general range of the observed MEVs of the bills for these colonies, which was around 70 to 80 percent of face value, see Figure 5. These redemption structures fell between the stylized value patterns shown in Figures 3 and 4.

Virginia is an intriguing case, but one that is still consistent with modeled APV explaining the movements in the MEV of Virginia bills. Virginia's MEV starts at around 90 percent of face value in 1755-6, plummets to around 75 percent of face value by 1765, and then by the early 1770s is back to around 90 to 95 percent of face value. This pattern is generally consistent with how the APV of Virginia's bills would move given changes in the redemption structure of Virginia's emissions over time.[21] Virginia's emissions in 1755-6 and the early 1770s depicted in Figure 2, which approximates the MEV for Virginia's bills in these years.

In 1757 through 1762, Virginia switched to a moderately long redemption window, closer to the APV outcomes in Figures 3 and 4 than the APV outcome in Figure 2. This APV is broadly consistent with the MEV of Virginia's bills in Figure 5. Overall, movements of the APV of bills, caused by changes in redemption structures over time, can explain the movements of the MEV of Virginia's bills over time. We need no other explanation.[22]

Table 1 reports the time-series properties of the MEV data in Figure 5. The MEV for each colony is a trend stationary series with a structural break at 1764 or 1765. The half-life to

shocks is reasonably short, under 1.72 years for all the colonies and under 0.78 years for three of the colonies. Except for Maryland, the pre-1765 trend is negative, statistically significant, but small in magnitude. The pre-1765 trend in Maryland is positive, statistically significant, and large in magnitude. The post-1765 trends are sign-reversed in each colony from their respective pre-1765 pattern, statistically significant, but small in magnitude.

The results in Table 1 are consist with colonial legislatures crafting redemption structures to achieve a stable pattern for their bills' APV, and hence MEV, over time. The small negative trend is largely the results of the timing of the Seven Years War, and the emission-redemption adaptations required to finance that war. While colonial legislatures could not achieve an ideal inside money that always traded at face value or at a perfectly constant value relative to its face value, they were able to control the APV of their bills enough to produce a paper money that traded at a predictably stable (mild-trend) expected value relative to its face value over time.

Table 1 and Figure 5 determine the likely impact on the MEV of bills caused by the 1764 Currency Act. Two major events happen in 1764, namely the end of the Seven Years/French and Indian War and the passage of the 1764 Currency Act. The evidence in Table 1 and Figure 5 disentangles these two events. First, the MEV in Figure 5 for New York, New Jersey, and Pennsylvania from 1750 through 1755 is hard to distinguish from 1765 through 1774.

Second, the change in legal tender powers affected all colonies in Figure 5, but the trend shift in MEV in 1764 was not in the same direction for all colonies. Maryland moved the opposite of the rest. Maryland was also the only colony that financed its participation in the Seven Years War differently, relying less on emitting bills to cover expenses. Maryland, unlike the other colonies in Figure 5, received no Parliamentary reimbursements to offset their contributions to that war (Greene 1980, p. 98). This finding is consistent with the exigencies of

Table 1. Time Series Properties of the Market Exchange Value (MEV) of Colonial Paper Money, 1709-1775

Independent Variables	Dependent Variable: (MEV_t - MEV_{t-1}) New York	New Jersey	Pennsylvania	Maryland	Virginia
Constant	189.8089***	311.9681***	146.0683*	-1927.9940***	1339.1400***
	(56.8560)	(86.2115)	(0.0995)	(282.3685)	(433.5551)
MEV_{t-1}	-0.3913**	-0.6984***	-0.3312*	-0.7213***	-0.5955***
	(0.0989)	(0.1215)	(0.0995)	(0.1036)	(0.1110)
Year	-0.0928***	-0.1492***	-0.0695+	1.1302***	-0.7341***
	(0.0291)	(0.0464)	(0.0459)	(0.1641)	(0.2450)
D	2.3730**	4.2918**	2.3044+	-20.6413***	17.0178***
	(0.9247)	(2.1025)	(1.469)	(3.5953)	(3.1831)
(or)					
D*Year	0.0013**	0.0024**	0.0013+	-0.0117***	0.0097***
	(0.0005)	(0.0012)	(0.0008)	(0.0020)	(0.0018)
# of Dependent Variable Lags	0	0	0	1	0
N	66	65	52	40	20
Years Spanned	1709-1775	1709-1774	1723-1775	1734-1775	1755-1775
Adjusted R^2	0.18	0.32	0.15	0.59	0.67
F	5.96***	11.02***	4.13**	15.22***	13.75***
Half-life in Years	1.40	0.58	1.72	0.54	0.77

Sources: The raw data are from Grubb (2014) and McCusker (1978) which were then transformed as described in the text.

Notes: Data are annual. Standard errors are in parentheses under their respective coefficients. Dickey-Fuller critical values are used for the MEV_{t-1} coefficients, see Enders (1995, p. 419). For all regressions, serial correlation was corrected by adding lags of the dependent variable until the Durbin's Alternative Tests for autocorrelation failed to reject the hypothesis of no serial correlation above the 0.1 level. The half-life is calculated using the following equation: $[-\ln(2)/\ln(1 + a_1)]$, where a_1 is the coefficient on the MEV_{t-1} independent variable. See Mark (2001, p. 32). For New Jersey and Pennsylvania, D = 1 for the years 1765-1775 and zero otherwise. For New York, Maryland, and Virginia, D = 1 for the years 1766-1775 and zero otherwise. D is a structural break capturing a change in monetary regimes due both to the 1764 Currency Act (end of legal tender designation) and the end of war financing pressure with the conclusion of the Seven Years War. The D selected yielded a local maximum regression fit. If the initial year for D is moved one year forward or one year backward from that reported here the regression fit is reduced. Either D or (D*Year) are used but not both together. The other coefficients, their statistical significance, and the regression fit are not affected by this choice.

*** indicates significance above the 0.01 level.

** indicates significance above the 0.05 level.

* indicates significance above the 0.1 level.

+ indicates significance above the 0.15 level.

financing of the Seven Years War causing the structural break in MEV in 1765-6 and not the 1764 Currency Act's banning legal tender laws. I show the logic behind why legal tender laws

did not affect MEV in the section on Legal Tender Laws below.

In conclusion, treating the paper money of most colonies as zero-coupon bonds rather than as fiat currency, and assuming its value is primarily determined by its asset present value, is consistent enough with the empirical evidence to warrant adoption and expansion of this approach. In other words, assuming that (LP - RD) ≈ 0 and so MEV ≈ APV is broadly consistent with the empirical evidence, and so represents a promising new approach to understanding colonial paper money. The next step is to do the extensive work needed to exactly establish the redemption structures in each paper money emission, and then estimate how well the exact measure of APV_t tracks MEV_t through time in each colony. So far this has only been done for New Jersey and post-1765 Maryland (Celia and Grubb 2014; Grubb 2014, 2015).

INTEREST-BEARING BILLS OF CREDIT

Emitting a bill of credit whose value remained constant at its face value could be achieved by having the bill pay annual interest at the market interest rate.[23] Figure 6 models the effect of adding annual interest payments to the present value of bills supported otherwise only by a redemption mechanism. All the assumptions in Figure 1 are carried through into Figure 6, except that 6 percent annual interest payments are made to the current holder of the bill. Payments have to be paid annually, as opposed to paid as an accumulated lump sum in the final redemption year. In addition, interest payments have to be separated and extracted from the bills themselves, as opposed to attached permanently to their face.

Other things equal, paying this annual interest pushes the present value of the bills, measured at annual intervals just before the interest is paid, to within 99 percent of their face value for all years j to N. As long as annual interest comparable to the market discount rate is paid, it does not matter whether redemption is in year N only or at the rate of 1/N per year. It also

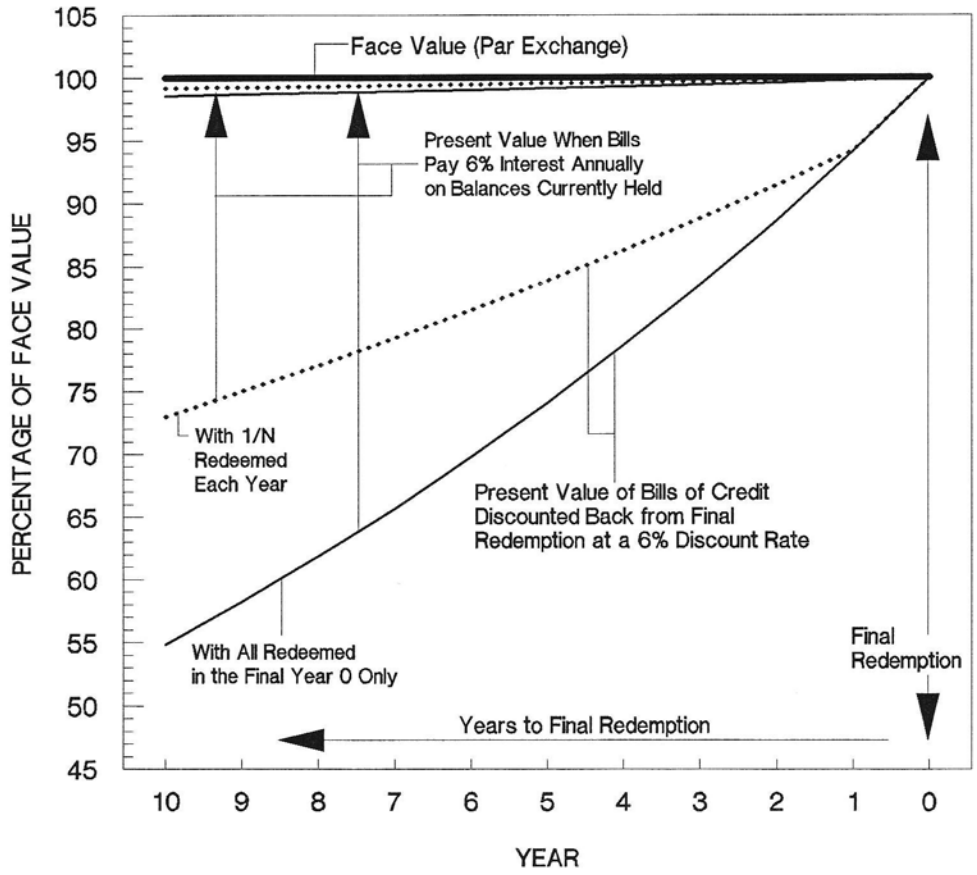

Figure 6. Present Value of Bills of Credit between Emission and Redemption with Annual Interest Paid Equal to the Market Discount Rate

does not matter whether the emission-redemption window is a few years or many years. Bills will circulate for almost exactly their face value in all years.

Interest-bearing bills were occasionally used in the colonies, mostly after 1750 in New England and briefly in North Carolina and Virginia in the mid-1750s, see Appendix Table A1. In 1764, Benjamin Franklin advocated this mechanism for supporting the value of bills of credit. He advised the Pennsylvania Assembly that the best way to support the value of its proposed 50,000£$_{PA}$ emission was to augment the tax-redemption mechanism with annual interest payments. Doing so would eliminate the need for a legal tender law, which was a bone of contention between the proprietor, John Penn, and the colonial assembly. Franklin also advocated annual interest payments for the U.S. paper Continental dollar first issued in mid-

1775. Interest payments, however, were not enacted in either case (Oberg 1992, v. 29, pp. 354-6; Labaree 1967, v. 11, pp. 15-8).[24]

In some cases, paying an annual interest may have been impractical. In the case of the U.S. paper Continental dollar, war prevented the raising of money to pay annual interest. In other cases, it may have generated computational inconveniences, or if the interest paid was higher than the market discount rate, it could lead to the bills being hoarded as investments rather than used as a medium of exchange. In 1767, Franklin commented on the use in New England of bills that bore an annual interest and the problems that arose from using them. He wrote:

> Some of the Colonies of New England, who have been many Years restrained from Making Bills a legal Tender, have, in order to keep their Value, and prevent the Inconveniences of a Discount, issued Bills bearing Interest at 5 per Cent.
>
> In a little Time after they were issued it became worth while to compute the Interest that had accrued on them. Tables were made showing the Interest arising on any Bill of any Sum for a Year, a Month, a Week, and a Day. And yet with all the Help these Tables could afford, it was a perplexing Thing to the common People to make these Computations, and took up Abundance of Time in Shops and Warehouses, to the great Hindrance of Business, there being sometimes in a Payment of Twenty Shillings, four, five, or more Bills of different Denominations, on which the Interest was to be computed.
>
> But the growing Interest had another ill Effect. The Bills were intended for a Currency, and the Interest defeated that Intention. For they were gradually hoarded, and disappear'd long before the Expiration of the Term for which they were omitted: It being a great Convenience to Money'd People to have their Money at Interest, and yet all the while in their Possession, ready for advantageous Purchases if such should offer, which it would not be if out on Mortgages. (Labaree 1970, v. 14, p. 36).

The problem with the interest-bearing bills that Franklin described in New England may have been with how governments paid the interest relative to the frequency with which the bills changed hands—the velocity of circulation (V).[25] The analysis in Figure 6 assumes that bills could only change hands as a medium of exchange once a year, just after the annual interest was paid to the holder, e.g. V = 1. It also assumes that the interest payments could not be deferred, accrued, accumulated, or otherwise attached to a given bill from a multi-year emission-to-redemption issuance. Under these two conditions, the problems Franklin listed should not have

existed and bills should have always traded at face value as illustrated in Figure 6. However, if either of these two conditions did not hold, then bills would not trade at face value over the relevant transacting interval.

Figure 7 shows what happens if annual interest was allowed to accrue across a multi-year emission-to-redemption issuance and was then paid as an accumulated lump sum to the last holder of the bill at the end of the N-year redemption window (year 0 in Figure 7). The present value of a bill starts substantially below face value at emission and ends substantially above face value at final redemption. Figure 7 uses all the structures and assumptions used in Figures 1 and 6, except that annual interest is only paid as an accumulated lump sum at the end of the N-year redemption window.

For example, the text printed on Connecticut bills of credit issued between 1755 and 1770 said, using the text from a 40 shilling bill issued on 26 March 1761, "The possessor of this bill, shall be paid by the Treasurer of the Colony of Connecticut, Forty Shillings Lawful Money, with Interest at Five per Cent, per Annum, by the 26th Day of March, 1766." This language indicates that the annual interest would be accrued and paid in a lump sum at the end of the redemption period, namely five years of interest accumulated from 1761 to 1766 all paid in a lump sum in 1766 (Newman 2008, pp. 103-8). Paying interest in this manner could have led to the speculation in, and the hoarding of, bills that Franklin noted in his observations.

Figure 8 shows the monthly present value of bills within the annual interest payment interval. Suppose bills pay an annual interest but changed hands more frequently than annually as a medium of exchange, such as monthly. What would the present value of such bills be each month between the annual interest payment points? Figure 8 uses all the structures and assumptions used in Figures 1 and 6, except that it shows what the present value would be with

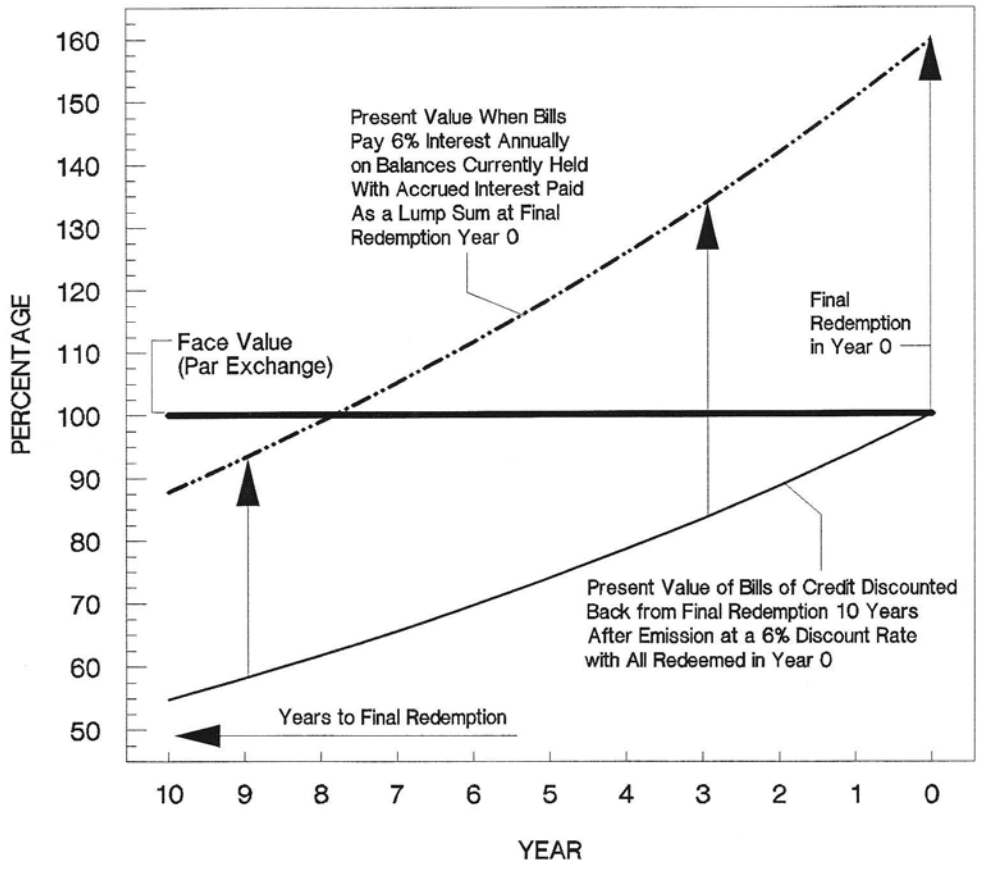

Figure 7. Present Value of Bills of Credit between Emission and Redemption with Annual Interest Paid Equal to the Market Discount Rate But Paid as an Accumulated Lump Sum at the End of the Redemption Window

different annual interest rates paid at the end of the year, e.g. a zero, 2, 3, 4, and 6 percent annual interest paid, for the preceding 12 months, namely after the last interest payment but before the next interest payment. As long as the transaction frequency is shorter than the interest payment frequency, the present value of bills will not equal their face value between the interest payment intervals. For annual interest rates that are between zero and the market discount rate, the present value of bills will be below face value early in the year and above face value later in the year.

Setting the annual interest rate equal to the discount rate, 6 percent in Figure 8, makes the present value of bills equal to their face value only at the beginning of the year and above their face value thereafter, reaching 6 percent above face value by year's end. After the interest is paid

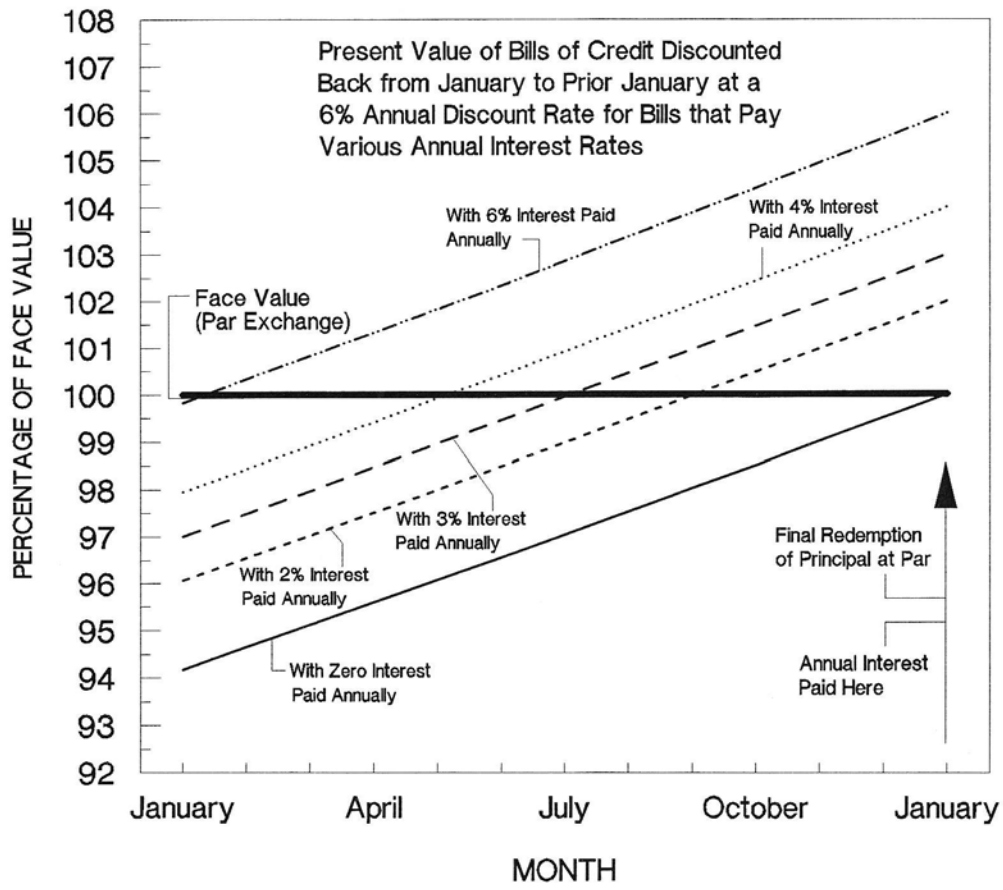

Figure 8. The Present Value of Bills of Credit between Annual Interest Rate Payments

at year's end, the bill's present value drops to par for the start of the next year, and the cycle repeats. Setting the annual interest rate equal to zero (with final redemption at year's end) makes the present value of the bill start at 6 percent below face value at the beginning of the year, rising steadily until it reaches face value at the end of the year. If bills are issued in one-year emission-to-redemption sequence, then this pattern repeats at the start of the next year.

Between these extremes, an annual interest rate set equal to half the market discount rate, 3 percent in Figure 8, makes a bill's present value equal its face value in the middle of the year, half way between interest payment points. At the beginning of the year it starts at 3 percent below face value. It rises steadily to 3 percent above face value by year's end. After the interest is paid at year's end, the bill's present value drops back to 3 percent below its face value for the

start of the next year, and the cycle repeats.

The only way to use interest payments to counterbalance time-discounting so that bills always trade at face value is to set the interest rate equal to the discount rate, and set the interest payment interval equal to the transaction frequency interval (V). When the transaction frequency is shorter than the interest payment frequency, traders in the marketplace will have to recalculate the present value of each bill used as a medium of exchange to account for when the future holder of the bill will receive an interest payment.

Whether these conditions were actually present in New England and so explain Franklin's observations is a topic of future research. Franklin, however, does say that the interest bearing bills issued "...were intended for a Currency…" and that people had to compute the interest accruing on them "...for a Year, a Month, a Week, and a Day." This suggests that the transaction interval, the frequency with which bills changed hands as a medium of exchange (V), was relatively short, being monthly, weekly or even daily—shorter than the annual interest payment interval. Thus, Figure 8 may illustrate an important constraint on using interest payments to support the value of bills of credit.

The solution to this problem would be to make the interest payment interval equal to the transaction interval. However, the transaction costs of making interest payments to bill holders at very frequent intervals, such as monthly, weekly, or daily, would likely swamp the within-year variation in the present value of the bills when interest was only paid annually. Such high transaction costs may explain why sub-annual interest payments were seldom observed and why supporting bills of credit through paying interest was somewhat rare.

As such, the best that might be achieved using this method would be to choose an annual interest rate near the mid-point between zero and the market discount rate, thus keeping the bills'

present value as near face value as possible, plus or minus 3 percent of par in Figure 8. This last point might explain why some colonies that did pay an annual interest on their bills moved towards a rate less than the prevailing market interest rate over time, e.g. see Connecticut in 1770 and New Hampshire from 1755-63 in Appendix Table A1.

In 1775, when Franklin advocated having the Continental dollar pay an annual interest as a way to support its current value, it may have been because Continental dollars were large denomination bills unfit for general circulation as a currency (Grubb 2013). Franklin may have expected their transaction frequency to be low. As such, Franklin's apparently shifting views on whether bills should pay an interest (yes in 1764, no in 1767, and yes in 1775), may actually be consistent when considering that they were conditional on the expected transaction frequency of the bills relative to the cost-effective frequency over which interest payments could be made.

LEGAL TENDER LAWS

Many contemporaries, and numerous scholars since, have assumed that legal tender laws supported the circulation and value of bills of credit in colonial America.[26] Legal tender laws have also been used to justify the assumption that bills of credit were fiat currencies, thus making the existence and analysis of redemption structures irrelevant. These assumptions, however, are erroneous, and were known by contemporaries to be erroneous. Legal tender laws contributed little to the value of the bills. Legal tender laws had their primary effect on creating problems in tort law regarding court-ordered restitution in debt default cases.

Two types of legal tender laws were used in the colonies, a "soft" and a "hard" version, with said laws embedded in the paper money act of each emission. "Soft" legal tender laws simply made it illegal to refuse payment in bills. Its purpose was to force bills into circulation. Only a few cases of soft legal tender laws can be found, e.g. Virginia used soft legal tender laws

for its first five emissions, but not thereafter.[27]

Most colonies used "hard" legal tender laws. Hard legal tender laws not only made it illegal to refuse payment in bills, but it also fixed the value of the bills so received in payment to be the specie-equivalent of the bills' face value. Its purpose, besides forcing bills into circulation, was to support the value of bills by making it illegal for them to trade at other than their face value. For examples of hard legal tender laws, see any of New Jersey's paper money acts.[28]

Legal tender laws *per se*, whether soft or hard, cannot make paper money trade at its specie-equivalent face value. The evidence in Figure 5 shows that bills traded considerably below their face value in colonies using legal tender laws. In Figure 5, values do not change much from when bills were a legal tender before 1764 to when legal tender laws were prohibited after 1764. The statistical analysis in Table 1 shows that structural breaks in value around 1764 are related to changes in redemption structures and Seven-Year-War finances rather than to the 1764 prohibition on legal tender laws. Contemporaries articulated why this should be so.

In 1764, Benjamin Franklin explained to the Pennsylvania Assembly the fallacy of thinking that legal tender laws *per se* could support the specie value of their bills of credit:

> And indeed of what Force can it [a legal tender law] be to fix an arbitrary Value on the Bills [of Credit], unless the Value of all Things to be purchased by the Bills could be fix'd by the same Law. I want to buy a Suit of Cloth, and am told by the Seller, that his Price is 20*s*. [20 Shillings] a Yard. Very well, say I, cut me off 5 Yards, and here are five 20*s*. Bills for you. I beg your Pardon, says he, the 20*s*. that I mean is 20*s*. lawful Money, according to such an Act of Parliament: Your Paper Money is greatly depreciated of late; it is of no more than half its nominal Value, your 20*s*. is really worth but ten; so that if you pay me in those 20*s*. Bills you must give ten of them for five Pounds. Don't talk so to me, says I, you are oblig'd by Act of Assembly to take these Bills at 20*s*. each. Very well, says he, if I *must* take them so I must; but as the Law sets no Price on my Goods, if you pay me with those Bills at 20*s*. each, my Cloth is 40*s*. a Yard, and so you must still give me ten of them; and pray then what becomes of your Law? (Labaree 1967, v. 11, p. 14).

In 1767, Franklin also pointed out that in colonies where bills of credit had been made a legal tender, the bills still traded below face value (Labaree 1970, v. 14, p. 35).

In 1776, Adam Smith, in the *Wealth of Nations*, echoed Franklin's point. Smith stated, "A positive law may render a shilling a legal tender for a guinea; because it may direct the courts of justice to discharge the debtor who has made that tender. But no positive law can oblige a person who sells goods, and who is at liberty to sell or not to sell, as he pleases, to accept of a shilling as equivalent to a guinea in the price of them." (Smith 1937, p. 311).

In 1788, Franklin made a more succinct and clear statement of this principle, "The making of paper [money] with such a sanction [a legal tender law] is...a folly, since, although you may by law oblige a citizen to take it for his goods, you cannot fix his prices; and his liberty of rating them as he pleases, which is the same as setting what value he pleases on your money, defeats your sanction." (Smyth 1907, v. 9, p. 638).

Suppose I have a good for sale in New Jersey in 1724 that is worth $1£_{Sterling}$ and I post its price as $1£_{Sterling}$ which at face value would be the same as 1.33 New Jersey paper pounds ($£_{NJ}$). However, the present value of a $£_{NJ}$ in 1724 is 80 percent of its face value, see Figure 5. As such, I would set my posted prices for the good to be $1£_{Sterling}$ or $1.66£_{NJ}$. I would have a two-tier price system that reflected the present value of the bills in the current marketplace relative to their face value. A legal tender law that requires that I accept bills in payment, but does not control prices or exchange rates, i.e. a soft legal tender law, cannot by itself support the value of the bills or push their value toward their specie-equivalent face value.

Now suppose that the legal tender law includes a statement fixing the face value of the bill in specie when used in trade, i.e. a hard legal tender law. Under a hard legal tender law the good I have for sale for which I posted a price of $1£_{Sterling}$ would now have to sell for $1.33£_{NJ}$. If someone offered $1.33£_{NJ}$, I could not refuse this offer under a hard legal tender law, even if the present value of a $£_{NJ}$ was 80 percent of its face value. I want to be paid $1.66£_{NJ}$ for the good but

I cannot post that price or refuse the offer of 1.33£$_{NJ}$ if I post the good's price as 1£$_{Sterling}$.

However, even a hard legal tender law does not support the value of the bills or cause them to trade closer to their face value. Figure 5 indicates that subjects must have found a way to nullify the effect of hard legal tender laws. The simplest way to nullify a hard legal tender law was to not post or contract in prices stated in specie or sterling units, but only to post or contract in prices expressed in the monetary units of the bills of credit. For example, for the good I want to sell in New Jersey in 1724 that is worth 1£$_{Sterling}$, if the present value of £$_{NJ}$ is 80 percent of its face value, I would be willing to (indifferent to) accepting 1.66£$_{NJ}$ or 1£$_{Sterling}$ for the good. If I post the price as 1£$_{Sterling}$ I may be forced to accept 1.33£$_{NJ}$ in payment under a hard legal tender law, thus losing money. I cannot post a two-tier price of 1£$_{Sterling}$ or 1.66£$_{NJ}$ because having posted a price of 1£$_{Sterling}$ I could not refuse 1.33£$_{NJ}$ in payment under a hard legal tender law.

The solution, however, is easy. I simply stop posting prices in sterling or specie units. I only post prices in bills-of-credit units of account. I post my price for the good in question to be 1.66£$_{NJ}$ only. Under a hard legal tender law, 1.66£$_{NJ}$ is equal to 1.25£$_{Sterling}$. But I cannot sell the good for 1.25£$_{Sterling}$ because that price is above its worth and no one will pay it. The good is actually worth, and I would accept, 1£$_{Sterling}$ in lieu of 1.66£$_{NJ}$, but I do not publicly say that. I would take the offer of 1£$_{Sterling}$ in lieu of 1.66£$_{NJ}$ but only under-the-table or off-the-record as a favor or discount off the 1.25£$_{Sterling}$ par equivalence to the 1.66£$_{NJ}$ posted price. By this behavior, I have completely nullified the hard legal tender law's effort to support the face value of the bills in trade.

The testable hypothesis implied by this analysis is that, when hard legal tender laws are operative, pricing in the marketplace should gravitate toward being dominated by pricing in the bills-of-credit monetary unit of account. Pre-1764, ubiquitous usage of each colony's paper

pound unit of account in recorded government transactions, marketplace transactions, newspaper statements, merchant account bookkeeping, and wills is consistent with this behavior nullifying the effect of legal tender laws on a bill's value. Conversely, when hard legal tender laws were inoperative, the testable implication is that pricing in the marketplace should be relatively less dominated by pricing in the bills-of-credit monetary unit of account. Preliminary evidence indicates that pricing followed these hypothesized patterns (Grubb 2004, 2013).

As such, hard legal tender laws only transform pricing in the marketplace so that it is dominated by the bills-of-credit monetary unit. If a seller happened to price in $£_{Sterling}$ and was forced by a customer under the auspices of the hard legal tender law to accept paper bills of credit at par value instead of at their present value, the seller would quickly adapt by 1) not pricing in $£_{Sterling}$ but only in bills-of-credit monetary units, and/or 2) never dealing with that customer again. Faced with this outcome, customers, especially repeat customers, would not force sellers to take bills at par rates but only at their present value. These sellers and customers would *privately* contract and price in both sterling and bills of credit and consummate such trades at their present value exchange rate without invoking hard legal tender law enforcements.

Hard legal tender laws, however, created potential problems in the application of tort law. They could cause havoc when non-contemporaneous trades suffered contract breach and ended up in court for adjudication. Non-contemporaneous trades are when the payments by one party are at some future date from the initial contract, or the initial delivery of the goods that corresponds to those payments. Breach of contract is when the party who pays last, the debtor or purchaser, reneges on the promised payment to the party who paid first, the creditor or seller. The creditor or plaintiff could then sue the debtor in court seeking to recover the promised payment. When finding in favor of the plaintiff or creditor, courts would make the plaintiff

whole by enforcing the payment promised. In cases where the defendant or debtor either could not deliver the specific payment promised, e.g. did not have the specific horse he promised to deliver, or the specific specie coins he promised to pay, or where the contractual payment was vague regarding the monetary instrument, such as “16 pounds”, the courts had to assign a monetary substitute that would make the plaintiff whole.

The presence of a legal tender law tied the hands of the courts in these breach of contract cases. The monetary substitute assigned to make the plaintiff whole had to be the designated legal tender. The issue for the courts was whether the legal tender monetary substitute would be priced at its present value (APV), its market value (MEV), or at its face value. If MEV ≈ APV, as argued here, it was really an issue of pricing at present value or at face value. If the courts priced at present value, the plaintiff was indeed made whole and no injustice would be done.

Benjamin Franklin claimed that in Pennsylvania this was indeed the case. In 1767, Franklin observed, “...it having ever been a constant rule there [in Pennsylvania] to consider British debts [those in sterling] as payable in Britain, and not to be discharged but by as much paper [money] as would purchase a bill for the full sterling sum.” Franklin goes on to write in a draft petition, “...in the Courts of Justice [in Pennsylvania], full satisfaction has ever been given in discharge of debts due to the British merchant [in sterling valuation]...” In 1760 the British Board of Trade made the same observation. They concluded that Pennsylvania had been exempted from Parliament’s 1751 Currency Act that forbade making paper money a legal tender because, “...the province had, without a Law, come of itself very near the regulation which the Law would have prescribed.” (Labaree 1966, v. 9, p. 149; 1970, v. 14, pp. 34-6, 80, 185).

But what if the courts valued bills at their face value when making the plaintiff whole in breach of contract cases? In such cases, the plaintiff would not be made whole, but would be

paid less than the sum originally contracted. The size of the underpayment would be the gap between the present value of the bills (or MEV) and their face value, see Figure 5.

If it were known that courts would use the face value rather than the present value to make plaintiffs whole in breach-of-contract cases, then strategic behavior by debtors and unjust outcomes for creditors would be encouraged. Given that bills had present values well below their face values, debtors would be tempted to breach their contracts knowing that courts would count bills at their face value when ordering restitution. Such suspected behavior in New England in the 1740s, and in Virginia in the late 1750s and early 1760s, may have been behind Parliament's passage of the 1751 and 1764 Currency Acts, respectively.

In 1776, Adam Smith, in the *Wealth of Nations*, made a similar observation. He said,

> The paper currencies of North America consisted...in a government paper, of which the payment was not exigible till several years after it was issued: And though the colony governments paid no interest to the holders of this paper, they declared it to be, and in fact rendered it, a legal tender of payment for full value for which it was issued. But allowing the colony security to be perfectly good, a hundred pounds payable fifteen years hence...in a country where interest is at six per cent. is worth little more than forty pounds ready money. To oblige a creditor...to accept of this as full payment for a debt of a hundred pounds actually paid down in ready money, was an act of such violent injustice, as has scarce...been attempted by the government of any other country which pretended to be free. It bears the evident mark of having originally been...a scheme of fraudulent debtors to cheat their creditors....
>
> No law, therefore could be more equitable than the act of parliament, so unjustly complained of in the colonies, which declared that no paper currency to be emitted there in time coming, should be a legal tender in payment (Smith 1937, pp. 310-11).

Smith's analysis of the initial conditions of colonial paper money regarding discounted valuation is not that different from what Franklin stated in his 1767 paper "The Legal Tender of Paper Money in America" (Labaree 1970, v. 14, pp. 32-9). Their conclusions regarding the effect of legal tender laws on these initial conditions, however, were diametrically opposed. Smith assumed that courts would assign the legal tender substitute at its face value, whereas Franklin pointed out that, at least in the middle colonies, the courts used the present value when assigning

a payment substitute in breach-of-contract cases.[29]

So what role did legal tender laws serve? If they did not support the value of paper money, and they potentially caused havoc when misapplied by courts in breach-of-contract cases, what good were they? Franklin gives a hint in 1767 when he wrote that the purpose of legal tender laws was "...the convenience to the possessor where *every one* is oblig'd to take them..." (Labaree 1970, v. 14, p. 34). This would be a "soft" legal tender law outcome. Knowing that bills could be used in any transaction may have enhanced their liquidity premium (LP in equation 1) and so enhanced their market value above their present value. Adding some LP to APV would push MEV toward face value. Preliminary estimate for New Jersey and post-1765 Maryland, however, indicate that legal-tender-law effects on changing LP were negligible, and that LP in general accounted for a small portion of MEV. MEV was primarily made up of APV (Celia and Grubb 2014, Grubb 2014).

Why have a hard, as opposed to just a soft, legal tender law? In most cases, hard legal tender laws were how colonial legislatures credibly anchored the value of their paper money to specie at the point of redemption. When a bill was to be redeemed, subjects could always pay in a bill's face value specie equivalence instead. If a subject did not have the bills of credit needed to pay their redemption obligation, they had to be allowed to pay in some other lawful way. The government had to specify the value equivalence between bills and this other lawful payment. It was this alternative payment in sterling or specie that anchored the face value of bills to the par sterling exchange rate at redemption. Hard legal tender laws were simply ways for the colonial government to credibly state and execute this outcome.

Hard legal tender laws may have served one other positive function. While not fully articulated as argued here, in 1767 Franklin offered the following reason for legal tender laws

(Labaree 1970, v. 14, pp. 35-6). Bills of credit required time-discounting to determine their present value. Staggered overlapping emissions could stabilize the expected present value of these bills. However, having bills from different emissions with different redemption dates and hence different present values circulating concurrently created a cumbersome medium of exchange. If each bill was priced correctly at its present value, valuation differences among concurrent bills in circulation would raise the transactions cost of using the paper money as a medium of exchange. Hard legal tender laws made the bills fungible when paid to satisfy redemption obligations for the various overlapping emissions. As long as total redemption obligations were equal to or greater than total bills in circulation, it would not matter which bill from which emission was used to satisfy any particular current redemption obligation. This action reduced the present value differences among bills from overlapping emissions currently outstanding. As such, hard legal tender laws served to remove confusion over the relative valuation of a colony's bills from different but overlapping emissions that were circulating concurrently.

Why the British passed the 1751 and 1764 Currency Acts makes sense in light of the forgoing analysis. These Acts did not ban paper money. They only restricted its emission-to-final-redemption span and its legal tender status. These restrictions only make sense if bills of credit were structured as zero-coupon bonds that required time-discounting to assess their APV_t, and hence their MEV_t, and courts did not take this into account in tort law cases. These Acts wanted to lessen the loss to creditors occurring when courts assigned the face value of bills, rather than their $APV_t \approx MEV_t$ value, when making a plaintiff whole in breach-of-contract cases. This explains the restriction on the emission-to-final-redemption span in the 1751 Currency Act. A shorter redemption span reduces the gap between the time-discounted APV and the face value,

see Figure 1. This restriction, however, could not completely solve this tort law problem as some gap in value between APV_t and face value would still exist.

The complete solution was to ban using bills as a legal tender. This solved the tort law problem, as restitution in breach-of-contract cases were no longer required to be in bills of credit. However, this solution had costs. These costs included losing the minor benefits discussed above from making bills a legal tender, but more importantly, they increased the cost of adjudicating breach-of-contract cases. How could a plaintiff now be made whole when the debtor did not fulfill the specifics of the contract? With specie money chronically scarce, and no other legal tender, how were courts to rule? The problem of tort law breach-of-contract cases and how to impose restitution was an on-going and paramount problem in colonial America, for examples see the legislative history of colonial New Jersey (Bush 1977, 1980, 1982, 1986).

The tort law problem generated by legal tender laws was contingent on bills of credit being structured as zero-coupon bonds. Thus, another solution to the problem would have been to require all bills to pay the market interest rate on their face value. This would have moved a bill's APV_t very close to face value regardless of redemption span or redemption structure, see Figures 6 and 8. Bills could remain a legal tender and courts could assign their face value when deciding restitution in tort cases without hurting creditors.

Merchants who thought they were being harmed by legal tender laws actually proposed this solution. Ernst (1973, p. 88) reports that in the debates over regulating colonial bills of credit leading to the 1764 Currency Act, Glasgow merchants requested that all colonial bills be required to pay 5 percent interest. This request, however, was not adopted into the Act. This proposal only makes sense if bills of credit were understood to be zero-coupon bonds with variable redemption spans. Why this solution was not adopted is unclear. Perhaps the transaction

costs, explained above, of implementing interest-bearing paper money were considered too high.

Why Virginia's behavior was singled out as the cause of the 1764 Currency Act (Ernst 1973), can now be answered. From 1755 through 1756, Virginia issued bills with short redemption windows and tightly staggered overlapping emissions. The APV of these bills would be close to face value, i.e. following a Figure 2 pattern. After 1756, Virginia shifted to longish redemption windows with tightly staggered overlapping emissions, and from soft to hard legal tender laws. The 1757 to 1762 value pattern was between those shown in Figures 3 and 4, see Figure 5 and Appendix Table A1.

This shift in emission-redemption structure and legal tender laws created stress for British creditors in the Virginia market. Any merchant who contract in Virginia pounds in 1755-6 found that the present value of average Virginia bills had fallen 20 percentage points by 1762. If courts enforced the restitution of contract debt claims from the mid-1750s in post-1760 bills, using as justification the new hard legal tender laws embedded in Virginia's more recent paper money acts, British creditors could lose a lot. Prohibiting legal tender laws stopped this potential loss. The rebound in the value of Virginia bills after 1768, however, was not due to the 1764 Currency Act. This rebound was simply the result of shifting to a Figure 2 redemption structure after 1768, see Figure 5 and Appendix Table A1. The 1764 Currency Act simply solved the tort law problem of courts improperly counting bills at face value rather than at their present value. It did not directly impact or improve the value of Virginia bills.

In conclusion, colonial assemblies did not set out intentionally to defraud people with paper money and legal tender laws. It was how courts interpreted legal tender laws and the face value exchange rate to sterling when applying such laws to breach-of-contract cases that could lead potentially to creditors being defrauded. Laws designating bills of credit, structured as zero-

coupon bonds, a legal tender primarily created problems only in the adjudication of tort law cases and had little bearing on fixing the trade value of colonial paper money. Colonial legislatures insisted on hard legal tender laws as convenient devices to anchor the value of their bills at the point of maturity and so provide credibility to the government's redemption exercise.

CONCLUSIONS

I have explored an alternative view of colonial paper money. Colonial legislatures put considerable effort into designing monetary structures. Taking that effort seriously implies that paper money was not just paper money, i.e. it was not just fiat currency. Instead, paper bills were either zero-coupon bonds or interest-bearing bonds. They served primarily as local barter assets in under-monetized economies. Their present values were contingent on their redemption structures, interest payments, and market discount rates. These contingencies varied across emissions. Thus, the face value of paper bills cannot be compared over time or summed across emissions for analytical purposes. This observation renders most past economic studies of colonial paper money performance meaningless. This observation also indicates that paper bills traded below face value due to time-discounting not depreciation. Scholars have simply confused time-discounting for depreciation. Finally, the market value of paper bills was primarily determined by their asset present values. Legal tender laws only affected tort law outcomes.

The preliminary findings here indicate that this research approach holds promise. The next stages involve the painstaking and time-consuming effort to establish the actual redemption structures as executed for each paper money emission, to construct the exact time-series of representative bills' present values, and relate those values to the respective paper money's market value. This has only been done so far for colonial New Jersey and post-1764 colonial Maryland (Celia and Grubb 2014; Grubb 2014, 2015).

With independence, British restrictions on bank corporations were removed and the U.S. shifted toward creating an inside paper money out of banknotes that were fractionally backed by specie reserves (outside money), with banknotes exchangeable for specie at face value on demand at the issuing bank. Banknotes were a superior paper money because their market value would always be close to their face value (barring a liquidity crisis). This was a feature that colonial bills of credit structured as zero-coupon bonds could not achieve.

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Appendix Table A1 Colonial Paper Money, 1690 to 1775

Colony/ State	Date Printed on the Bill: Year Month Day	Face Value of Amounts Authorized to be Emitted	Annual Interest Rate Paid (%)	Maximum Initial Issuance-to-Final Redemption Interval in Years	Legal Tender?	*Information Printed on the Bills:*[d] Emission Date	Redemption Date	Interest Rate	In addition to the numerical face value— what that value was redeemable or valued in, or how it was redeemable or valued
New England Colonies/States									
Massachusetts									
1690	Dec. 10	7,000£	0.0	-----	yes[b]	yes	no	no	any "stock" in the treasury
1691	Feb. 3	42,000£	5.0[c]	-----	yes	yes	no	no	any "stock" in the treasury
1702	Nov. 21	10,000£	0.0	-----	yes	yes	no	no	any "stock" in the treasury
1708	Nov. 21	40,000£	0.0	-----	yes	yes	no	no	any "stock" in the treasury
1710	May 31	35,000£	0.0	-----	yes	yes	no	no	any "stock" in the treasury
1711	July 6	40,000£	0.0	-----	yes	yes	no	no	any "stock" in the treasury
1713	Oct. 14	10,000£	0.0	-----	yes	-----	-----	-----	-----
(1714-1740)		958,477£[a]	0.0	5-10.00	yes	yes	no	no	any "stock" in the treasury
1737	Feb. 4	36,000£	0.0	-----	yes	yes	no	no	any "stock" in the treasury
	July 7	2,625£	0.0	-----	yes	yes	no	no	specie
1741	Jan. 15	30,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1742	July 1	15,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1743	Jan. 12	12,000£	0.0	-----	yes	yes	no	no	(valued in) specie
	Nov. 12	12,000£	0.0	-----	yes	yes	no	no	(valued in) specie
(1744-1750)		666,837£	0.0	-----	yes	yes	no	no	(valued in) specie
1750	Jan. 27	3,000£	0.0	-----	yes	yes	no	no	(valued in) lawful money
[1751 Currency Act]									
1750		18,400£	6.0	2-3.00	no	-----	-----	-----	-----
1751		9,000£	6.0	2-3.00	no	-----	-----	-----	-----
1752		18,614£	6.0	2-3.00	no	-----	-----	-----	-----
1753		956£	6.0	2-3.00	no	-----	-----	-----	-----
1754		9,332£	6.0	2-3.00	no	-----	-----	-----	-----
1755		36,508£	6.0	2-3.00	no	-----	-----	-----	-----
1756		121,194£	6.0	2-3.00	no	-----	-----	-----	-----
1757		94,181£	6.0	2-3.00	no	-----	-----	-----	-----
1758		118,644£	6.0	2-3.00	no	-----	-----	-----	-----
1759		150,106£	6.0	2-3.00	no	-----	-----	-----	-----
1760		211,346£	6.0	2-3.00	no	-----	-----	-----	-----
1761		210,597£	6.0	2-3.00	no	-----	-----	-----	-----
1762		209,866£	6.0	2-3.00	no	-----	-----	-----	-----
1763		124,873£	6.0	2-3.00	no	-----	-----	-----	-----
1764		72,334£	6.0	2-3.00	no	-----	-----	-----	-----
1765		131,063£	6.0	2-3.00	no	-----	-----	-----	-----
1766		12,385£	6.0	2-3.00	no	-----	-----	-----	-----
1767		197,000£	6.0	2-3.00	no	-----	-----	-----	-----
1768		157,000£	6.0	2-3.00	no	-----	-----	-----	-----
1769		125,850£	6.0	2-3.00	no	-----	-----	-----	-----
1770		100,000£	6.0	2-3.00	no	-----	-----	-----	-----
1771		88,158£	6.0	2-3.00	no	-----	-----	-----	-----
1772		75,091£	6.0	2-3.00	no	-----	-----	-----	-----
1773		909£	6.0	2-3.00	no	-----	-----	-----	-----
1774		16,000£	6.0	2-3.00	no	-----	-----	-----	-----
Connecticut									

1709 July 12	24,000£	5.0[c]	-----	no	yes	no	no	any “stock” in the treasury
1709 July 12	10,000£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1713 May	20,000£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1713 May	10,000£	0.0	-----	yes	yes	no	no	any “stock” in the treasury
1724 Dec. 1	2,000£	0.0	-----	yes	yes	no	no	any “stock” in the treasury
1728 Oct.	4,000£	0.0	-----	yes	yes	no	no	any “stock’ in the treasury
1733 July 10	30,000£[a]	0.0	7.79	yes	yes	no	no	any “stock” in the treasury
1740 May 8	30,000£[a]	0.0	-----	yes	yes	no	no	(valued in) specie
1740 July 8	10,000£	0.0	-----	yes	yes	no	no	any “stock” in the treasury
1744 May 10	4,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1744 Oct. 11	15,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1745 Mar. 14	40,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1746 May 8	3,000£	0.0	-----	yes	yes	no	no	any “stock” in the treasury
1746 May 8	55,000£	0.0	-----	yes	yes	no	no	(valued in) specie
[1751 Currency Act]								
1755 Jan. 8	7,500£	5.0	3.00	no	yes	yes	yes	lawful money
1755 Mar. 13	12,500£	5.0	4.17	no	yes	yes	yes	lawful money
1755 Aug. 27	30,000£	5.0	5.00	no	yes	yes	yes	lawful money
1755 Oct. 9	12,000£	5.0	4.50	no	yes	yes	yes	lawful money
1758 Mar. 8	30,000£	5.0	4.17	no	yes	yes	yes	lawful money
1759 Feb. 7	20,000£	5.0	4.25	no	yes	yes	yes	lawful money
1759 Mar. 8	40,000£	5.0	5.00	no	yes	yes	yes	lawful money
1759 May 10	20,000£	5.0	4.00	no	yes	yes	yes	lawful money
1760 Mar. 13	70,000£	5.0	5.00	no	yes	yes	yes	lawful money
1761 Mar. 26	45,000£	5.0	5.00	no	yes	yes	yes	lawful money
1762 Mar. 4	65,000£	5.0	5.00	no	yes	yes	yes	lawful money
1763 Mar. 12	10,000£	5.0	2.00	no	yes	yes	yes	lawful money
1764 Mar. 8	7,000£	5.0	3.00	no	yes	yes	yes	lawful money
1770 May 10	10,000£	2.5	2.00	no	yes	yes	yes	lawful money
1771 Oct. 10	12,000£	0.0	2.00	no	yes	yes	no	lawful money
1773 June 1	12,000£	0.0	2.00	no	yes	yes	no	lawful money
New Hampshire								
1709 Dec. 6	8,000£	5.0	5.00	no	yes	no	no	any “stock” in the treasury
1710 Dec. 2	2,500£	5.0	-----	no	yes	no	no	any “stock” in the treasury
1711 May 14	1,000£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1711 Oct. 10	2,000£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1712 Oct. 15	500£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1714 May 14	1,200£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1717 May 20	15,000£[a]	0.0	11.00	no	yes	no	no	any “stock” in the treasury
1722	4,800£	0.0	-----	no	yes	no	no	any “stock” in the treasury
(1724-1729)	9,700£	0.0	13.00	no	yes	no	no	any “stock” in the treasury
1737 Apr. 1	7,900£	0.0	5.00	no	yes	no	no	any “stock” in the treasury
1740 Aug. 7	2,700£	0.0	2.00	no	yes	no	no	any “stock” in the treasury
1742 Apr. 3	6,000£	0.0	-----	yes	yes	no	no	(valued in) specie
1743 June 2	25,000£[a]	0.0	-----	yes	yes	no	no	(valued in) specie
1745 Feb. 16	87,000£	0.0	21.00	yes	yes	no	no	(valued in) specie
[1751 Currency Act]								
1755 Apr. 3	30,000£	1.0	5.75	no	yes	no	yes	(valued in) specie
1756 Jan. 1	15,000£	1.0	5.00	no	yes	no	yes	(valued in) specie
1756 June 1	70,500£	1.0	6.50	no	yes	no	yes	(valued in) specie
1759	13,000£	2.5	3.00	no	yes	no	yes	Sterling bills of exchange
1760 Mar. 1	8,000£	2.5	4.75	no	yes	yes	yes	Sterling bills of exchange
1761 Jan. 1	7,000£	2.5	5.00	no	yes	yes	yes	Sterling bills of exchange
1761 May 1	12,000£	2.5	4.67	no	yes	yes	yes	Sterling bills of exchange
1762 Jan. 1	8,000£	2.5	5.00	no	yes	yes	yes	specie

1762	July 1	10,000£	2.5	5.00	no	yes	yes	yes	specie
1763	Jan. 1	10,000£	2.5	5.00	no	yes	yes	yes	specie
Rhode Island									
1710	Aug. 16	13,300£	0.0	5.00	yes	yes	no	no	any “stock” in the treasury
1715	July 5	40,000£[a]	0.0	10.00	no	yes	no	no	any “stock” in the treasury
1721		40,000£[a]	0.0	5.00	no	yes	no	no	any “stock” in the treasury
1724		2,000£	0.0	-----	no	yes	no	no	any “stock” in the treasury
1728		49,000£[a]	0.0	20.00	no	yes	no	no	any “stock” in the treasury
1731		60,000£[a]	0.0	20.00	no	yes	no	no	any “stock” in the treasury
1733		104,000£[a]	0.0	20.00	no	yes	no	no	any “stock” in the treasury
1738		100,000£[a]	0.0	20.00	no	yes	no	no	any “stock” in the treasury
1740	Dec. 2	24,000£[a]	0.0	20.00	yes	yes	no	no	(valued in) specie
1743	Feb. 14	40,000£[a]	0.0	20.00	no	yes	no	no	(valued in) specie
1744		8,750£	0.0	-----	no	yes	no	no	(valued in) specie
1745		8,750£	0.0	-----	no	yes	no	no	(valued in) specie
1746		11,250£	0.0	-----	no	yes	no	no	(valued in) specie
1746-7	Feb. 17	15,000£	0.0	-----	no	yes	no	no	(valued in) specie
1747		7,500£	0.0	-----	no	yes	no	no	(valued in) specie
1750	Mar. 18	50,000£[a]	0.0	20.00	no	yes	no	no	(valued in) specie
[1751 Currency Act]									
1755		60,000£	0.0	2.00	no	yes	no	no	(valued in) specie
1756	Feb. 27	8,000£	0.0	1.00	no	yes	yes	no	lawful money
1756	Aug.	6,000£	0.0	2.00	no	yes	yes	no	lawful money
1758	May 8	10,000£	5.0	5.00	no	yes	yes	yes	lawful money
1758	Dec. 23	10,909£	6.0	5.00	no	yes	yes	yes	lawful money
1759	Mar. 15	12,000£	5.0	5.00	no	yes	yes	yes	lawful money
1759	Apr. 4	4,000£	5.0	5.00	no	yes	yes	yes	lawful money
1759	June 23	4,000£	5.0	3.00	no	yes	yes	yes	lawful money
1760	Mar. 10	16,000£	5.0	5.00	no	yes	yes	yes	lawful money
1760	May 12	11,000£	5.0	5.00	no	yes	yes	yes	lawful money
1762	Mar. 20	5,000£	5.0	5.00	no	yes	yes	yes	lawful money
1762	Apr. 10	2,000£	5.0	5.00	no	yes	yes	yes	lawful money
1762	May 8	2,000£	5.0	5.00	no	yes	yes	yes	lawful money
1762	Nov. 1	4,000£	5.0	5.00	no	yes	yes	yes	lawful money
1766	Mar. 1	1,000£	0.0	2.00	no	yes	yes	no	lawful money
1767	Feb. 28	2,000£	0.0	2.00	no	yes	yes	no	lawful money
Middle Colonies/States									
New York									
1709	May 31	5,000£	5.0[c]	1.50	yes	yes	no	no	any “fund” in the treasury
1709	Nov. 1	8,000£	2.5[c]	4.00	yes	yes	no	yes	any “fund” in the treasury
1711	July 20	10,000£	0.0	7.50	yes	yes	no	no	any “fund” in the treasury
1714	July 1	27,680£	0.0	21.00	yes	yes	no	no	any “fund” in the treasury
1715	July 5	6,000£	0.0	5.00	yes	-----	-----	-----	-----
1717	Nov. 28	16,607£	0.0	22.00	yes	yes	no	no	any “fund” in the treasury
1723	July 2	2,140£	0.0	3.00	yes	yes	no	no	any “fund” in the treasury
1724	July 10	5,670£	0.0	4.00	yes	yes	no	no	(valued in) current money
1734	Nov. 15	12,000£	0.0	11.67	yes	yes	no	no	(valued in) current money
1737	Dec. 10	48,350£[a]	0.0	12.00[h]	yes	yes	no	no	(valued in) current money
1746	May 10	13,000£	0.0	2.50	yes	yes	no	no	(valued in) current money
1746	July 21	40,000£	0.0	10.30	yes	yes	no	no	(valued in) current money
1747	Nov. 25	28,000£	0.0	8.00	yes	yes	no	no	(valued in) current money
1755	Mar. 25	45,000£	0.0	5.60	yes	yes	no	no	(valued in) current money
1755	May 12	10,000£	0.0	6.50	yes	yes	no	no	(valued in) current money

1755	Sept. 15	8,000£	0.0	5.16	yes	yes	no	no	(valued in) current money
1756	Feb. 16	10,000£	0.0	5.67	yes	yes	no	no	(valued in) current money
1756	Apr. 20	52,000£	0.0	9.54	yes	yes	no	no	(valued in) current money
1758	Apr. 15	100,000£	0.0	9.58	yes	yes	no	no	(valued in) current money
1759	Apr. 2	100,000£	0.0	8.58	yes	yes	no	no	(valued in) current money
1759	July 20	150,000£	0.0	1.00[i]	yes	-----	-----	-----	-----
1760	Apr. 21	60,000£	0.0	7.54	yes	yes	no	no	(valued in) current money
[1764 Currency Act]									
1771	Feb. 16	120,000£[a]	0.0	14.00	no	yes	no	no	(valued in) current money
New Jersey									
1709	July 1	3,000£	2.5[c]	2.00	yes	yes	no	no	any “fund” in the treasury
1711	July 14	5,000£	0.0	5.00	yes	yes	no	no	any “fund” in the treasury
1717	Jan. 24	4,670£	0.0	5.00	yes	yes	no	no	any “fund” in the treasury
1724	Mar. 25	40,000£[a]	0.0	12.00	yes	yes	no	no	any “fund” in the treasury
1733	Mar. 25	20,000£[a]	0.0	16.00	yes	yes	no	no	(valued in) specie
1737	Mar. 25	40,000£[a]	0.0	16.00	yes	yes	no	no	(valued in) specie
1746	July 2	10,000£	0.0	-----[g]	yes	yes	no	no	(valued in) specie
1755	May 15	15,000£	0.0	4.50	yes	yes	no	no	(valued in) specie
1755	Sept. 8	15,000£	0.0	5.22	yes	yes	no	no	(valued in) specie
1756	Jan. 26	10,000£	0.0	5.83	yes	yes	no	no	(valued in) specie
1756	June 22	17,500£	0.0	6.42	yes	yes	no	no	(valued in) specie
1757	Apr. 12	10,000£	0.0	6.59	yes	yes	no	no	(valued in) specie
1757	June 14	5,000£	0.0	6.42	yes	yes	no	no	(valued in) specie
1757	Nov. 20	30,000£	0.0	16.42	yes	yes	no	no	(valued in) specie
1758	May 1	50,000£	0.0	20.58	yes	yes	no	no	(valued in) specie
1758	Oct. 20	10,000£	0.0	2.51	yes	yes	no	no	(valued in) specie
1759	Apr. 10	50,000£	0.0	8.63	yes	yes	no	no	(valued in) specie
1760	Apr. 12	45,000£	0.0	13.63	yes	yes	no	no	(valued in) specie
1761	Apr. 23	25,000£	0.0	17.58	yes	yes	no	no	(valued in) specie
1762	Apr. 8	30,000£	0.0	18.63	yes	yes	no	no	(valued in) specie
1763	Dec. 31	10,000£	0.0	18.00	yes	yes	no	no	(valued in) specie
1764	Apr. 16	25,000£	0.0	19.60	yes	yes	no	no	(valued in) specie
[1764 Currency Act]									
(1765-1774)		0							
Pennsylvania									
1723	Apr. 2	15,000£[a]	0.0	8.33	yes	yes	no	no	any “fund” in the treasury
1724	Jan. 17	30,000£[a]	0.0	8.08	yes	yes	no	no	(valued in) current money
1729	Sept. 15	30,000£[a]	0.0	16.00	yes	yes	no	no	(valued in) current money
1731	Apr. 10	85,000£[a]	0.0	16.00	yes	-----	-----	-----	-----
1739	Aug. 10	80,000£[a]	0.0	16.00	yes	yes	no	no	(valued in) current money
1756	Jan. 1	55,000£	0.0	4.00	yes	yes	no	no	(valued in) current money
1756	Oct. 1	30,000£	0.0	10.00	yes	yes	no	no	(valued in) current money
1757	Mar. 10	45,000£	0.0	4.00	yes	yes	no	no	(valued in) current money
1757	July 1	55,000£	0.0	3.58	yes	yes	no	no	(valued in) current money
1758	May 20	100,000£	0.0	5.75	yes	yes	no	no	(valued in) current money
1759	Apr. 25	100,000£	0.0	7.83	yes	yes	no	no	(valued in) current money
1760	May 1	100,000£	0.0	10.00	no	yes	no	no	(valued in) current money
1764	June 18	55,000£	0.0	8.25	yes	yes	no	no	(valued in) current money
[1764 Currency Act]									
1767	June 15	20,000£	0.0	4.00	no	yes	no	no	(valued in) current money
1769	Mar. 1	16,000£	0.0	4.00	no	yes	no	no	(valued in) current money
1769	Mar. 10	14,000£	0.0	14.00	no	yes	no	no	(valued in) current money
1771	Mar. 20	15,000£	0.0	10.00	no	yes	no	no	(valued in) current money

1772	Apr. 3	25,000£	0.0	10.00	no	yes	no	no	-----
1773	Mar. 20	12,000£	0.0	15.00	no	yes	no	no	-----
1773	Oct. 1	150,000£[a]	0.0	16.00	no	yes	no	no	-----
Delaware									
1723	Apr. 23	5,000£[a]	0.0	8.00	-----	-----	-----	-----	-----
1723	Nov. 2	6,000£[a]	0.0	8.00	-----	-----	-----	-----	-----
1729		12,000£[a]	0.0	16.00	-----	-----	-----	-----	-----
1734	Mar. 1	12,000£[a]	0.0	16.00	yes	yes	no	no	(valued in) current money
1746	Feb. 28	20,000£[a]	0.0	12.00	-----	yes	no	no	(valued in) current money
1756	May 1	2,000£	0.0	7.00	-----	yes	no	no	(valued in) current money
1758	Mar. 1	4,000£	0.0	7.00	-----	yes	no	no	(valued in) current money
1758	May 1	8,000£	0.0	7.00	-----	yes	no	no	(valued in) current money
1759	June 1	27,000£[a]	0.0	9.00	yes	yes	no	no	(valued in) current money
1760	May 31	4,000£	0.0	8.00	-----	yes	no	no	(valued in) current money
[1764 Currency Act]									
(1765-1774)		0							
Chesapeake Colonies/States									
Maryland									
1733	Mar. 13	90,000£[a]	0.0	31.00[e]	yes	yes	no	no	(valued in) current money
1756	July 14	30,000£	0.0	8.00	yes	yes	no	no	(valued in) current money
[1764 Currency Act]									
1767	Jan. 1	$173,733	0.0	11.00	no	yes	no	no	sterling bills of exchange[f]
1770	Mar. 1	$300,000[a]	0.0	12.00	no	yes	no	no	sterling bills of exchange[f]
1774	Apr. 10	$346,667[a]	0.0	12.00	no	yes	no	no	sterling bills of exchange[f]
Virginia									
1755	June	20,000£	5.0	1.00	yes	-----	-----	-----	-----
1755	Dec. 11	40,000£	5.0	4.59[j]	yes	-----	-----	-----	-----
1756	Mar.	25,000£	5.0	4.35[j]	yes	-----	-----	-----	-----
1756	Mar.	30,000£	5.0	4.35[j]	yes	-----	-----	-----	-----
1756	Mar.	10,000£	0.0	1.72	yes	-----	-----	-----	-----
1757	June 8	84,963£	0.0	7.73[jk]	yes	yes	no	no	(valued in) current money
1758	Apr. 12	32,000£	0.0	6.88[k]	yes	yes	no	no	(valued in) current money
1758	Oct. 12	57,000£	0.0	7.92[k]	yes	yes	no	no	(valued in) current money
1759	Apr. 5	52,000£	0.0	9.04[k]	yes	yes	no	no	(valued in) current money
1759	Nov. 21	10,000£	0.0	9.92[m]	yes	yes	no	no	(valued in) current money
1760	Mar. 11	20,000£	0.0	7.58[k]	yes	yes	no	no	(valued in) current money
1760	May 24	32,000£	0.0	9.41	yes	yes	no	no	(valued in) current money
1762	Apr. 7	30,000£	0.0	7.54	yes	yes	no	no	(valued in) current money
[1764 Currency Act]									
1769	Nov. 7	10,000£	0.0	2.04[l]	no	yes	no	no	(valued in) current money
1771	July 11	30,000£	0.0	4.42[l]	no	yes	no	no	(valued in) current money
Southern Colonies/States									
North Carolina									
1712		4,000£	yes?	-----	yes	-----	-----	-----	-----
1713		8,000£	yes?	-----	yes	-----	-----	-----	-----
1715		24,000£	0.0	-----	yes	-----	-----	-----	-----
1722	Oct. 19	12,000£	0.0	-----	yes	yes	no	no	(valued in) current money
1729	Nov. 27	40,000£[a]	0.0	15.00	yes	yes	no	no	(valued in) current money
1735	Mar. 1	12,500£	0.0	-----	no	yes	no	no	lawful money
1748	Apr. 4	21,350£	0.0	-----	yes	yes	no	no	proclamation money
1754	Mar. 9	40,000£	0.0	-----	yes	yes	no	no	proclamation money

1756	Sept. 13	3,400£	6.0	1.17	no	yes	yes	yes	proclamation money
1757	May 28	5,306£	6.0	1.33	no	yes	yes	yes	proclamation money
1757	Nov. 21	9,500£	6.0	1.00	no	yes	yes	yes	proclamation money
1758	May 4	7,000£	6.0	1.58	yes	yes	yes	yes	proclamation money
1758	Dec. 22	4,000£	6.0	2.50	yes	yes	yes	yes	proclamation money
1760	July 14	12,000£	0.0	-----	yes	yes	no	no	proclamation money
1761	Apr. 23	20,000£	0.0	-----	yes	yes	no	no	proclamation money
[1764 Currency Act]									
1768	Dec. 5	20,000£	0.0	3.50	no	yes	yes	no	proclamation money
1771	Dec.	60,000£	0.0	10.00	no	yes	no	no	proclamation money
South Carolina									
1703	May 8	6,000£	12.0	3.00	yes	-----	-----	-----	-----
1707	July 5	8,000£	0.0	9.00	yes	-----	-----	-----	-----
1708	Feb. 14	3,000£	0.0	-----	no	-----	-----	-----	-----
1708	Apr. 24	5,000£	0.0	-----	no	-----	-----	-----	-----
1711	Mar. 1	2,000£	0.0	-----	yes	-----	-----	-----	-----
1711	Nov.10	4,000£	0.0	-----	no	-----	-----	-----	-----
1712	June 7	36,000£[a]	0.0	-----	yes	-----	-----	-----	-----
1715	Aug. 27	30,000£	0.0	-----	yes	yes	no	no	(valued in) current money
1716	Mar. 24	5,000£	0.0	-----	yes	-----	-----	-----	-----
1716	June 30	15,000£	0.0	-----	no	-----	-----	-----	-----
1716	Aug. 4	15,000£	0.0	-----	no	-----	-----	-----	-----
1719	Feb. 20	15,000£	yes?	-----	yes	-----	-----	-----	-----
1720	June 18	19,000£	0.0	-----	yes	-----	-----	-----	-----
1723	Feb. 23	40,000£	0.0	-----	yes	yes	no	no	(valued in) current money
1731	Aug. 20	104,775£	5.0	6.67	yes	yes	no	no	(valued in) current money
1737	Mar. 5	35,010£	0.0	5.00	yes	yes	no	no	(valued in) current money
1740	Apr. 5	25,000£	0.0	4.00	yes	yes	no	no	(valued in) current money
1740	Sept. 19	11,508£	0.0	4.00	yes	yes	no	no	(valued in) current money
1757	July 6	229,300£	0.0	5.40	no	-----	-----	-----	-----
1760	July 31	316,693£	0.0	5.33	no	yes	yes	no	(valued in) current money
1760	Aug. 20	125,000£	0.0	6.25	yes	yes	yes	no	(valued in) current money
1762	May 29	6,000£	0.0	-----	yes	-----	-----	-----	-----
[1764 Currency Act]									
1767	Apr. 18	60,000£	0.0	5.42	yes	yes	yes	no	(valued in) current money
1770	Apr. 7	70,000£	0.0	5.00	no	yes	yes	no	(valued in) current money
Georgia									
1755	Feb. 17	7,000£[a]	0.0	7.83	yes	yes	no	no	(valued in) sterling
1760	May 1	1,100£	0.0	3.42	yes	yes	yes	no	(valued in) sterling
1762	Feb. 17	3,010£	0.0	-----	yes	yes	no	no	(valued in) sterling
1762	Mar. 25	540£	0.0	5.00	no	yes	yes	no	(valued in) sterling
[1764 Currency Act]									
1765	July 8	650£	0.0	3.21	no	yes	yes	no	(valued in) sterling
1766	Mar. 6	1,815£	0.0	5.00	no	yes	yes	no	(valued in) sterling
1768	Apr. 11	3,375£	0.0	3.08	no	yes	yes	no	(valued in) current money
1768	Dec. 24	93,046£	0.0	2.33	no	yes	yes	no	(valued in) current money
1768	Dec. 24	2,200£	0.0	3.33	no	yes	yes	no	(valued in) sterling
1770	May 10	23,355£	0.0	1.00	no	yes	yes	no	(valued in) current money
1773	Sept.29	4,299£	0.0	3.00	no	yes	yes	no	(valued in) current money
1774	Mar. 12	800£	0.0	3.75	no	yes	yes	no	(valued in) sterling

Sources: Information derived and compiled first from Newman (2008); with missing information added from Brock (1975, pp. 26-8, 38-9, 45, 47-9, 66, 72-3, 81-2, 96-9, 108-10, 116-7, 272-5, 300-4, 326-7, 346-7, 386-7, 419, 596); Bullock (1900, pp. 137, 152, 174, 207, 215, 225-6, 232, 238-40); Rodney (1928, pp. 17-36) with corrections made to these secondary sources for NY, NJ, PA, MD, and VA from information found in the original sources as reprinted in

Archives of Maryland (v. 19, pp. 579-84; v. 20, pp. 127-38; v. 24, pp. 480-521; v. 39, pp. 92-113; v. 61, pp. 264-75; v. 62, pp.133-42; v. 64, pp. 242-51); Bush (1977, pp. 63-6, 68-70, 109-113, 209-213, 301-19, 427-38, 474-87; 1980, pp. 21-8, 307-19, 345-55, 373-82, 413-25, 455-71, 495-502, 517-29, 539-55, 563-78, 621-39, 663-79; 1982, pp. 73-89, 125-40, 207-21, 289-306); *Colonial Laws of New York* (v. 1, pp. 654-7, 666-74, 689-97, 730-2, 737-40, 785-8, 815-26, 847-57, 938-47; v. 2, pp. 12-3, 137-48, 173-86, 198-205, 885-92, 1015-47; v. 3, pp. 294-5, 381-2, 548-63, 577-93, 660-74, 784-7, 1038-50, 1078-93, 1131-9; v. 4, pp. 43-59, 60-76, 156-9, 199-202, 215-35, 301-4, 317-37, 350-5, 385-7, 398-418, 491-4, 554-6, 649-52, 708-10; v. 5, pp. 149-78, 881); Grubb (2015); Hening (1969, v. 6, pp. 435-8, 461-8, 521-30; v. 7, pp. 9-33, 46-54, 69-87, 163-9, 171-231, 255-65, 331-7, 347-53, 357-63, 465-6, 495-502; v. 8, pp. 342-8, 493-503, 647-52; v. 9, pp. 61-71); *Statutes at Large of Pennsylvania* (v. 3, pp. 324-8, 389-407; v. 4, pp. 98-116, 197-208, 344-59; v. 7, pp. 100-7, 197-211; v. 8, pp. 15-22, 204-20, 273-300, 417-28, 447-55, 488-90, 495-7).

Notes: Dashed lines indicate that the information was not available in the sources cited. The nominal amount actually emitted could be less than the nominal amount authorized. Only paper monies issued by political legislative bodies are considered. Bills issued explicitly to replace existing bill that were too torn or ragged to continue in circulation or were under threat of being counterfeited or were to merely replace wholesale existing bills are excluded. £ refers to the pounds of each colony, respectively, e.g. Pennsylvania pounds for Pennsylvania, New York pounds for New York, and so on. $ = Spanish silver dollars. Lawful money, also called proclamation money, meant colonial currency valued at the official par of £132.75 colonial currency per £100.00 pounds sterling (McCusker 1978, pp. 121, 126, 136, 176). Lawful money was a unit-of-account rating. To receive "lawful money" from a colony's treasury did not mean one received specie. One could still be paid paper money or its equivalent by the treasury. Payments in "lawful money" when rendered in paper money only meant that the paper money was legally rated as equivalent to specie at the proclamation rate set in colonial law. Its value when used as an actual medium of exchange could deviate from this rate. "Current money" meant money as defined by a colony's legal tender acts. It typically referred to a colony's paper money. The "Issuance-to-Redemption Interval" counts either the years over which these bills could be used to pay the taxes or repay the mortgage-loans of the issuing colony, or how many years into the future before the bills could be exchanged for their face value in specie or sterling bills of exchange, where applicable, by the respective issuing colonial authority. This interval is for the period initially legislated and does not take into account any subsequent postponements or extensions of redemption. "Legal tender" refers to colonial laws that made the notes legal tender for all transactions within the issuing colony, both public and private. Whether an issue was designated a legal tender was taken from the sources cited and from the language printed on the notes. The interest rate reported does not include the interest charged by the colony on bills of credit issued as land-mortgage loans to subjects. In some cases an emission was not listed as a legal tender, but later was forcibly exchanged by law for a new emission that was designated a legal tender. In these cases, the prior emission was listed in the table to be a legal tender.

[a] Some amounts were emitted as loans to subjects who pledged their lands as collateral. The annual interest rate charged by these colonies for these loans and the time-interval of principle repayment ranged from 4 to 10 percent and from 5 to 22 years. A typical loan was at a 5 percent annual interest rate for 12 years.

[b] The act passed on Dec. 15, 1692 by the Massachusetts assembly gave all Massachusetts bills legal tender status within the colony (Newman 2008, p. 185). It is assumed that this act held for all subsequent emissions by Massachusetts through 1750.

[c] This was not an interest rate paid directly, but a percentage premium granted when paying taxes using the bills issued. It functioned as a de facto interest rate paid and so is counted as such.

[d] Taken from the face of the printed bills reproduced in Newman (2008). Dashed lines indicate that no surviving bills were found. Legislated acts often indicated what was to be printed on the bills, but only if surviving bills were found to verify this information was it included in the table.

[e] One-third was to be redeemed in 15 years and the remaining two-thirds in 31 years. The number reported here is when the last was to be redeemed.

[f] Maryland invested proceeds from an export tax on tobacco from 1734 to 1765 in Bank of England stock which was then used to support redeeming its bills in London, via sterling bills of exchange .

[g] To be redeemed with the specie reimbursement promised by the British Crown for military expenditures, but with no expected redemption/reimbursement date given (Bush 1980, pp. 21-8).

[h] The loan portion of this December 1737 emission, 40,000£, had its final redemption date (its principal pay-off date) extended in 1743 to 16.00 years from its initial emission date (effectively April 1738), then extended again in 1750 to 22.00 years from its initial emission date, then extended again in 1756 to 23.00 years from its initial

emission date, then extended again in 1757 to 24.00 years from its initial emission date, then extended again in 1758 to 25.00 years from its initial emission date, then extended again in 1759 to 26.00 years from its initial emission date, then extended again in 1760 to 27.00 years from its initial emission date, then extended again in 1761 to 28.00 years from its initial emission date, then extended again in 1762 to 29.00 years from its initial emission date, and then extended again in 1763 to 30.00 years from its initial emission date.

[i] This emission was a one-year loan to His Majesty's forces to be repaid (redeemed) through sterling bills of exchange drawn on His Majesty's paymaster.

[j] An additional 99,962.5£ of the June 8, 1757 emission were printed and forcibly swapped for the bills of the 1755 and first two 1756 emissions along with their accrued interest on December 1, 1757. The swapped bills would follow the interest payments and redemption dates designated for the June 8, 1757 emission. In effect, this action was an ex post facto removal of interest payments on the 1755 and 1756 bills after December 1, 1757, along with an ex post facto alteration in the redemption or maturity dates of these bills. See note m below. The payment of accrued interested on the swapped bills to December 1, 1757 added a net gain of 4,962.5£ in bills to the June 8, 1757 emission above the 80,000£ in new bills initially authorized.

[k] In November of 1761 the legislature changed the final redemption dates of these emissions to all being on October 20, 1769. This action extended the Maximum Issuance-to-Final Redemption Interval for the June 8, 1757 emission to 12.35 years, for the April 12, 1758 emission to 11.52 years, for the October 12, 1758 emission to 11.02 years, for the April 5, 1759 emission to 10.54 years, and for the March 11, 1760 emission to 9.60 years.

[l] In March of 1773 the legislature called in all bills from the November 7, 1769 and July 11, 1771 emissions that were still in circulation, amounting to 36,834£, to be swapped for new bills dated March 4, 1773. The swapped amount implies that 68 percent of the November 7, 1769 emission was still outstanding past its initial redemption date. This action was done to thwart the suspected counterfeiting of the 1769 and 1771 bills. The new bills were to be redeemed on June 1, 1774. This action changed the Maximum Issuance-to-Final Redemption Interval for the November 7, 1769 emission to 4.56 years, and for the July 11, 1771 emission to 2.90 years.

[m] This emission was contingent on the Virginia treasury not being about to borrow 5,000$£_{VA}$ and not having 5,000$£_{VA}$ leftover from prior emissions sitting unused in the treasury, and with said redeemed using 30,000$£_{Sterling}$ promised the colony by Parliament. Given that it was necessary to emit new bills in 1760, it is assumed that there were no unused bills in the treasury and that the treasury was unable to borrow funds, thus triggering the contingency for issuing this emission.

Footnotes

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[1] Franklin continued with "but the making them a legal Tender in all Payments, and keeping the Quantity within reasonable Bounds." (Labaree 1970, v. 14, pp. 33-6). However, Franklin, as shown below, argued elsewhere that legal tender laws had no influence on the value of paper money. For this statement, however, he was under instruction from the Pennsylvania Assembly as its representative to the British government to argue for the necessity of a legal tender law.

[2] *Bills of Credit* were also referred to as *Treasury Notes* in some colonies, such as in Virginia, see Hening (1969, v. 6, pp. 435-8, 461-8, 521-30; v. 7, pp. 9-33, 46-54, 69-87, 163-9, 171-231, 255-65, 331-7, 347-53, 465-6, 495-502; v. 8, pp. 342-8, 493-503, 647-52; v. 9, pp. 61-71).

[3] Banks successfully emitting paper banknotes backed by fractional specie reserves, with banknotes exchangeable for their face value in specie on demand at the issuing bank, would not appear in English-speaking North America until near the end of the American Revolution (Hammond 1957, pp. 3-64).

[4] See Goldberg (2009); Grubb (2003, 2004, 2006a, 2006b, 2010, 2012); Hanson (1979, 1980); McCallum (1992); Michener (1987, 1988); Michener and Wright (2005, 2006a, 2006b); Officer (2005); Perkins (1988, pp. 163-86); Rousseau (2006, 2007); Rousseau and Stroup (2011); Smith (1985a, 1985b, 1988); Sumner (1993); Weiss (1970); West (1978); Wicker (1985). The classical quantity theory of money, at least a prominent version, takes the equation-of-exchange identity, $MV \equiv PY$, as expressed in growth rates, $\ln(M) + \ln(V) \equiv \ln(P) + \ln(Y)$, and by assuming that $\ln(V)$ and $\ln(Y)$ are long-run constants transforms it into the quantity "theory" of money [$\ln(P)$ = some constant + $\ln(M)$]; where M = the money supply, V = the velocity of that money's circulation, P = prices in that money, and Y = traded real output (Bordo 1987; Fisher 1912). Economists have typically set M for each colony equal to the face value quantity of that colony's paper money in circulation.

[5] Even scholars focusing on the fiscal backing of colonial paper money have made such assumptions and ignored such structures. While they claim that colonial paper monies were not fiat currencies but asset monies, they fail to treat these monies as anything other than fiat currencies in their empirical applications. They fail to incorporate rational asset pricing, reconstruct actual redemptions, or incorporate time-discounting. They appear to consider only

fiscal backing's effect on risk discounts (RD in equation 1 below). See Smith (1985a, 1985b, 1988); Wicker (1985). On fiat money, see Shubik (1987).

[6] For additional examples, see *Archives of Maryland* (v. 14: 174, 390-1; 39: 92; v. 61, pp. 265; v. 62, p. 133; v. 63, p. 242); Baxter (1965, pp. 11-2); Bezanson, Gray, and Hussey (1935, p. 322); Breen (2004, p. 98); Brock (1975, pp. 1-18, 25-9, 70-76, 86-7, 92, 106-8, 113-5, 137, 141-5, 150-1, 154, 165-6, 169, 176, 230, 240-1, 267-8, 283, 324, 333, 350-1, 353-6, 361, 386-8, 413, 438-9, 443, 447, 456, 462, 464, 466, 468, 497, 524, 529, 532, 536, 550); Bush (1977, p. 301; 1986, p. 212); Davis (1964, v. 1, pp. 55, 62, 70-1, 113-4, 123, 131, 144, 155, 177, 183-7, 189, 192-3, 200-4, 210-2, 233-4, 254-5, 259, 270, 298, 310-1, 320, 336-7, 352-61, 379, 387, 398, 401-3, 407-8, 418-35; v. 2, pp. 7-9, 23, 27, 67, 69-89, 98, 101, 112-3, 150-5, 165-9, 174-6, 184, 234-5, 237, 280, 293-4, 307, 312, 321, 379, 396, 433-4, 449, 453-4; v. 3, pp. 3-4, 35-6, 67, 80-7, 94-6, 130-3, 145-6, 152-6, 160-7, 172-4, 193-5, 198-200, 203-4, 207, 211-3, 225-6, 256, 276, 289, 297, 314, 339, 341, 370-2, 386-7, 391, 406-7, 412, 430, 439-40, 446-7, 450-2, 456, 462-7, 474; v. 4, pp. 4, 22-3, 33-4, 56, 110, 120, 150, 193-8, 211, 234, 380-2, 390-1, 416-7, 437-42, 452); Fisher (1911, pp. 273, 289-90, 294); Grubb (2004; 2006a; 2006b; 2008); Hammond (1957, p. 11); Hening (1969, v. 6, pp. 467, 528; v. 7, pp. 18, 32, 81, 166, 360; v. 8, pp. 501, 648, 651); Kemmerer (1939, pp. 868-9; 1940, pp. 121, 123, 282, 304; 1956, pp. 107-12, 137-9, 142); Labaree (1959-1974, v. 1, pp. 14, 152; v. 4, pp. 345-8; v. 5, pp. 194-5, 244, 246; v. 7, p. 123; v. 9, p. 147; v. 11, p. 13; v. 13, pp. 449, 466-7; v. 14, pp. 33-4, 38, 77-87, 232, 286-7; v. 16, pp. 2, 254; v. 18, p. 135); Lester (1938, pp. 326-8, 330-8, 346-8, 351, 359-60, 368; 1939, pp. 184, 186, 188-90, 208, 213); McCusker (1978, pp. 117-8); McCusker and Menard (1985, pp. 338-41); *Statutes at Large of Pennsylvania* (1896, v. 3, pp. 324, 389; v. 4, pp. 98, 322, 344); Nettels (1934, pp. 8, 11, 13, 20, 59, 79-80, 84-5, 91-4, 99, 120, 126-7, 144-6, 151, 157, 160, 162-78, 202-28, 231-49, 253-5, 276, 279-83); New Jersey Historical Society (1852, pp. 53, 59, 136-7, 167, 221-3); Newell (1998, pp. 116, 118, 120, 135, 173); Perkins (1994, pp. 13, 17, 19-23, 26, 51-5, 78); Ricord and Nelson (1885, v. 9, p. 135); Weiss (1970, pp. 773-4); Whitehead (1882, v. 5, pp. 87-8, 91, 254, 423; v. 6, pp. 134-5, 137).

[7] For examples, see Brock (1975, pp. 83, 114-5, 166, 268-9, 286-7, 304-5, 313, 322, 354-5, 362, 386-8, 395, 439, 447, 457, 485-6, 503-4, 523, 529, 536, 561-2); Davis (1964, v. 1, pp. 34-5, 351, 401-2, 418; v. 2, pp. 8, 25-6, 32, 49-51, 78, 82, 282, 321-3, 326-30, 379; v. 3, pp. 235-6, 246, 259-60, 313-4, 341-2; v. 4, pp. 8, 55-6, 62, 85, 157, 200-1, 380, 387, 391, 400-2, 416-9); Grubb (2006a; 2006b); Kemmerer (1940, pp. 121-2; 1956: 107, 122, 140); Labaree (1962, v. 5, pp. 245; 1970, v. 14, p. 77); Lester (1938, pp. 344, 352, 363, 374); McCusker and Menard (1985, pp. 338-41); Nettels (1934, pp. 88-9, 203-5, 207, 249, 280-2); New Jersey Historical Society (1852, p. 222); Perkins (1994, pp. 18-9, 22-8, 53-5, 81); Ricord and Nelson (1885, v. 9, pp. 407, 412); Rotwein (1970, p. 69); Weiss (1970, pp. 773-4, 783).

[8] See Baxter (1965, pp. 14, 16-38); Brock (1975, pp. 430-1, 466, 509, 532); Bush (1977, p. 301); Davis (1964, v. 1, pp. 113, 204, 400, 435-7; v. 2, pp. 48, 70-71, 75, 80, 236, 368, 373, 375-6, 453-4; v. 3, pp. 189, 204, 229, 406-7, 424, 430, 447, 450, 458, 474; v. 4, pp. 57, 107, 109, 137); Hening (1969, v. 6, p. 467); Kemmerer (1939, pp. 868-9; 1956, pp. 108-10); Lester (1938, pp. 331-2, 372; 1939, p. 208); McCusker (1978, pp. 117-8); Nettels (1934, pp. 59, 99, 120, 126, 157,

160, 162-78, 185, 195, 208-28, 250-5); Newell (1998, p. 118); Perkins (1994, pp. 57-62, 67, 381-2); Sen, McCleskey, and Basuchoudhary (2015). See also Innes (1913, 1914).

[9] On specie being scarce before bills were ever issued, see Brock (1975, pp. 141-5, 165, 169, 240-1, 350-1, 361, 365, 462, 466, 468, 550); Bush (1977, p. 301); Davis (1964, v. 1, pp. 200, 336; v. 2, pp. 69, 170, 174-6, 237, 307, 396; v. 3, pp. 94, 198-200, 456); Hening (1969, v. 6, p. 467); Kemmerer (1956, p. 109); Lester (1938, pp. 327-8, 330-8, 346-8, 359; 1939, pp. 184, 208); *Statutes at Large of Pennsylvania* (v. 3, pp. 324, 389); Nettels (1934, pp. 8, 13, 20, 59, 126, 144, 160, 162-78, 202-208, 231-49, 253-5, 280-3); Newell (1998, p. 120); Whitehead (1882, v. 5, pp. 87, 91, 254).

[10] See fn. 4.

[11] See fn. 3, and the observations of Benjamin Franklin (Labaree 1967, v. 11, pp. 13-5; 1970, v. 14, pp. 35-8) and James Madison (Hutchinson and Rachal 1962, v. 1, p. 304). When banking structures collapsed, script similar to colonial bills of credit often reappeared as a currency substitute for banknotes, e.g. see Friedman and Schwartz (1963, pp. 324-5, 433). The Argentine financial crisis of the late 1990s is a recent example. With the banking system temporarily inoperative, individual Argentine states issued their own paper currency backed by their own state's future taxes, such as the Patacon 2 issued by the Provincia De Buenos Aires, as a currency substitute for banknotes. The face of the Patacon 2 said, "...[the Patacon 2] will have an expiration of a maximum period of FIVE (5) years counted from the date of emission..." and that "...tender of the Patacon 2 will be acceptable, at the nominal value, for payments of obligations to the Province of Buenos Aires..." (Patacon note B44266921 translated by Anne Pfaelzer de Ortiz). Personal conversations with merchants in Argentina at that time indicated that they would generally accept as currency U.S. dollars, Argentine national pesos, and their own state's paper currency at individually negotiated or market-determined discounts off their face value, but would not directly accept the paper currency issued by other nearby Argentine states. This Patacon system was almost identical to the system of bills of credit used in the North American colonies (Grubb 2003, pp. 1780-1). See also fn. 24.

[12] For examples, see the paper money issued by Massachusetts between 1690 and 1738; Connecticut between 1709 and 1734, and in 1740 and 1746; New Hampshire between 1709 and 1741; Rhode Island between 1710 and 1739; New York between 1709 and 1724; New Jersey between 1709 and 1725, and from 1754 through 1763; and Pennsylvania in 1723 (Bush 1977, pp. 63-6, 68-70, 109-3, 209-13; 1980, p. 220; Newman 2008, pp. 90-7, 102, 184-97, 224-31, 248-9, 270-6, 332, 372-81).

[13] This decomposition has some resemblance to the discussions of paper money by Benjamin Franklin in 1729 (Labaree 1959, v. 1, p. 153); by Gouverneur Morris in 1778 (Barlow 2012, pp. 73-6); and by James Madison in 1779 (Hutchinson and Rachal 1962, v. 1, pp. 305-6). As such, it can be considered consistent with how some prominent colonial Americans thought about their paper money. It also has some resemblance to the theory of money presented by John Maynard Keynes in the *General Theory* (1991, pp. 222-44 [chapter 17]) and could be considered an exercise to operationalize and apply that theory. This approach is simply an application of the

standard economic theory of opportunity cost. The observed value or cost of X minus the value or cost of the next best alternative in a counterfactual or hypothetical world without X equals the opportunity cost of X. Fogel (1964) applied this approach to measure the contribution of railroads to the economy. Namely, the cost of shipping by railroad minus the next best cost of shipping the same goods in a counterfactual world without railroads equals the social savings to railroads (which is the same as railroad's opportunity cost). The Nobel Prize committee's press release on 12 October 1993, naming Fogel as a co-recipient of the economics Nobel Prize, cited Fogel's application as a "…scientific breakthrough…on the role of the railways in the American economy." (www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1993/press.html). This idea is applied here to answer the question "What is money?" or more accurately to measure a "thing's" money component. The simply answer is that this "moneyness" is measured by its opportunity cost. The difficult part, as with Fogel's analysis of railroads, is empirically applying this approach.

[14] While a 6 percent discount rate is used for APV calculations for heuristic purposes, it is the rate Benjamin Franklin and Adam Smith both suggest was likely in use (quoted below). On 17 January 1777, Robert Morris said that 6 percent was the opportunity cost of capital placed in private securities (Smith 1980, v. 6, p. 117). Six percent was also the rate used by the national government for loans between 1776 and 1790, and the most common rate mentioned in colonial America throughout the eighteenth century. See Barlow (2012, pp. 110, 125, 128); Brock (1975, pp. 260, 328, 332, 435, 462); Catanzariti, *et al*, (1988, v. 7, p. 547); Davis (1964, v. 1, p. 326; v. 2, pp. 38, 68, 83, 99-100, 315, 321; v. 3, p. 168; v. 4); Elliot (1843); Grubb (2014, 2015); Homer and Sylla (1991, pp. 274-313); Hutchinson and Rachel (1962, v. 1, p. 308); *Journals of the Continental Congress* (v. 2, pp. 25-26; v. 6, p. 1037; v. 7, pp. 102-03, 158, 168; v. 8, pp. 725-26; v. 9, pp. 955, 989; v. 10, p. 59; v. 11, p. 416; v. 12, pp. 929-30, 932, 1074, 1256; v. 13, pp. 112, 141, 146-7, 441, 497; v. 14, pp. 717, 720, 731-32, 783, 820, 901; v. 15, pp. 1147, 1197, 1210, 1225, 1245-6, 1288, 1319, 1405; v. 16, pp. 264-65, 288; v. 17, pp. 464, 568, 804; v. 18, p. 1017; v. 19, pp. 6, 167; v. 21, p. 903; v. 23, p. 831; v. 24, p. 39; v. 26, p. 32; v. 27, pp. 395-6); Labaree (1959, v. 1, p. 142; 1967, v. 11, pp. 13-15); Nettels (1934, p. 267); *Pennsylvania Gazette* (30 April; 21 and 28 May; 25 June; 2, 16, and 23 July 1777); Smith (1937, pp. 310-2); Smith (1979, v. 4, p. 295; 1980, v. 6, pp. 117-8, 212-3, 228-9, 238-9, 245, 252, 259-62, 270, 277, 295, 346, 368, 372, 386, 400-1, 404; 1981, v. 7, pp. 524, 581, 617, 623, 635, 642-3; 1981, v. 8, p. 25; 1983, v. 10, p. 205; 1985, v. 11, pp. 94, 137-8, 361; 1986, v. 13, pp. 132, 604-5; 1987, v. 14, pp. 51, 463, 500; 1988, v. 15, pp. 377, 396; 1989, v. 16, pp. 307-8, 490, 531; 1990, v. 17, p. 365; 1992, v. 19, p. 139; 1994, v. 21, p. 467).

[15] This is how the amount of paper money in circulation is presented in the *Historical Statistics of the U.S.* (Carter, et al. 2006, pp. 692-6). As such, these data are largely meaningless for most economic analysis purposes.

[16] See fns. 14 and 17; Celia and Grubb (2014); Grubb (2014, 2015).

[17] See fn. 14.

[18] Virginia made two attempts to solve the problem of value variation among bills currently outstanding due to their being from different emissions with different redemption spans with different ending dates. In 1757, Virginia swapped all prior emission bills for bills with a common redemption date. This made all bills of the same denomination currently outstanding have the same APV value. The reason given for this move was "it will be prejudicial to have notes of different values circulating at the same time…" (Hening 1969, v. 7, pp. 69-87). This reasoning only makes sense if the bills were seen as zero-coupon bonds, with their value primarily determined by their APV. Again in 1761, Virginia changed the non-uniform redemption dates of all bills currently outstanding to a common date for all. This move again made all bills of the same denomination currently outstanding have the same APV value. See Appendix Table A1, notes k and l.

[19] I have not sorted out the paper money emissions and the APV behavior of paper monies in New England, North and South Carolina, and Georgia. I'm reluctant to rely solely on secondary sources for information on these colonies for this stage of the analysis.

[20] Derived from the exchange rates quoted in 1703/1704 in New Jersey before bills of credit were issued (McCusker 1978, p. 172). In addition, *The Boston Evening Post*, 25 October 1773, estimated the cost of shipping specie between the colonies and London to be 6 percent. It was comprised of 2.5 percent for insurance and brokerage, 2.5 percent for commissions, and 1 percent for freight (Brock 1992, pp. 74, 124). Adding the opportunity cost of time raises the cost to approximately the rate estimated here. The transaction costs paid by the New Jersey government for moving specie across the Atlantic from 1760 through 1765 was approximately 7.46 percent (Bush 1982, pp. 10-13, 315-16).

[21] The interest payments on Virginia's bills emitted in 1755-6 were removed in 1757. As such, they are not considered here as affecting these bills' APV, see Appendix Table A1, note j.

[22] Scholars, having found it difficult to account for the large swing in the value of Virginia's bills between 1755 and 1770, have resorted to stories about malfeasance, embezzlements, and wartime disruptions to the tobacco market as explanations, see Ernst (1973, pp. 51-88, 174-96); Labaree (1970, v. 14, p. 80).

[23] See fns. 14 and 17.

[24] Adam Smith, in the *Wealth of Nations*, also noted the absence of annual interest paid by colonial government on their bills of credit (Smith 1937, p. 310). Jeremy Bentham proposed sophisticated interest-bearing paper money regimes (circulating annuities) for England in 1795 and 1800, see Stark (1952 v. 2, pp. 150-300).

[25] See fn. 4.

[26] The colonies lobbied against passage of the 1764 Currency Act and, once passed, worked to repeal it. In the meantime, they hesitated to authorize new paper money without legal tender status, see Appendix Table A1. In the words of Cecilius Calvert (Lord Baltimore, the proprietor

of Maryland), the 1764 Currency Act's legal tender prohibition "must a[n]nihilate the valuable consequence of all such Paper Curren[c]y" (*Archives of Maryland*, v. 14, pp. 141, 170). When Pennsylvania decided in 1767 to attempt a non-legal-tender paper money emission, Benjamin Franklin commented, "I am glad you made a Trial of paper Money without a *legal Tender*. The Quantity being small, perhaps may be kept up in full Credit notwithstanding..." Labaree (1970, v. 14, p. 231, italics in the original). See also *Archives of Maryland*, v. 61, pp. c-ci; Ernst (1973, pp. 43-173); Greene and Jellison (1961, pp. 489-93, 503-6); Labaree (1967, v. 11, pp. 175-7; 1968, v. 12, pp. 47-61; 1969, v. 13, pp. 447-9, 465-7; 1970, v. 14, pp. 32-9, 76-88, 180-2, 185, 285-8).

[27] Hening (1969, v. 6, pp. 435-8, 461-8, 521-30; v. 7, pp. 9-33, 46-54, 69-87, 163-9, 171-231, 255-65, 331-7, 347-53, 465-6, 495-502; v. 8, pp. 342-8, 493-503, 647-52; v. 9, pp. 61-71).

[28] Bush (1977, pp. 63-6, 68-70, 109-13, 209-13, 301-19, 427-38, 474-87; 1980, pp. 21-8, 307-19, 345-55, 373-82, 413-25, 455-71, 495-502, 517-29, 539-55, 563-78, 621-39, 663-79; 1982, pp. 73-89, 125-40, 207-21, 289-306).

[29] Adam Smith relied on William Douglass, a strident anti-paper-money polemicist from New England, for his information about paper money in America (Bullock 1897, pp. 265-91; Davis 1964, v. 3, pp. 307-63; Smith 1937, p. 310). Smith's views of colonial paper money may have been colored by this reliance.