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## The Invention of Inflation-Indexed Bonds in Early America

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**T**he world's first known inflation-indexed bonds were issued by the Commonwealth of Massachusetts in 1780 during the Revolutionary War. They were issued to U. S. soldiers as deferred compensation for their service, and were called depreciation notes or soldiers' depreciation notes. While there are earlier examples of measures to compensate people for their money's loss of purchasing power, this appears to be the first time that a debt contract specified payments formally linked to a price index, and in this historic bond it was a consumer price index.<sup>1</sup>

This important invention came about when stark necessity spurred invention and practical people under pressure devised these bonds as an immediate expedient to deal with problems they must have regarded as of life-and-death importance. The long-term significance of such bonds, which would also be issued by other entities in much later and more normal times, came to be appreciated by scholars only decades, even centuries, later.

Those anonymous inventors in 1780 apparently did so without the help of any academic or theoretical literature on indexation. John Maynard Keynes is widely quoted as asserting that most economic innovations derive ultimately from some "academic scribblers."<sup>2</sup> But, in fact, in the case of indexed bonds, there was no academic precursor.

As of 1780, there appears to have been virtually no

mention in any scholarly literature of indexed bonds or even of the concept of indexation. *Ninety years ago* Wesleyan University Professor Willard Fisher sought an earlier reference to indexation and the best he could find was a statement by Adam Smith, in 1776, that seems at best to refer to the concept only obliquely, and dismissing it.<sup>3</sup> Histories of the theory of indexation often start with William Stanley Jevons, who wrote expansively in favor of indexed bonds and other indexed contracts in 1875. A much earlier if less eloquent reference, and apparently the first clear treatment of the concept of indexation, is from Joseph Lowe, in 1822. That was already forty-two years after the Massachusetts issuance of indexed bonds.

The conventional history of the formal creation of indexed bonds starts in the twentieth century. Professor Irving Fisher of Yale University was a lifelong advocate of inflation-indexed bonds, and the company he co-founded, Rand-Kardex Co., first issued inflation-indexed bonds in 1925. These are the first true inflation-indexed bonds that I have been able to discover since those of 1780, that is, the first bonds tied explicitly to an index of consumer prices and not just to a price of a single commodity.

There were no significant imitators of Fisher's bonds for some years, and he died in 1947 with little evidence that his campaign was a success. But, around that time, other inflation-related securities began to appear. Finland introduced indexed bonds in 1945, Israel and Iceland in 1955, Brazil in 1964, Chile in 1966, Colombia in 1967, Argentina in 1972, the United Kingdom in 1975, Australia in 1985, Mexico in 1989, Canada in 1991, Sweden in 1994, New Zealand in 1995, United States in 1997, and France, 1998, and Japan and Italy in 2004. Starting in 1925, the concept of indexed bonds disseminated over many decades due to the advocacy of Irving Fisher and others of his time.<sup>4</sup> This huge worldwide explosion of indexed bonds began 145 years after the first example was issued.

### **The 1780 Issue of Inflation-Indexed Bonds**

Already by 1780, the state of Massachusetts had had longstanding problems with an unstable price level due to the state government's excessive printing of paper money. These problems had persisted for the better part of a century when the depreciation notes were issued. Inflation had been a deep-set problem that accounted for a lot of the problems of the state, and that had occupied a great deal of public attention over these years.

The problems started with the Massachusetts government's attempt to pay for an unsuccessful 1690 invasion of Quebec during King William's War (1689–1697). Unable to pay its soldiers immediately, the state government resorted to printing paper money that it promised to redeem later. These were bearer notes, so many or most of the soldiers spent them immediately, and the notes entered circulation as a form of paper money. Since they were not immediately redeemable in specie they sold at a discount, a discount that varied over time not only due to changes in discount rates but also due to changes in public perceptions of the likelihood that they would eventually be paid in specie.<sup>5</sup>

Further, such notes were issued to soldiers during Queen Anne's War (1702–1713). Massachusetts issued more paper money than it could reasonably be expected to repay. Printing of money continued and public faith in the paper declined—it then sold at a substantial discount from sterling for many years.

Already by 1743, the governor of Massachusetts William B. Shirley (1694–1771) wrote of these problems in a report to the Board of Trade, that in the last thirty years the currency had “gradually sunk in their value from forty to four hundred forty percent below

sterling money.” Since a 1712 law had made the local currency legal tender at face value for all debts, he noted that losses were incurred by “creditors of all kinds who had had dealings with the people of New England, and had not been cautious enough to ascertain the value of their debts, by special contracts for the payment of ’em, either in sterling or proclamation money.”<sup>6</sup>

The intellectual environment in New England had apparently prepared the way for this innovation, and evidence of this environment can be found as early as 1742 in Massachusetts legislation that specified that, in times of highly depreciated currency, court judgments should take account of the depreciation as calculated using the exchange rate between a new local currency, later called equity bills, and the British pound sterling. Similar legislation was enacted around that time in Connecticut, New Hampshire, and Rhode Island. This legislation established a precedent for acknowledging the effects of a currency depreciation.

The costs of King George’s War (1744–1748) threatened to destroy the value of the large amount of currency issued by Massachusetts to pay for the war. A further crisis was avoided when Britain, in whose behalf Massachusetts had fought the war, shipped over enough solid coin to redeem the new currency.

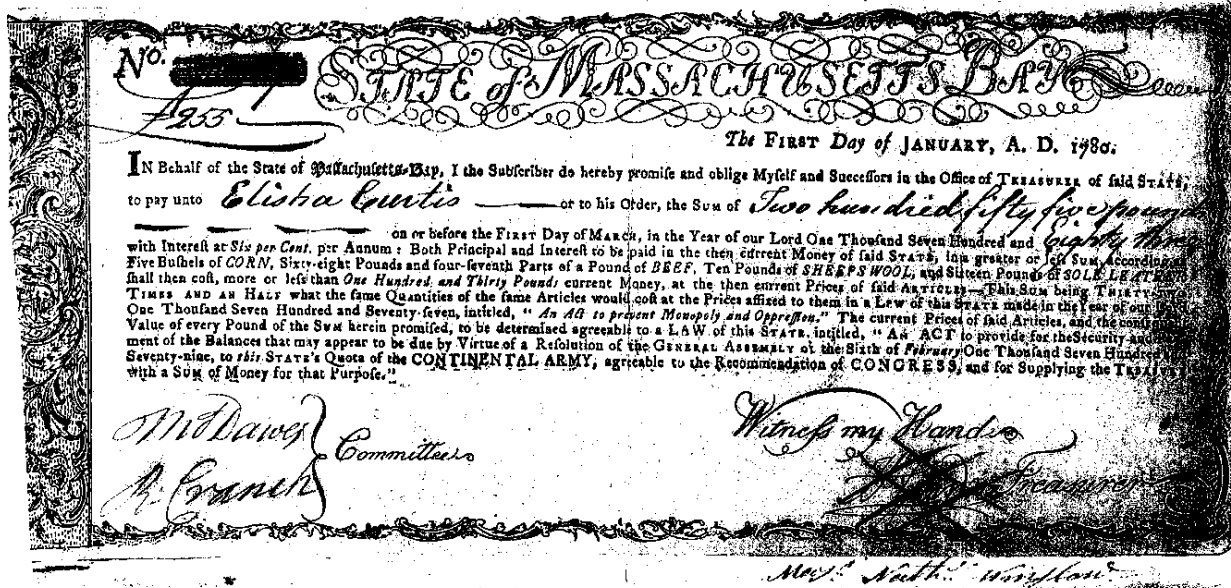
Problems reappeared when the state of Massachusetts once again issued paper money to pay for its part in the Revolutionary War. Once again, the state government could not raise enough money through taxes, and once again the soldiers were paid in bearer notes that they were obliged to sell immediately at a substantial discount. The wartime inflation meant that soldier’s pay was losing much of its value between the time promised and actually received, and by the time the soldiers were able to spend it or send it to their families. The soldiers had been paid only nominally but had been cheated by inflation out of their real pay, a situation that strongly discouraged their willingness to serve their country further.

A 1777 Massachusetts act called “An Act to Prevent Monopoly and Oppression” attempted to deal with inflation by fixing prices. The act listed prices measured in Massachusetts pounds for fifty commodities in Boston, to allow government price-fixing to forestall wartime inflation. The policy was disastrous; it substantially shut down the market for these basic necessities and was quickly abandoned. Another expedient was clearly necessary to assure just compensation to soldiers.

By the late 1770s, when these first inflation-indexed bonds were conceived and designed, the U. S. War of Independence was in a difficult stage. In 1779, the British Army had just captured the state of Georgia and had taken Charleston, South Carolina. The eastern seaboard of the United States was blocked by the British Navy. The morale of the U. S. Army was low: they were poorly fed, poorly clothed, and often sick. The morale was so low that, as we now know, there were actual army mutinies in 1780 and 1781. There was real concern in 1779 that it would be impossible to keep an army if something were not done to address their pay’s loss of value. The invention of indexed bonds came in response to this very real and dangerous crisis.

The U.S. Congress issued a letter in 1779 to be read by ministers from the pulpit, that detailed the problem:

The present situation of public affairs demands your most serious attention, and, particularly, the great and increasing depreciation of your currency requires the immediate and strenuous and united efforts of all true friends to their country, for preventing an extension of the mischiefs that have already flowed from that source. . . .



Indexed bond issued by the State of Massachusetts Bay, January 1, 1780. Commodity-linked bond, to pay "unto Elisha Curtis, or his Order, the Sum of Two hundred fifty five pounds on or before the First Day of March, in the Year of our Lord One Thousand Seven Hundred and Eighty three."

Our enemies prosecuting the war by sea and land with implacable fury and with some success, taxation at home and borrowing abroad, in the midst of difficulties and dangers, were alike impracticable. Hence, the continued necessity of new emissions.<sup>7</sup>

The monetary situation was therefore an inevitable consequence of the precarious national situation, its resolution an inherent aspect of the national defense, and as their patriotic duty Congress called upon the states to assure that their soldiers were fairly compensated. The Massachusetts legislature passed a resolution on February 6, 1779, to give just settlement of the soldiers' claims, and committees were established that would propose adjustments. The work of these committees led then to the creation of the indexed bonds.

The depreciation bonds were created in Massachusetts by "An Act to provide for the Security and Payment of the Balances that may appear to be due by Virtue of a Resolution of the General Assembly of the sixth of February, One Thousand Seven Hundred and Seventy-nine, to this States Quota of the Continental Army, agreeable to the Recommendation of Congress, and for Supplying the Treasury with a Sum of Money for that Purpose," January 13, 1780. The act was part of an effort to substantiate the promise of the 1777 act, which had failed to fix prices. Unable to fix prices, the government of Massachusetts did the next best thing, to provide enough income to their soldiers so that they could buy the basket of goods defined by a subset of the list of goods in the 1777 act as if they still had their specified prices. Perhaps due to the difficulties of collecting price data, the indexed bonds were based on only four of the fifty commodities described in the 1777 act.

We can read from these engraved bonds themselves (and surrounded by a border apparently in the hand of the official engraver for Massachusetts, Paul Revere) the terms of the indexation. An example of these bonds, dated January 1, 1780, states:

Both Principal and Interest to be paid in the then current Money of said STATE, in a greater or less SUM, according as Five Bushels of CORN, Sixty-eight Pounds and

## TABLE OF DEPRECIATION.

Date.	Beef stated in the Monopoly Bill at 4d and 3d is 3½d per pound.		Indian corn stated in the Monopoly Bill at 4s per bushel.		Wool stated at 2s per pound in said Bill.		Sole Leather stated at 1s 3d per pound.		Mean rate of Depreciation.
	Current Price Monthly.	Rate of Depreciation.	Current Price Monthly.	Rate of Depreciation.	Current Price Monthly.	Rate of Depreciation.	Current Price Monthly.	Rate of Depreciation.	
1777. January.	4d	1.142 for 1	4s	1. for 1	3s	1.50 for 1	1s 3d	1. for 1	1.16 for 1
February.	4d	1.142	4s	1.	2s	1.	1s 3d	1.	1.03
March.	4d	1.142	4s	1.	2s	1.	1s 3d	1.	1.03
April.	4d	1.142	4s	1.	4s	2.	1s 3d	1.	1.28
May.	8d	2.284	4s	1.	4s	2.	1s 3d	1.	1.57
June.	8d	2.284	6s	1.50	4s	2.	1s 3d	1.	1.60
July.	8d	2.284	8s	2.	4s	2.	1s 3d	1.	1.82
August.	8d	2.284	10s	2.50	5s	2.50	2s 10d	2.25	2.38
September.	8d	2.284	12s	3.	5s	2.50	2s 10d	2.25	2.50
October.	8d	2.284	12s	3.	12s	6.	5s	4.	3.82
November.	8d	2.284	12s	3.	12s	6.	5s	4.	3.82
December.	10d	2.857	16s	4.	12s	6.	5s 7½d	4.50	4.34
1778. January.	10½d	3.	18s	4.50	12s	6.	5s 7½d	4.50	4.50
February.	12½d	3.580	18s	4.50	12s	6.	5s 7½d	4.50	4.64
March.	13d	3.714	20s	5.	12s	6.	5s 7½d	4.50	4.80
April.	15d	4.285	24s	6.	12s	6.	5s 7½d	4.50	5.19
May.	16½d	4.714	32s	8.	12s	6.	5s 7½d	4.50	5.80
June.	18d	5.142	32s	8.	12s	6.	5s 7½d	4.50	5.91
July.	17d	4.857	40s	10.	12s	6.	5s 7½d	4.50	6.34
August.	16½d	4.714	40s	10.	12s	6.	5s 7½d	4.50	6.30
September.	17d	4.857	40s	10.	12s	6.	8s 5½d	6.75	6.90
October.	17d	4.857	40s	10.	12s	6.	8s 5½d	6.75	6.90
November.	18d	5.142	40s	10.	12s	6.	8s 5½d	6.75	6.97
December.	18d	5.142	48s	12.	12s	6.	8s 5½d	6.75	7.47
1779. January.	1s 10d	6.285	£2 12s	13.	15s	7.50	8s 5½d	6.75	8.38
February.	2s 2d	6.857	£2 16s	14.	15s	7.50	11s 3d	9.	9.34
March.	3s 6d	12.	£3	15.	15s	7.50	11s 3d	9.	10.87
April.	4s 6d	15.428	£3 4s	16.	18s	9.	11s 3d	9.	12.35
May.	6s	20.571	£3 12s	18.	18s	9.	11s 3d	9.	14.14
June.	6s	20.571	£4	20.	20s	10.	16s 10½d	13.50	16.02
July.	6s 6d	22.285	£3	40.	30s	15.	16s 3d	13.	22.57
August.	6s 6d	22.285	£6	30.	22s 6d	11.25	22s 6d	18.	20.38
September.	6s	20.571	£4 10s	22.50	22s 6d	11.25	16s 10½d	13.50	16.95
October.	6s	20.571	£4 10s	22.50	24s	12.	16s 10½d	13.50	17.14
November.	6s 6d	22.285	£5	25.	42s	21.	33s 9d	27.	23.37
December.	7s	24.	£8	40.	60s	30.	33s 9d	27.	30.25
1780. January.	8s 9d	30.	£8	40.	60s	30.	37s 6d	30.	32.50

four-seventh Parts of a Pound of BEEF, Ten Pounds of SHEEPS WOOL, and Sixteen Pounds of SOLE LEATHER shall then cost, more or less than One Hundred and Thirty Pounds current money, at the then current Prices of said ARTICLES— This SUM being THIRTY-TWO TIMES AND AN HALF what the same Quantities of the same Articles would cost at the Prices affixed to them in the Law of this STATE made in the Year of our Lord One Thousand Seven Hundred and Seventy-seven, intituled, “An Act to prevent Monopoly and Oppression.”

The paragraph defines a price index, specified in terms of fixed quantities of the articles. The index equaled 4.0 in 1777 and 130.0 in 1780, a 32.5-fold increase. Calculations were made of the amount owed to soldiers in light of this depreciation of their pay. The soldiers were then given in 1780, to settle their claims, the inflation-indexed bonds, divided into four equal parts. Those who enlisted for the rest of the war were given four notes maturing in 1781, 1782, 1783, and 1784. Others were paid in notes maturing in 1785, 1786, 1787, and 1788. A table from the act shows calculation of the index for 1777 to 1780 (see table 14.1).

The quantities used to define the index were apparently not based on any representative market basket. Certainly, it is far more likely that a family would consume five bushels of corn than sixteen pounds of sole leather in a year's time. The quantities were instead defined so that they represent equal currency values of the commodities in 1777. According to the 1777 act, “Good Indian meal or corn” cost 4 shillings a bushel, “good merchantable sheeps wool” 2 shillings a pound, “good well-fatted grass fed beef” 3 pence a

Table 14.1. *Table of Depreciation.* From Resolves of the General Assembly, January 13, 1780, “An Act to provide for the Security and Payment of the Balances that may appear to be due by Virtue of a Resolution of the General Assembly of the sixth of February, One Thousand Seven Hundred and Seventy-nine, to this States Quota of the Continental Army, agreeable to the Recommendation of Congress, and for Supplying the Treasury with a Sum of Money for that Purpose.”

PRESIDENT LANGDON'S ACCOUNT

Debit

The State of Massachusetts's Pay to Sam<sup>l</sup> Langdon as President of Harvard College.

Cr.

£	Value of 20/
To 1 Years Salary to Octo <sup>r</sup> 14 1776 .....	200. 0. 0
To 1 Year 2 Months & 17 Days Sal <sup>r</sup> to Jan <sup>r</sup> 1. 1777 .	242. 4. 5
To 1 Year D <sup>o</sup> to Jan <sup>r</sup> 1. 1778 .....	200. - -
To D <sup>o</sup> . . . . . Jan <sup>r</sup> 1. 1779 .....	200. - -
To D <sup>o</sup> . . . . . Jan <sup>r</sup> 1. 1780 .....	200. - -
To 8 Months & 13 D <sup>o</sup> D <sup>o</sup> to Sept <sup>r</sup> 13 1780 .....	140. 9. 1
£1 182. 13. 6	
685. 7. 11	
Balance	497. 6. 7
Sept <sup>r</sup> 11. 1780. Errors   excepted p Sam <sup>l</sup> Langdon	
	685. 7. 11
	497. 6. 7
	1 182. 13. 6

The above Computation is made by a Table of Depreciation prepared by a Committee of the General Court for settling the Pay of the Soldiers, as far as June 1779, For Febr & May 1780 it is continued on the same Principles.

Table 14.2. Account of inflation-indexation calculations for the compensation for Samuel Langdon, president of Harvard College, 1780. From Willard C. Fisher, "The Tabular Standard in Massachusetts History," *The Quarterly Journal of Economics* 27, no. 3 (May, 1913): 454.

pound, "stall fed beef, well fatted" 4 pence a pound, and "tanned hides" 1 shilling 3 pence a pound. The quantities specified on the bond all cost £1 at these prices (where the two beef prices are averaged to be 3.5 pence a pound). This index is neither Laspeyres or Pasche, but might be roughly justified in terms of a model which asserts that the price change of each commodity equals an underlying inflation rate plus a noise term, that is, measured as a fraction of base year price, independent across commodities and identically distributed.<sup>8</sup>

Once in place, the indexation implicit in the Massachusetts indexed bonds led to at least one other application: to index the pay of the president of Harvard College, Samuel Langdon. The account (see table 14.2) shows the pay that President Langdon received from 1774 to 1780 according to his promised rate of pay of £200 per annum, along with the real value, in January 1775 prices, of these payments and some other, much larger, payments that were made to him in 1780, apparently in an effort to compensate him for the real value of his pay lost to inflation. The account converts all these payments to 1775 prices and sums them. The difference between this sum and the sum of the actual payments is the amount owed to President Langdon in January 1775 prices. This is an early, perhaps the first, cost of living allowance in a civilian labor contract.

The invention of indexed bonds, and of indexation more generally, in 1780 was a bright spot in the history of financial innovation. But, unfortunately, it did not stick. The notes were soon replaced. A 1782 act provided for the eventual consolidation of the state debt and the replacement of the depreciation notes with new specie securities. The consolidation was complete by 1786, two years before the maturity of the longest-dated notes issued in 1780. In 1786 an act stipulated that "it is altogether unnecessary that the Committee, or Agents, appointed for the collecting and ascertaining the value of the several articles specified in the Notes issued for the pay of the late Continental Army, commonly called depreciation Notes, be any more contained in office."<sup>9</sup> The experiment with indexed bonds ended abruptly, and with no explanation.

Despite its abrupt end, the invention of indexation in Massachusetts in 1780 is an example of significant financial innovation. It helped solve some pressing problems facing a new nation, and did so in a logical and orderly way that could have been generalized to solve many other subsequent monetary problems.

## The Role of Economic Theory in Promoting Indexation

It seems that necessity was the mother of this invention. The creation of indexed bonds in Massachusetts in 1780 appears to deny the importance of the “academic scribblers” that Keynes extolled, for the invention appeared long before the scholars wrote about it. And yet, in another sense, it only reinforces their importance, for the practice of indexation of bonds did not take hold at that time. It is a reasonable supposition that the indexed bonds did not continue because there was no well-conceived model that would justify and explain them.

Since the indexation was proposed in 1780 as an expedient to deal with a most pressing temporary problem, there was no economic theory explaining its fundamental importance. When the Revolutionary War ended in 1783, there was thus no longer a perceived need for these bonds. Collecting data and computing a price index consumes resources, and if inflation is no longer a pressing and immediate issue then indexation might plausibly be dropped. The price index used was very crude, and its defects might be seen to outweigh its advantages in a time of relatively stable prices. In fact, however, the history of the United States in the nineteenth century reveals considerable instability of prices, and so it would have been better if the indexation *had* continued.

The failure to pursue the idea of indexation after 1780 may also be due to some of the problems of index number theory that were only intuitively grasped at the time. In the twentieth century, index number theorists realized that there is a substantial problem with a simple index such as that used in Massachusetts in 1780. If one of the commodities used to define the index becomes scarce, a shortage of it develops, and the price of that commodity might jump very high. Consumers would normally substitute for another commodity, and thus would not need as much money as indicated by the price index to maintain their standard of living. The price index would then jump sharply and become unrepresentative of the increase in the true cost of living. If bondholders were paid the amount specified in the index formula they would enjoy a windfall, since they could switch their consumption to other commodities that were not in short supply. They would find that their purchasing power has been increased dramatically by the indexation. The bond issuers, on the other side of the transaction, were similarly affected but in the opposite direction.

Well into the twentieth century Irving Fisher proposed that the solution to this problem would be to tie indexed payments to a sort of price index that he called an ideal index. The Fisher ideal index has no predictable bias. Now, in the twenty-first century, there is clear recognition of the significance of an ideal index, and efforts are being made in many countries to bring measures of inflation closer to such an ideal. Thus, a technical problem with the original concept of indexed bonds was solved over many years of research in economic theory and no longer stands as a serious obstacle to their implementation.

Another reason that the indexed bonds of 1780 were not pursued after the war may have been the difficulties that a less educated population would have with index number calculations. Not only are people troubled by “math anxiety” when doing index calculations but they also have a difficulty with intuitive understanding of the indexation concept. If this is true today, then it is all the more likely to have been true in colonial America.

In 1997, I did a survey study of randomly selected people in the United States and Turkey to try to determine the reason for their relative lack of interest in indexed bonds. Turkey was included for comparison, since Turkey was a high inflation country then. I

first tried to find out whether the general public could understand the concept of indexation, even testing them with a simple arithmetic problem that related to the basic issues of indexation. More or less, people who agreed to answer the questionnaires in both countries seemed to be able to deal with the concept of indexation if challenged to do so.

Thus, there are certainly plenty of people around who are capable of understanding indexation. And yet, some of these same people would also say that they did not want the indexation. There appeared to be no logical explanation for this resistance. One of the respondents explained that "I want to know how much money I will be getting." Perhaps that statement best captures the basic sentiment. There seems to be a pattern of wanting money for its own sake and mistrusting mathematical formulas.

Perhaps this resistance to indexation is another reason that the 1780 indexation scheme did not catch on. The only example we have of private indexation inspired by the public indexation scheme implicit in the depreciation notes is the example of President Langdon of Harvard. Then, as now, only the intellectuals and academics, apparently, embraced indexation.

The example of Harvard President Langdon calls to mind an experience of mine of a few years ago. When I talked to a Treasury official in 1996 about possible plans for the issuance of U.S. indexed bonds, I was told that there was a joke at the U.S. Treasury Department that if and when the indexed bonds are one day issued, Treasury should send the prospectus to the membership roster of the *American Economics Association*, as these are the only people likely to be really interested. Of course, the indexed bonds issued in the United States did get off to a slow start, but now make up approximately 2 percent of the national debt. So, the modern demand for indexation has moved considerably beyond the economists, and the demand might well have extended far beyond President Langdon in the eighteenth century if other conditions had been right.

In the eighteenth century, as now, the concept of indexation must have been a difficult one, and the underlying economic theory beyond the intuitive ken of most people. Economists and financial theorists can understand the concept. But if indexation is to succeed, a public effort must be undertaken to teach its value to ordinary citizens. The world apparently was not ready for an extensive use of indexed bonds in the eighteenth century.

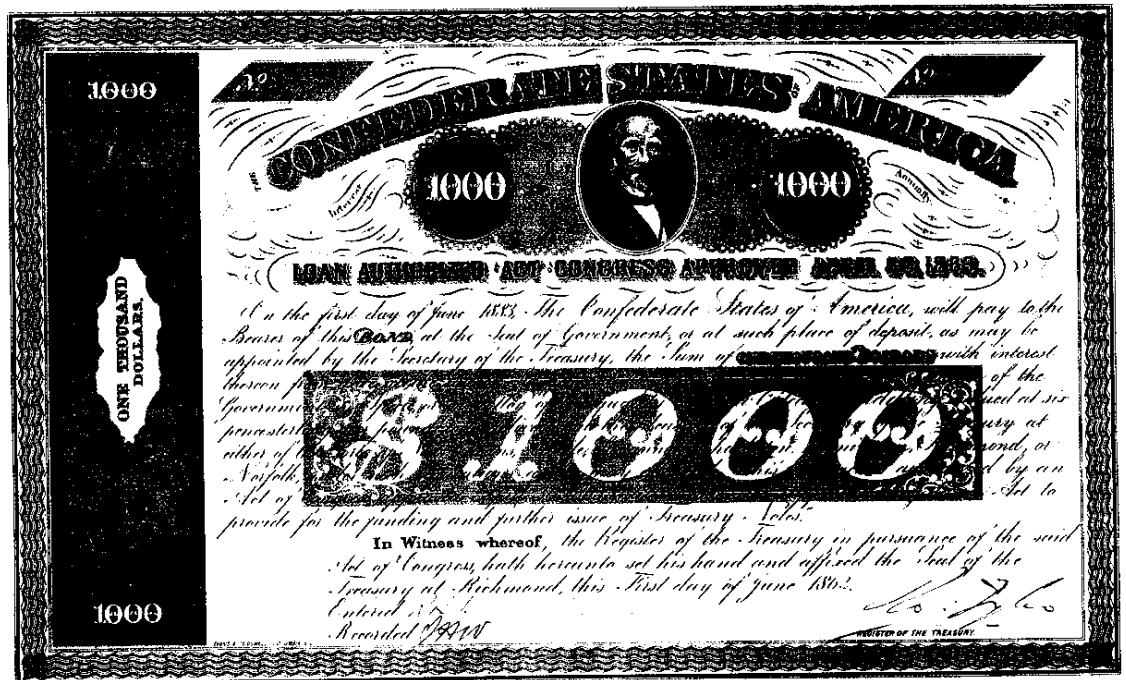


## Appendix

Bonds that make interest payments in a specified commodity have a long history. A Confederate States of America loan of 1863 (below) is payable, at the pleasure of the government, either in specie or cotton. A bond issued by the state of Hesse in Germany in 1923 (next page) is payable in rye. In both examples, the bonds were issued after hyperinflation had soured the market for nominal bonds, and the commodity terms were necessary to find a market for government debt.

These bonds are, however, not indexed bonds, since they are not defined in terms of an index number of commodities. An index number, like the one defined in the Massachusetts Soldier's Depreciation Notes of 1780 (facsimile is on page 242), represents a measure of the purchasing power of money or the cost of living, rather than just the price of a single commodity.

*Confederate States of America \$1,000 loan. June 1, 1863.* This twenty-year bond issued by the Confederate States promises to pay "the sum One Thousand Dollars plus interest at the rate of six percent per annum, at the pleasure of the Government, in Specie, or in Cotton of the quality of New Orleans Middling, valued at six pence sterling per pound, to be delivered at the pleasure of the Secretary of the Treasury at either of the Ports of New Orleans, Mobile, Savannah, Charleston, Wilmington, Richmond, or Norfolk, under such regulations as he may establish."





10 Zentner Roggen, 5 percent Schuldverschreibung. December 12, 1923. Bond issued by the State of Hesse, promising to pay 5 percent interest over the monetary value of 10 hundredweights of rye. The interest payments were linked to the price of rye during the month of May at the Frankfurt Commodity Exchange. The final repayment would be based on the rye prices during the three months prior to the redemption. In case the Frankfurt Exchange would cease to exist, quotations would be taken from Berlin.