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ABSTRACT

We examine econometrically the real effects of paper money's introduction into colonial New England over the 1703-1749 period. Departing from earlier analyses that focus primarily on the depreciation of paper money in the region, we show that expansion of the money stock promoted growth in modern sector activity and not the other way around. We also find that bills emitted for seigniorage purposes had a positive effect on the modern sector, while bills issued through loan banks did not.

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1. Introduction

In the hundred years that followed its founding in 1620, New England was transformed from a small subsistence farming collective to the commercial hub of the New World. The rise of trade and commerce in the region was consistent with the pursuit of its comparative advantage, given that poor soil and climate, at least when compared to that of the South and the Chesapeake regions, limited the production of cash crops such as indigo and tobacco. Yet the rise of commerce was inhibited for some time by the lack of a viable medium of exchange. In this study, we examine whether the introduction and subsequent expansion of paper money by colonial legislatures had quantifiable effects on real activity in colonial New England. The emphasis on the relationship between monetization and growth differs from earlier work that tends to focus on adherence to the quantity theory of money, the inflationary effects of paper money, and how the New England case typified its mismanagement (e.g., West, 1978; Smith, 1984, 1985; Michener, 1987; Grubb, 2005; Officer, 2005).[1]

The main hypothesis is simple: by reducing transactions frictions and increasing the availability of entrepreneurial credit, monetization with paper issues facilitated the emergence and development of New England's commercial sector. This seems reasonable given the economic environment that prevailed there in the 18th century. In particular, New England emerged as a hub for a diverse and sophisticated network of non-agricultural (i.e., modern) industries such as processing, trade, distribution and marketing, as well as a variety of small-scale production activities. Such activities required a widely-accepted, readily-available and storable medium of exchange.

While book credit and barter could be useful for local transactions, a lower-cost method of exchange was needed for arms-length trades. Gold or silver coins could have served this function, but the colonies had been prohibited from minting their own and settlers could only bring limited quantities of specie across the Atlantic. Further, England's mercantilist policies tended to drain specie from the colonies – so much so that coins were driven from circulation as early as 1717 (Officer, 2005, p. 115). At a time when specie was scarce or non-existent, issues of paper money were able to encourage trade and commerce.

We show that paper money emissions had measurable long-run effects on modern sector activity using the tools of modern macroeconomics. In particular, estimates from a set of vector error correction models (VECMs) and the associated impulse responses show that money played a leading role in commerce and not the other way around. Our methodology allows for separate identification of short and long-run effects, and we find the effect of monetization on real activity to be particularly potent in the long-run. This is consistent with monetization stimulating growth and not just temporary increases in spending. We also find that direct money issues by the colonial legislatures, used primarily to finance ongoing military conflicts, had stronger real effects than indirect emissions through loan banks. This might be expected given that the former were more likely to represent exogenous shocks to

[1] Our views are conistent with Lester (1938, 1939), who recognized the negative effects of monetary expansion in the British North American colonies but admitted the possibility that, in addition to inflation, monetary expansion had positive real effects.

the money supply.

Section 2 reviews the economic environment in colonial New England and describes key moments in its history of paper money. In Section 3 we discuss the data and framework for estimation. We test for a link between money and real outcomes in Section 4. Section 5 compares the effects of paper money emitted through seigniorage and land banks, and Section 6 concludes.

2. Historical Background

Not long after establishing the Massachusetts Bay Colony in 1629, New England colonists discovered that their climate was not well suited to large-scale farming.[2] Some manufacturing did emerge during the 17th century but was for the most part unsuccessful due to high fixed costs and a lack of skilled labor (McCusker and Menard, 1985 p. 97). When a dramatic fall in immigration during the 1640s led to plummeting prices, bankruptcies and foreclosures (Canny, 1994, p. 41), provincial leaders tried to legislate recovery by providing tax breaks, monopoly rights and subsidies to preferred industries, but these interventions did not have the desired effects.[3] Moreover, many of the non-agricultural sectors that eventually did succeed required technologically advanced inputs from England, and poor infrastructure initially hampered distribution of these inputs to interior towns such as Greenwich and New Salem.[4]

Despite the difficulties faced by some sectors, infrastructure improvements initiated by New England legislatures in the 1640s and 1650s, such as quality controls, inspections and,

[2]See Middleton (2002, p. 89). The lack of fertile soil prompted Sir Francis Brewster in 1654 to call New England "that unprofitable plantation, which now brings nothing to this nation, but to the contrary buries numbers of industrious people in a wilderness, that produceth nothing but provisions to feed them" (Brewster, 1964, p. 88). In 1691 William Petty argued that New England was a hopeless terrain and that the best option was to relocate New England settlers from their "unprofitable" economy to more prosperous regions (Andrews,1938, vol. 4., pp. 338-9).

[3] For example, in 1741 Boston's General Court set out to develop ironworks (Woodman, 1975). The implementation was carried out by John Winthrop Jr., who made several attempts at Braintree, Massachusetts in 1641 and later near the town of Lynn in 1646, but a lack of skilled labor led to the project's failure. Cases such as this one demonstrated that iron smelting was best kept limited to small-scale bloomaries that produced mostly elementary tools (Middleton, 2002, p. 90).

[4]For example, rum could not be refined without mechanical equipment imported from Britain, and New England's nascent processing sector relied on British machinery such as crankshafts, gears, cogs, axles, hammers, nails, files, chisels, knives and plows (Middleton, 2002).

most importantly, the construction of road and bridge networks, began to facilitate arm's length market interactions among interior townships and between townships and the coastal merchants who provided British wares.[5] Inland traders quickly exploited these networks to trade, in exchange for household surpluses, the advanced products that were necessary for diverse small-scale manufacturing and processing industries such as rum distilling, iron smelting and molasses production. The existence of these trading networks promoted the expansion of industries around New England's older export sectors. For example, fishing and grain trade required caskmaking, shipping, and middlemen services, while metal bands, produced by ironworks, were required for caskmaking. Shipbuilding required timber and milling, and development of the latter led to cheaper inputs for caskmakers. Production diversity led to development of the required preparation and packing warehouses, as well as accounting and insurance functions for traders and merchants (Middleton, 2002, p. 208).

As a result, New England settlers soon became proficient in providing transportation, storage, distribution and mercantile services. This once again reflected their comparative advantage. Unlike the South's homogenous plantation exports, which were simple to manage and naturally outsourced to Dutch, English, Scottish and later New England merchants, the diverse production and processing industries that emerged in the northern colonies by the late 17th century required sophisticated complementary functions. New England increasingly provided these functions for herself, the southern and middle colonies, and the Caribbean.

By the 1750s, New England was the New World's center for processing, transportation, storage, distribution, marketing and mercantile services, with the areas around Boston and Newport having over 100 distilleries and rum refineries. By the 1770s, there were more active sugar refineries and rum distilleries in Massachusetts, Connecticut and Rhode Island than in the other ten colonies combined (McCusker, 1970, pp. 431-437; McCusker and Menard, 1985, pp. 290-293). New Yorkers even complained that their wheat was purchased by Boston traders, processed in Massachusetts, and sold back to New Yorkers at a profit (Newell, 1998, p. 69). Yet instead of being monopolized by Boston merchants, the majority of New Englanders managed to participate in some aspect of the market system. The region's economic development was sufficiently pronounced that English merchants soon became concerned about competition from the Northern economy: "[New England] is already the rival and supplantress of her mother" (A Comparison Between the British Sugar Colonies and New England, 1732, pp. 8-9).

New England's diverse production mix and complex trading system required a viable transactions medium, such as specie. Specie was easier to carry than more bulky goods, stable in value, and widely accepted, yet the crown for the most part banned the export of specie and bullion to the colonies. This meant that coins were in short supply, especially outside of Boston, and this increased transactions costs (Nettles, 1934, pp. 125-126, 138-141).

[5] Connecticut and Massachusetts general courts, for instance, disposed funds to complete inter-town infrastructure and large projects like the Hampton ferry and a bridge across the Saugus river near Lynn. Various towns also required inhabitants to construct local roads and bridges collectively (Newell, 1998, p. 55).

Without ample specie for day-to-day transactions, merchants, traders and producers used a variety of substitutes for money such as barter, shop notes, book credit and commodity monies. Trade within towns was often coordinated by shopkeepers who, in addition to supplying finished goods, also kept transactions records for the residents.[6] Barter was common in exchange between towns and country traders. The latter often traveled extensively to supply creditors with specific products and would often travel to multiple destinations before finding the desired matches. For example, an inland trader might take furs from Lancaster, credit a seller's account, carry the furs (and other goods) to the Atlantic, exchange them for British imports in Boston, and finally travel back to Lancaster (trading along the way) where the original seller would take goods equal in value to his credit. All of this involved risk because traders might not survive the return journey or acquire suitable goods in exchange.[7]

The introduction of paper money relaxed these bartering constraints, even though the first and many subsequent issues were enacted to finance government expenditures, especially military conflicts during wartime. Indeed, the Massachusetts legislature approved the first colonial paper money issue in 1690 to finance a failed military expedition against Newfoundland. These tax anticipation bills were not printed for use as transactions media, but rather as a way to defer payment to the militia. The initial plan was to levy a special tax the next year that could be paid in real goods, specie or tax bills, but by the time tax season approached, the bills had become circulating currency and were "better than money" (Hutchinson, 1936, Vol. 1, pp. 340-341).

The popularity of these tax bills (or "tenor" as they were called) led to the first peacetime emission in 1702, and in 1709 the Hartford government issued Connecticut bills to combat the "great scarcity of money" and, conveniently, to finance an expedition against the French (Hutchinson, 1936, Vol. 2, p. 289). New Hampshire also issued their own bills, followed by Rhode Island in 1710. The tenor of all four colonies circulated at par with one another, crossed borders freely within New England, and in 1712 became legal tender for public and private debts. While bills were ostensibly redeemable at future dates, tax levies were not commensurate with emissions and the supply of bills in circulation increased throughout the first half of the 18th century.

There were two ways in which paper money got into circulation. First, seigniorage emissions were printed directly to finance government debts, the bulk of which were related to military expeditions but could also be used for government salaries, infrastructure projects, fort repairs and day-to-day administrative expenses. The second method of emission was

[6]For example, shopkeepers kept records of day or half-day labor owed by one settler to another. Also common was the 'truck' system, in which laborers were paid in commodities or shop credits.

[7]For example, Thomas Fitch, a wealthy Boston merchant, purchased imports with a variety of goods brought from the west. Fitch often advanced goods to traders on credit and required specific products in return. For example, in 1703 he provided nails to a country trader who agreed in return to deliver "Turpentine in August or Septem. next." (from *Thomas Fitch Letterbook,* cited in Newell (1998, p. 91).

through 'land banks.' Under this system legislatures disbursed bills to town leaders who selected citizens to whom the bills would be loaned, using land as collateral. To the extent that land bills were based on underlying assets, they did not increase the money supply permanently, but Smith (1985, pp 549-551) argues that they were only imperfectly tied to underlying asset values and therefore may have had more permanent effects.

New England's money supply increased dramatically over the period 1703-1749, even after accounting for currency depreciation. As Table 1 shows, there were £112,800 old tenor outstanding in 1710. By 1749 the outstanding total of £4,033,700 implied a cumulative increase of 3,475 percent! Of special interest is the fact that while this paper money did lose value, it only depreciated by 694 percent over the period. Most of this depreciation occurred between 1745 and 1749 when colonies printed large amounts of money to fund the Louisburg expedition during the War of Jenkin's Ear. This incomplete price adjustment implies that paper money emissions let to increases in the real money stock.

Loan bank and treasury-issued paper money was hotly debated by contemporaries. Anecdotal evidence described in Brock (1975, 1992) shows prolonged and intense discussions regarding the relative costs and merits of the New England monetary experiments. With regard to the currency debate, detractors, many of whom were creditors (i.e., Boston merchants) emphasized the consequences of currency devaluation, while supporters argued that transactions media stimulated trade and commerce and that existing money stocks were not sufficient to support the region's growing economy.

It is well known that New England paper money often depreciated rapidly, especially after 1740. The New England colonies, and Rhode Island in particular, are often held up as classic examples of overissuance. While not disputing that the issues were often inflationary, we believe that the existing discussion, by focusing primarily on the costs of inflation, ignores an important dimension of paper money issues: monetization. In a world with better data, one would ideally like to estimate the relative inflationary costs and monetization benefits of colonial paper money. In absence of comprehensive economic data, however, we take the more modest approach of investigating whether increases in the real money stock and paper money stimulated economic activity. The next section sets out the quantitative framework that we use to do this.

3. Framework For Estimation

Our analysis begins with the well-known quantity theory of money

$$MV = PY, \tag{1}$$

where M is the money supply, V is the velocity of money, or the number of times that a typical single currency unit is used over some fixed period of time, P is the price level and Y is a measure of real economic activity. Because V is not observable, assuming it to be constant over time is adequate to make (1) estimable. This approach, as adopted by West

(1978) after also assuming constancy of Y and taking logs, generates the usual empirical test of the quantity theory

$$\ln(P) = \beta_0 + \beta_1 \ln(M) + \beta_2 \ln(Y) + \varepsilon, \tag{2}$$

where a positive and significant coefficient on β_1 is typically viewed as evidence that increases in nominal money are reflected in higher prices. Our empirical analysis involves relaxing the assumption of a constant Y as described in Rousseau (2006, 2007, 2010). In that formulation, the release of pent-up demand for a low-cost transactions medium draws more transactions into the modern sector of an economy and has an additional positive spillover on that sector's production. Still assuming constant velocity, rearrangement of the quantity theory thus suggests a relationship between real balances and economic activity:

$$Y = f\left(\frac{M}{P}\right). \tag{3}$$

We aim to develop an empirical representation of this equation that allows for both the possibility that $\frac{M}{P}$ determines Y and also that Y determines $\frac{M}{P}$. One way to test for long-run comovement among these variables is to use the cointegration framework developed in Johansen (1991). If a pair of nonstationary variables are cointegrated, this means that there exists a linear combination of them that is stationary. Engle and Granger (1987) further show that there would be a valid "error correction" mechanism through which the variables are related. This vector error correction model (VECM) is formed by embedding the stationary linear combination in an otherwise standard vector autoregression in first differences. For an underlying vector autoregression (VAR) with k lags, the VECM takes the form

$$\triangle Y_t = \mu_1 + \sum_{i=1}^{k-1} \alpha_{1,i} \triangle Y_{t-i} + \sum_{i=1}^{k-1} \beta_{1,i} \triangle \left(\frac{M}{P}\right)_{t-i} + \gamma_1 \left[aY_{t-1} + b\left(\frac{M}{P}\right)_{t-1} \right] + \varepsilon_{1,t}, \tag{4}$$

$$\triangle \left(\frac{M}{P}\right)_{1,t} = \mu_1 + \sum_{i=1}^{k-1} \alpha_{2,i} \triangle Y_{t-i} + \sum_{i=1}^{k-1} \beta_{2,i} \triangle \left(\frac{M}{P}\right)_{t-i} + \gamma_2 \left[aY_{t-1} + b\left(\frac{M}{P}\right)_{t-1} \right] + \varepsilon_{2,t}. \tag{5}$$

Note that if Y and $\frac{M}{P}$ have unit roots and are cointegrated, all of the terms in the regression are stationary, including the residuals $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$. Consider equation (4), which regresses differences of Y on a constant, a series of its own lags, lags of $\triangle\left(\frac{M}{P}\right)$, and the cointegrating relationship $\left[aY_{t-1} + b\left(\frac{M}{P}\right)_{t-1}\right]$. The lag differences capture short-run adjustments up to lag k in both $\triangle Y$ and $\triangle\left(\frac{M}{P}\right)$. The cointegrating combination (i.e., $[a,b]\prime$) represents the long-run equilibrium relationship. When used with the data to form the linear combination, the coefficient on this error correction term, γ_1, gives the speed at which $\triangle Y$ adjusts to perturbations in the long-run relationship. With a normalized to unity, the signs of b and γ

allow the investigator to deduce the direction of any long-run effect of fluctuations in money on Y.

To see how estimated coefficients indicate the direction of causation, consider the case where none of the short-run parameters are significant and γ_1 and γ_2 are both significant. This would imply that $\frac{M}{P}$ causes Y in a long-run sense and vice versa. In this case the model cannot disentangle the direction of causation.

Suppose, however, that γ_1 is statistically significant but γ_2 is not. This would indicate that Y responds to fluctuations in the equilibrium relationship between $\frac{M}{P}$ and Y, but that $\frac{M}{P}$ does not. If b and γ_1 were both negative, this would imply that depressions in the equilibrium relationship generated by increases in $\frac{M}{P}$ would force the dependent variable, Y, upward. An econometrician would say that $\frac{M}{P}$ is "weakly exogenous for Y," meaning that $\frac{M}{P}$ causes Y in a long-run statistical sense.

Since a VECM is an algebraic re-formulation of a standard VAR in levels, stability of the VECM implies that we can gain information about the overall adjustment process by estimating the underlying VAR and calculating the associated impulse responses. The VAR takes the form

$$Y_t = \mu_1 + \sum_{i=1}^{k} \alpha_{1i} Y_{t-i} + \sum_{i=1}^{k} \beta_{1i} \left(\frac{M}{P}\right)_{t-i} + \varepsilon_{1,t}, \tag{6}$$

$$\frac{M}{P}_t = \mu_2 + \sum_{i=1}^{k} \alpha_{2,i} Y_{t-i} + \sum_{i=1}^{k} \beta_{2,i} \left(\frac{M}{P}\right)_{t-i} + \varepsilon_{2,t}. \tag{7}$$

Since the VAR does not involve transformation into error-correction format, the coefficients on the regressors in levels allow the investigator to trace out the overall effects (i.e., combining the short and long-run) of Y to shocks in $\frac{M}{P}$ and of $\frac{M}{P}$ to shocks in Y with impulse response functions.

4. Data

We begin with a measure of New England's money supply constructed from various sources. This includes treasury-issued and land bank tenor (bills of credit), privately-issued merchants' notes, and the stock of specie.

The amounts of paper money in circulation for each of the four New England colonies (i.e., Massachusetts, Connecticut, New Hampshire, and Rhode Island) are the cumulative sum of issues less any retirements from Carter et al. (2006, Vol. 5, Series Eg302-Eg305, pp. 692-3, *Historical Statistics* hereafter).[8]

[8]The data in *Historical Statistics* are corrected and refined versions of series that appear in Brock (1975).

Table 1
Components of the Real Money Supply and Y, New England 1703-1749.

Year	Seigniorage Notes £ Tenor	Land Bank Notes £ Tenor	Private Notes £ Tenor	Silver in Circulation £ Tenor	Money Supply £ Tenor	Price Level (1703=1)	Imports in 1700-02 £ Sterling
1703	6,400	0	0	173,848	180,248	1	59,608
1704	17,700	0	0	167,834	185,534	0.980	74,896
1705	29,500	0	0	160,329	189,829	0.946	62,504
1706	31,100	0	0	153,798	184,898	0.064	57,050
1707	40,800	0	0	144,399	185,199	1.093	120,630
1708	57,000	0	0	130,725	187,725	1.066	115,505
1709	69,400	0	0	114,802	184,202	1.146	120,349
1710	112,800	0	0	96,414	209,214	1.158	106,338
1711	92,900	50,000	0	83,337	226,237	1.053	137,421
1712	188,900	25,000	0	70,260	284,160	1.131	128,105
1713	219,500	0	0	57,676	277,176	1.281	120,778
1714	146,400	50,000	0	45,092	241,492	1.383	121,288
1715	174,500	80,000	0	32,508	287,008	1.166	164,650
1716	71,000	170,000	0	19,925	260,925	1.126	121,156
1717	135,800	175,000	0	7,340	318,140	1.212	132,001
1718	145,300	163,500	0	0	308,800	1.358	131,885
1719	138,500	152,000	0	0	290,500	1.377	125,317
1720	126,300	150,500	0	0	276,800	1.256	128,767
1721	68,600	239,000	0	0	307,600	1.223	114,523
1722	126,000	237,500	0	0	363,500	1.321	133,722
1723	150,700	236,000	0	0	386,700	1.340	176,486
1724	181,200	234,500	0	0	415,700	1.432	168,507
1725	213,400	233,000	0	0	446,400	1.501	201,768
1726	266,400	211,500	0	0	477,900	1.713	200,882
1727	269,800	190,000	0	0	459,800	1.654	187,277
1728	256,400	266,000	0	0	522,400	1.647	194,589
1729	265,300	242,000	0	0	507,300	1.852	161,102
1730	277,000	218,000	0	0	495,000	1.886	208,196
1731	285800	260,000	0	0	545,800	1.648	183,466
1732	290,000	242,000	0	0	532,000	1.793	216,600
1733	284,750	375,250	14,904	0	674,904	1.948	184,570
1734	483,600	346,000	122,906	0	952,506	2.119	146,460
1735	495,550	316,750	144,145	0	956,445	2.457	189,125
1736	529,700	297,500	46,341	0	873,541	2.495	222,158
1737	518,300	282,700	31,073	0	832,073	2.763	223,923
1738	454,000	359,000	33,613	0	846,613	2.537	203,233

Table 1, continued.
Components of the Real Money Supply and Y, New England 1703-1749.

Year	Seigniorage Notes £ Tenor	Land Bank Notes £ Tenor	Private Notes £ Tenor	Silver in Circulation £ Tenor	Money Supply £ Tenor	Price Level (1703=1)	Imports in 1700-02 £ Sterling
1739	562,700	329,600	32,221	0	924,521	2.379	220,378
1740	459,300	472,900	19,555	0	951,755	2.775	171,081
1741	587,981	458,818	186,837	0	1,233,637	3.535	198,146
1742	526,063	544,736	92,811	0	1,163,611	3.341	148,899
1743	626,045	510,655	19,555	0	1,156,255	3.126	172,461
1744	775,627	636,573	0	0	1,412,200	3.006	143,982
1745	1,430,809	602,491	0	0	2,033,300	3.590	140,463
1746	2,698,591	568,409	0	0	3,267,000	4.663	209,177
1747	3,319,772	534,327	0	0	3,854,100	6.165	210,640
1748	3,540,554	494,245	0	0	4,034,800	8.580	197,682
1749	3,589,536	444,164	0	0	4,033,700	8.129	238,286

Note. Seigniorage and land bank bills are from *Historical Statistics* Series Eg302-Eg305 and Brock (1975, pp 23, 26, 38, 44-45, 47-49). See Section 4 of text for details on construction. Private notes and silver in circulation are from Officer (2005, pp. 114-117). The money supply is the sum of seignorage, land bank and private notes, and silver in circulation. See Section 4 for derivation of our price level index from wheat and molasses prices from Cole (1938, Table 36, p. 117) as well as codfish prices from *Historical Statistics* (Vol. 5, Series Eg248, p. 675). Imports from England (in constant 1700-02 sterling) are from *Historical Statistics* (Vol. 5, Series Eg437, pp. 710-11).

The paper money component is constructed from data on bills issued by treasuries (hereafter "seigniorage") and those issued on loan through land banks. Later we will examine, in addition to the effect of the total real money supply on Y, the relative effects of these two components. We obtain the loan bank component by using, for every instance in which a colonial legislature approved a loan bank emission, the value of paper money emitted and the pre-specified redemption schedule to calculate the balance outstanding for each year. The underlying accounts of loan bank issues are from Brock (1975, pp 23, 26, 38, 44-45, 47-49). Seigniorage bills are obtained by subtracting the outstanding loan bank stock from the total paper money stock. Since the paper money of the New England colonies circulated at par across their boundaries, the total paper money stock for the region is the sum of the outstanding balances for the four colonies.

For privately-issued notes, we use the series compiled by Officer (2005, pp. 114-16). These include Boston Merchant's notes, New London Society notes, New Hampshire Merchant's notes, Silver Bank notes, and notes of the Massachusetts-chartered private "Land Bank." No comprehensive measure of specie exists for the period, but Officer (2005, pp. 116-17) constructs a reasonable proxy in Massachusetts tenor equivalents from the existing fragmen-

tary sources, and we use his estimates here.[9] The total money stock and its components are given in Table 1.

To convert the nominal stock of paper money into real terms, we need a measure of P. This presents a challenge because there is no comprehensive price measure for New England over the period. One approach, taken by McCallum (1992) and Smith (1985), assumes that sterling prices are stable and uses the exchange rate to convert tenor to sterling values.

We prefer to measure the price level using real goods actually traded in Massachusetts, and build a new index to do so. There are only three available price series for the period: the prices of a bushel of wheat (1703-1749) and a gallon of molasses (1720-1749) from Cole, (1938, Table 36, p. 117), and a hundredweight of merchantable codfish (1703-1749) from *Historical Statistics* (Vol. 5, Series Eg248, p. 675). Since molasses prices begin in 1720, we use an AR(1) model to backcast them to 1703. The constructed index, presented in Table 1, averages the resulting series after normalizing each good's price to unity in 1703.[10]

Since we test for an effect of monetization on the level of activity in the *modern* sector, it is not obvious that the ideal measure of Y would be gross domestic product, given its large agricultural component, even if it were available (Rousseau and Sylla, 2005, p. 11). On the other hand, modern sector activity might be well-proxied by a measure of commerce, and imports from England in constant 1700-1702 sterling are available for the period of our study from *Historical Statistics* (Vol. 5, Series Eg437, pp. 710-11).[11] These data were compiled under supervision under the British Inspector General and are presented in the final column of Table 1. This series is sufficiently comprehensive because the majority of New England trade occurred between Boston and London, rather than with Southern Europe, the East Indies, South America or other British colonies (McCusker, 1978).

We believe that the imports series contains important information about development in the modern sector, which should lead to increased income and consumption. Additionally,

[9] Officer's underlying sources include a direct estimate of £200,000 at the end of 1699 from Davis (1900). There are also two estimates of the relative amounts of specie to bills. Brock (1992, p. 7) states that: "in 1710 there was perhaps as much silver in circulation as there were bills." Davis (1911, vol. 4, p. 157) cites an anecdotal account from 1743 which places bills in circulation at three times silver balances in 1712. The final observation is a generally-accepted estimate of 1717 as the date at which no specie remained in circulation. Officer then measures the amount of specie in circulation by linearly interpolating these points using the trade deficit as a weighting factor.

[10] To proxy price variation, West (1978) uses only wheat prices. To this Officer (2005) adds molasses prices after 1720. This provides more accurate price information after 1720 but does not treat the years before and after 1720 symmetrically.

[11] Exports from New England are a less satisfactory proxy because they were influenced heavily by Navigation Laws, especially after 1740, and this series aggregates both New England exports with re-exports from the Caribbean and other colonies.

a developed modern sector requires more inward investment, which increases income, again allowing for more consumption. Further, the fact that many purchased imports were necessary inputs for modern production, they would have generated another positive spillover on economic activity.

5. Results

Before proceeding with the time-series analysis, we first check the stationarity properties of real money and Y. The first column of Table 2 presents Augmented Dickey-Fuller test statistics for these series, which fail to reject the null hypothesis of a unit root in all cases. We therefore go on to test for a cointegrating relationship between the two series. The Johansen (1991) statistics for the trace and maximum eigenvalue tests presented in the right panel of the table indicate that at least one of the tests is consistent with a single cointegrating relationship between Y and each component of $\frac{M}{P}$.

Table 2
Unit Root and Cointegration Tests for $\frac{M}{P}$ and Y.

Dickey-Fuller Test	Johansen Test			
		$Trace$		$Maximum\ eigenvalue$	
	ADF Statistic	≤ 0	≤ 1	≤ 0	≤ 1
Y	0.941				
$\frac{M}{P}$	0.996	11.601*	2.153	9.448*	2.150
$\frac{S}{P}$	1.594	8.665*	2.033	6.632	2.033
$\frac{LB}{P}$	-0.559	9.029*	0.360	8.668	0.360

Note. The left panel gives Augmented Dickey-Fuller tests of the null hypothesis of unit root using a specification with a constant, a time trend and two additional lag differences of the dependent variable. The second panel presents test statistics for Johansen tests of a cointegrating link between the row series and Y. The column labeled ≤ 0 tests the null of no cointegration while the row labeled ≤ 1 tests the null of at most one cointegrating vector. The Johansen test uses three lags for the underlying VAR, and includes an unrestricted intercept. Critical values are from Table 1 in Osterwald-Lenum (1992). An * denotes statistical significance at the 10% level or less.

By inserting the cointegrating vector that emerges from the Johansen procedure into equations (4) and (5), we can then form a VECM to identify any short and long-run effects that are present. The order of the underlying levels VAR is $k = 3$, as chosen by a series of nested likelihood ratio tests, so the corresponding VECM will use $k - 1 = 2$ first differences of the data.

Our main result is presented in the first two columns of Table 3, labeled "Total Money Supply," which present estimation results from equations (4) and (5). The ECT in the money equation is not significant, consistent with the absence of a long-run causal channel from Y to $\frac{M}{P}$. On the other hand, the ECT in the Y equation is significant with a negative sign. When combined with the negative estimate of b in the cointegrating vector from the Johansen test (presented in the final row of Table 3) this implies a strong positive response of Y to long-run fluctuations in the money supply. Significance of the ECT in the Y equation along with absence of significance in the money equation suggests that direction of long-run causality is from money to output and not the other way around. The positive effect of money on Y is not evident in the VECM's short-run parameters. This is consistent with the hypothesis that monetization stimulated long-term development of the modern sector rather than only immediate spending. In all cases the Durbin-Watson statistics suggest that the residuals are not serially correlated.

We now quantify the dynamics of this adjustment. In particular, we would like to know if money had caused a discrete increase in Y at some specific horizon, or if the effect cumulated gradually. Because VECM estimates are stable by construction, we can exploit the fact that the VECM is a re-formulation of a standard VAR in levels. In other words, stationary and serially uncorrelated errors in a VECM imply that the corresponding VAR in levels will also be stationary. Our strategy for assessing adjustment dynamics is thus to estimate equations (6) and (7) and use the coefficients to construct response functions of each variable to a one standard-deviation shock to the other.

Panel 1 of Table 4 presents estimates for equations (6) and (7). The first two rows present the individual coefficient estimates. Centered below these are block exogeneity tests of the null hypothesis that lags 1-3 of a given variable (i.e., Y or $\frac{M}{P}$) are jointly zero. The results are consistent with those found in the VECM: real money balances cause Y but not the other way around.

The upper panel of Fig. 1 shows the corresponding impulse response functions along with 90% confidence bands. The figure on the left plots the percentage change in Y over time to a one standard deviation shock to $\frac{M}{P}$. The effect becomes statistically significant after two years and persists until fourteen years from the initial shock. On the right we plot the response of $\frac{M}{P}$ to a one standard deviation shock to Y. Here, the effect is not significant, again confirming that money drives Y but not the other way around. Overall, results from the VECM, VAR and impulse responses provide strong evidence that New England's monetization led to permanent increases in economic activity.

We now examine the effect of paper money emitted through each of New England's two monetary mechanisms: bills emitted for seigniorage by the treasuries and bills authorized

Table 3
Estimates from Vector Error Correction Models, New England, 1703-1749.

	Total Money Supply		Seigniorage Bills		Loan Bank Bills	
	$\triangle \mathrm{Y}_t$	$\triangle \left(\frac{M}{P}\right)_t$	$\triangle \mathrm{Y}_t$	$\triangle \left(\frac{S}{P}\right)_t$	$\triangle \mathrm{Y}_t$	$\triangle \left(\frac{LB}{P}\right)_t$
ECT_{t-1}	-0.436***	0.074	-0.563***	-0.168	-0.021*	-0.352**
	(0.123)	(0.104)	(0.167)	(0.292)	(0.011)	(0.139)
$\triangle \mathrm{Y}_{t-1}$	-0.186	-0.178	-0.108	0.032	-0.413***	-0.565
	(0.145)	(0.123)	(0.167)	(0.293)	(0.151)	(1.836)
$\triangle \mathrm{Y}_{t-2}$	-0.115	-0.220*	-0.056	-0.031	-0.197	-2.419
	(0.133)	(0.113)	(0.150)	(0.263)	(0.149)	(1.817)
$\triangle(\frac{M}{P})_{t-1}$	-0.423**	-0.021				
	(0.179)	(0.152)				
$\triangle(\frac{M}{P_I})_{t-2}$	-0.002	-0.271				
	(0.199)	(0.169)				
$\triangle(\frac{S}{P})_{t-1}$			-0.157	-0.328*		
			(0.100)	(0.176)		
$\triangle(\frac{S}{P})_{t-2}$			-0.063	0.054		
			(0.093)	(0.163)		
$\triangle(\frac{LB}{P})_{t-1}$					0.008	-0.387***
					(0.011)	(0.134)
$\triangle(\frac{LB}{P})_{t-2}$					-0.015	-0.444***
					(0.011)	(0.132)
R^2	0.422	0.186	0.375	0.154	0.293	0.438
Durbin-Watson	2.148	2.069	1.932	1.964	2.111	2.118
Coint loading [a, b]	[1, -0.583]		[1, -0.276]		[1, 0.531]	

Note. All variables are in log levels. The first two columns report coefficients from estimating equations (4) and (5) using the entire New England money supply expressed in terms of constant tenor. The third and fourth columns report coefficients from estimating equations (4) and (5) using only seigniorage or land bank bills. Standard errors in parentheses. *, **, and *** denote statististical stignificance at the 10%, 5% and 1% levels, respectively.

Table 4
Estimates from VAR Models, New England, 1703-1749.

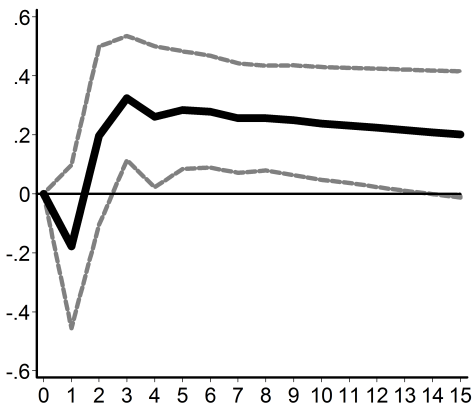
	Y_{t-1}	Y_{t-2}	Y_{t-3}	$\frac{M}{P}_{t-1}$	$\frac{M}{P}_{t-2}$	$\frac{M}{P}_{t-3}$	R^2
Panel 1: Total Money Supply							
Y	0.379***	0.070	0.118	-0.179	0.427*	-0.017	0.70
	(0.142)	(0.144)	(0.124)	(0.168)	(0.237)	(0.195)	
Granger test		24.35			9.311		
P-value		(0.000)			(0.025)		
$\frac{M}{P}$	-0.0978	-0.044	0.229**	0.908***	-0.235	0.222	0.87
	(0.120)	(0.121)	(0.105)	(0.142)	(0.200)	(0.164)	
Granger test		5.605			101.92		
P-value		(0.132)			(0.000)		
Panel 2: Seignorage Bills							
Y	0.332**	0.053	0.059	-0.007	0.090	0.063	0.67
	(0.152)	(0.156)	(0.141)	(0.088)	(0.104)	(0.086)	
Granger test		7.56			5.221		
P-value		(0.006)			(0.156)		
$\frac{S}{P}$	-0.0878	-0.030	0.091	0.619***	0.330*	-0.057	0.82
	(0.258)	(0.265)	(0.239)	(0.150)	(0.177)	(0.146)	
Granger test		0.249			60.50		
P-value		(0.969)			(0.000)		
Panel 3: Loan Bank Bills							
Y	0.457***	0.121	0.079	0.004	-0.017	0.020**	0.67
	(0.141)	(0.152)	(0.140)	(0.010)	(0.011)	(0.010)	
Granger test		23.53			5.018		
P-value		(0.000)			(0.170)		
$\frac{LB}{P}$	0.120	-0.948	3.53**	0.355***	-0.109	0.383***	0.76
	(1.761)	(1.891)	(1.742)	(0.128)	(0.140)	(0.123)	
Granger test		5.074			26.99		
P value		(0.166)			(0.000)		

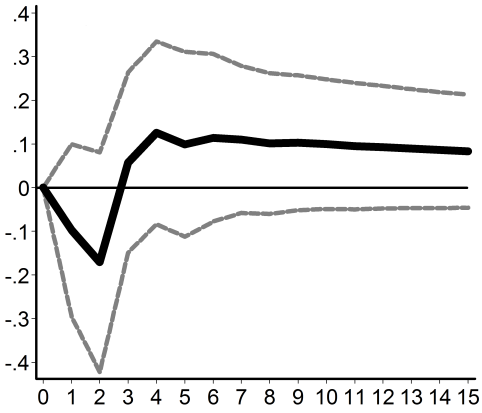
Note. The table includes results for two-variable VARs with three lags. The rows for panels 1 and 2 correspond to equations (6) and (7). The dependent variable for each equation is listed in the left column. Coefficient estimates appear in the columns for the independent variables, given by the column labels, with standard errors in parentheses. The rows labeled "Granger test" report block Wald statistics and the rows labeled "P-value" report corresponding tail probabilities for the null hypothesis that the lags of each system variable are jointly zero. All variables are in log levels. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Fig. 1. Impulse Response Functions, New England, 1703-1749.

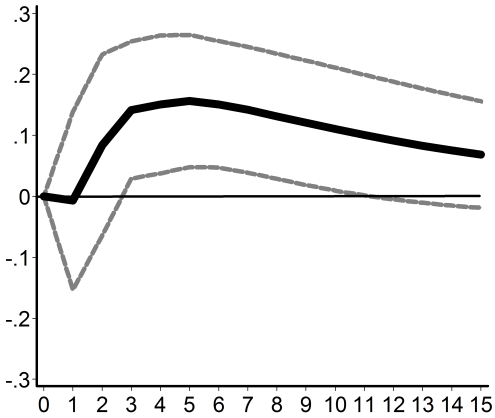
Effect of $\frac{M}{P}$ on Y	Effect of Y on $\frac{M}{P}$

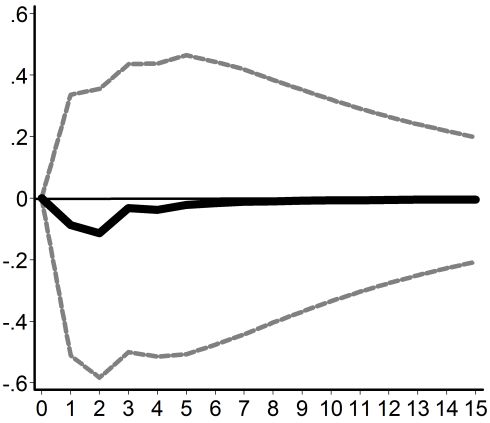
Panel 1: Total Money Stock



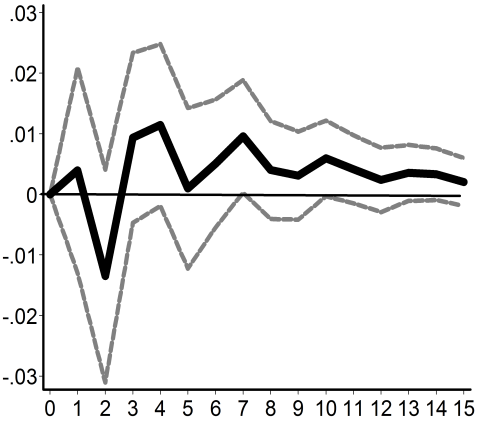


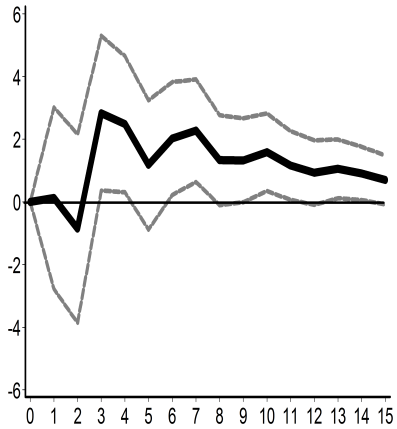
Panel 2: Seigniorage Bills





Panel 3: Loan Bank Bills





Note. These figures plot annual responses to a one standard deviation shock, constructed from parameters estimated in vector autoregrerssions with three lags. The dashed lines are 90% confidence bands.

by legislatures to be loaned on collateral to colonists. We denote these two series by S and LB, respectively. Columns 3 through 6 of Table 3 present estimates from equations (6) and (7). Results for the seigniorage system are similar to those for the total money stock. The final two columns of Table 3 report results for paper money emitted through land banks. Here, the ECT is significant in the $\frac{LB}{P}$ equation, suggesting that legislatures may have emitted loan bank bills in response to output. The sign of this effect, $a\gamma_2$ =(-0.352)(0.531)=-0.189 is negative, indicating that decreases in output led to future increases in loan bank emissions. This may be because economic downturns led colonists to pressure legislatures for new emissions. Turning to the Y equation, the ECT is weakly significant and the estimated effect of land bank money on Y is small and negative. This suggests that the timing of loan bank emissions may not have been conducive to modern sector development.

The associated VARs in Table 4 bear out these findings. Panel 2 shows that seigniorage bills weakly Granger cause Y at the 16% level, but Panel 3 indicates bi-directional causality between loan bank emissions and Y. The corresponding impulse response functions in Fig. 1 show a protracted effect of seigniorage issues on Y that begins by the third year after emission and continues through the eleventh year. Moreover, there is no measurable effect of Y on the timing of seigniorage emissions. This is similar to our findings for the entire money stock.

By comparing Panel 1 with Panel 2 of Fig. 1, we can see that the effect of shocks to the full money stock had a larger and more protracted effect on Y than did seigniorage issues. This is consistent with the view that paper money, while effective in monetizing the region, may not have been as effective as specie, the latter not being subject to inflation costs and being more widely accepted outside the region. The impulse responses for land bank emissions in the lower panel of Fig. 1 indicate no measurable effect of loan bank bills on Y at all but repeated and long-term effects of Y on real loan bank balances.

Overall, these results indicate a positive and meaningful effect of New England's monetization on modern sector activity.[12]

6. Conclusion

At the broadest level, our study offers support for the proposition that, in addition to causing currency depreciation, New England's monetization facilitated emergence of a modern economic sector. While the large-scale production of staple crops may involve fewer transactions requiring currency, availability of a viable transactions medium to carry out a wide range of arms-length transactions is central to a modern economy's effectiveness. To the

[12]The main results are qualitatively similar when we repeat our empirical analysis converting tenor value to pound sterling equivalents using the exchange rate, which assumes constant British prices, or when we use a domestic price index that includes only wheat and codfish prices. These findings are available from the authors upon request.

extent that imports reflect such activity, our estimates provide quantifiable historic evidence on the importance of a widely-accepted medium of exchange, namely fiat paper money.

In particular, using data on money, prices, and imports from England, a series of vector error correction models and the associated impulse responses indicate that monetary expansions had positive and statistically significant effects on economic activity that were strongest in the long run. The presence of such effects suggest that money promoted New England's diverse trade and processing sector rather than supporting only temporary increases in spending.

We next show that paper money issues aimed at funding government expenditures followed a similar pattern, affecting modern sector development but not being affected by it. On the other hand, paper money issued as loans against land did not have a measurable effect on New England's modern sector. The latter result may arise because land bank issues were often enacted by legislatures under pressure from citizens, so that this form of money may have grown in response to anticipated demand shocks. Alternatively, to the extent that loans were temporary (i.e., were paid back according to a set schedule), land bank issues may not be a good example of permanent changes in the money supply.

Our primary contribution is to use widely-available data on money, output and prices to show that New England's experiments with paper money in the colonial period influenced output in a quantitatively meaningful way. Previous scholars have focused on the effects of money emissions on the extent and speed of devaluation. By departing from this literature to answer a broader question about the relationship between monetization and economic development, we conclude that it is important to consider the benefits of fiat paper money in addition to the costs when evaluating those monetary regimes that employed it.

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