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The Bullionist Controversy: A Time-series Analysis

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The bullionist and antibullionist models of the Bank Restriction Period (1797–1821) represent early monetarist/nonmonetarist approaches to macroeconomics under a paper standard and floating exchange rate. In contrast to the existing literature, the competing models (plus a modern bullionist alternative) are presented as chains of causation linking individual hypotheses rather than simply as sets of individual hypotheses. For the first time, multivariate time-series analysis is used to test the models, and data are much improved over previous studies. Evidence is preponderantly, though not exclusively, in favor of the antibullionist position. Copyright © 2000 John Wiley & Sons, Ltd.

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> The so-called 'bullionist' controversy... was probably the most important Foreign Exchange controversy for all time (Einzig, 1970, p. 202).

SUMMARY

The Bank Restriction Period (1797–1821) was the sole British experience with a paper standard and floating exchange rate to 1914. Contemporary observers disagreed vigorously about the relationships among the price level, exchange rate, and money supply (represented by Bank of England notes). On one side were the bullionists, comparable with modern monetarists. They argued that Bank of England notes determined the price level, which then determined the exchange rate. On the other side were the antibullionists, who emphasized non-monetary influences on the exchange rate, which helped to determine the price level, which was then accommodated by Bank of England note circulation. A modern bullionist theory partially bridges the gap between the two camps; its focus is on Bank of England note circulation determined by demand and supply. Superior data and more sophisticated techniques than those of previous authors are employed to test the three positions. Evidence is preponderantly in favour of the antibullionist approach, which ironically is out of fashion in modern macroeconomics.

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INTRODUCTION

The Bank Restriction Period provides the earliest example of divergent monetarist/nonmonetarist approaches to macroeconomics under a paper standard and floating exchange rate. During the

Bank Restriction Period, Britain's *domestic* gold standard was replaced by a paper standard, because all banks refrained from making cash payments, that is, redeeming their notes (and deposits) in gold coin. Britain's *international* gold standard was replaced by a floating exchange rate, because conventional gold points were inoperative: gold could not be obtained at a fixed price in domestic currency, as above, nor could gold bullion generally be sold for domestic currency at a meaningful official price. The gold price at the Mint (£3 17s. $10\frac{1}{2}$d. per standard ounce), combined with waiting time, was too far below the market price for there to be private customers, except in 1817–1820, when favorable payment arrangements were temporarily in effect. Though the Bank of England's payment was speedier, its normal buying price (£3 17s. 6d.) was too low to be operative, and Bank of England purchases of gold took place only at higher prices, aligned with the market.[1]

The Bank Restriction Period began on 27 February 1797, with implementation of an Order in Council prohibiting the Bank of England from making cash payments, formalized by the Bank Restriction Act of 3 May 1797. Full resumption of specie payments, and therefore return to the gold standard, occurred on 1 May 1821.[2]

The Bank Restriction Period gave rise to 'the bullionist controversy', the most famous monetary debate in the history of economic thought. A measurement issue provided the nomenclature: the 'bullionists' asserted, and the 'antibullionists' denied, that the premium on gold bullion correctly gauged the depreciation of the paper pound. However, substantive topics—determination of the exchange rate and price level, and the behavior of the Bank of England—dominated both the contemporary debate and the interest of post-Bank Restriction Period writers. Here the bullionists adopted a clear monetarist approach and the antibullionists a decidedly nonmonetarist position.

The survey literature of the bullionist debate, as well as the writings of the contemporary protagonists, do not explicitly present the competing bullionist and antibullionist models as chains of causation. So it is not surprising that existing empirical testing considers the various hypotheses only separately and individually, resulting in purely bivariate testing of the models. Also, previous researchers have either lacked the advantage of good data or made inappropriate data selection.

In this paper the first task is to present the contemporary bullionist and antibullionist models, along with a modern bullionist alternative, as chains of causation linking individual hypotheses. Then time-series analysis is used to test the competing models in multivariate form, with careful attention to data collection and construction of variables. The empirical results provide strong, though not uniform, support for the antibullionist position.

BULLIONIST AND ANTIBULLIONIST MODELS

Methodology and Notation

There is no need to provide another comprehensive survey of the bullionist debate.[3] The better procedure is to exposit each side by a testable model. While there were certainly nuances in the positions of contemporary authors, a general model for each side is readily discerned from the contemporary and survey literature. In Viner's (1937, pp. 120, 127) words, the 'essential doctrines of the bullionists' and of the antibullionists are delineated in contrasting models, abstracting from 'qualifications conceded by the bullionists' and antibullionists.

Consider the following notation:

BN	Bank of England notes ('Banknotes') in circulation
BP	Balance of payments (positive if deficit, negative if surplus)
ER	Exchange rate (price of pound in terms of foreign currency), with inverse denoted as ER^{-1}
HR	State of harvest (inversely related to quality)
ME	External military expenditure (direct expenditure plus government transfer payments)
MS	Money supply (M1)
PG	Price of gold, with inverse denoted as PG^{-1}
PL	Price level
PM	Price of imports
PW	Price of wheat

TI Trade interference due to war (such as the Continental System and the American embargo)

Hypotheses are of the form $X \rightarrow Y$ ('X causes Y, with $\partial Y/\partial X > 0$'). The exchange rate and gold price inverses, ER^{-1} and PG^{-1}, are used in lieu of ER and PG, respectively, where indicated for a positive derivative. Shorthand for multiple hypotheses is W, $X \rightarrow Y$ ('$W \rightarrow Y$ and $X \rightarrow Y$') and $X \rightarrow Y$, Z ('$X \rightarrow Y$ and $X \rightarrow Z$').

Bullionist Model

The bullionist chain of causation is:

$$BN \rightarrow MS \rightarrow PL \rightarrow ER^{-1}, PG \quad (1)$$

The first relation, $BN \rightarrow MS$, reflects the bullionist correct perception of the fact that banknotes constituted the monetary base and indeed the ultimate reserve of the entire financial system during the Bank Restriction Period. There was a hierarchy of banks: the Bank of England, London private banks, and country banks. *BN* (held as reserves by the country banks and London private banks) were nonredeemable, deposits at the Bank of England (held as reserves only by the London private banks) cashable only in *BN*. The country banks—but not the London private banks—issued banknotes. Reserves of the country banks were principally deposits at the London private banks.

Strictly speaking, gold coin was a component of the monetary base, but the premium on gold bullion did not have a counterpart in the premium of gold coin (guineas and, from July 1817, sovereigns) over *BN*. There was no legal market for domestic coin in terms of paper money, Gresham's law operated, and an overwhelming proportion of the guineas and sovereigns nominally in circulation or newly minted were in fact hoarded or exported. One can defend the bullionist relation $BN \rightarrow MS$ by characterizing *BN* as the active component of the monetary base.

For the bullionists (and antibullionists), the money supply had as components *BN*, country banknotes, and coin. In excluding deposits from *M*1, the writers of the Bank Restriction Period were not far off the mark. First, except in London, 'deposits' generally meant time or savings deposits rather than demand deposits. Second, excluding interbank transactions, demand deposits typically were exchanged for cash rather than transferred to another account.[4]

The second relation in the chain, $MS \rightarrow PL$, pertains to the quantity theory of money. Underlying this theory is the bullionist view that the Bank of England effectively pegged the market interest rate at 5%, by standing ready to discount all 'good' commercial bills at that rate. This became the mainstream view of historians. The implication is that the monetary base is perfectly elastic at the constant discount rate of 5%: a powerful impetus to the quantity theory.

There is good reason for the bullionist and mainstream view; for the usury laws set a 5% limit on annual interest on bills of exchange, and the discount rate of the Bank of England was fixed at this rate. While bill brokers could charge a commission and private banks could require a minimum balance (thus circumventing the usury laws), the Bank of England did not use such devices. For these three reasons, the *market* discount rate (for good bills, those eligible for Bank of England discounting) did not exceed 5% during the Bank Restriction Period. In fact, only for about a year (beginning July 1817), did the market rate even fall below 5%.[5]

However, there is empirical basis for a contrary position. First, only 'good' bills—a minority of bills—were acceptable by the Bank of England. A 'good' bill bore at least two London names and had a maximum of 65 days until maturity. Also, the submitter of a bill had to be on the Bank of England's list of clients. Second, there is good evidence that the Bank of England effectively regulated discounts via a rationing system.[6] These facts act against the quantity theory but support the concept of *BN* as an autonomous policy variable. The chain of causation is complete with $PL \rightarrow ER^{-1}$, *PG*, which is the purchasing power parity theory (given the foreign price level).

Antibullionist Model

The antibullionist model involves a balance-of-payments theory of the exchange rate, with demand and supply for bills of exchange, represented by the balance of payments (*BP*), yielding ER^{-1} and *PG*. The state of the harvest (*HR*) determines the domestic price of grain,

represented by the price of wheat (*PW*). The exchange rate is an ingredient in the price of imports (*PM*), which, together with *PW*, determines *PL*. The antibullionists saw three principal determinants of *BP*: *PW*, trade interference (*TI*), and external military expenditure (*ME*). The full antibullionist causal chain, more complex than the bullionist version, is:

$$\begin{array}{l} \mathrm{HR}\rightarrow\mathrm{PW}\ \rightarrow\ \mathrm{PL}\rightarrow\mathrm{BN} \\ \qquad\quad\swarrow\qquad\quad\nwarrow \\ \mathrm{TI,\,ME}\rightarrow\mathrm{BP}\rightarrow\mathrm{ER}^{-1},\ \mathrm{PG}\rightarrow\mathrm{PM} \end{array} \tag{2}$$

In emphasizing the price of wheat, the antibullionists recognized the highly agrarian state of the British economy, notwithstanding the industrial revolution in progress. Crafts (1985, p. 15) calculates that between 37.0 and 41.7% of the labor force was agricultural in 1801–1803. Deane and Cole (1969, p. 166) estimate that agriculture, forestry, and fishing accounted for 32.5, 35.7, and 26.1% of national income in 1801, 1811, and 1821. The antibullionist emphasis on wartime interference with trade and on external military expenditure reflected the French Revolution and Napoleonic Wars, in which Britain was engaged for much of the Bank Restriction Period. Except for brief respites (March 1802–May 1803 and April 1814–February 1815), war was continuous throughout this period until Waterloo.

The antibullionists used the real-bills doctrine to reverse the indirect $BN \rightarrow PL$ causation of the bullionists. They accepted that the Bank of England behaved passively in its note issuance, but used the real-bills theory to demonstrate that excess issue (which would increase the price level) would be returned to the Bank of England. Then—the theory extended—only nonmonetary forces could cause real income and the price level to increase and would underlie the demand for discounting to finance a higher volume of transactions, whence $PL \rightarrow BN$.

The bullionists rejected this argument as false, for ignoring the fact that the Bank of England operated without restraint on its note issue. They offered, rather, as a second-best alternative to resumption of cash payments, the *policy rule* that *BN* issuance should be oriented to the exchange rate and price of gold: $ER,\ PG^{-1} \rightarrow BN$.

Modern Bullionist Model

A 'modern bullionist' would view the monetary base (essentially *BN*) as determined by demand and supply. With supply perfectly elastic at the pegged market interest rate, *BN* is neither exogenous nor the first link in the causal chain. Rather, *BN* is proximately determined by the demand for the monetary base. One implication of the modern approach is removal of the bullionist fear that *BN* could rise without limit. While true in theory, in practice this was impossible, because *BN* was subject to the interest rate peg and so was an endogenous variable. Given not only an interest rate target, but also one that was unchanged throughout the Bank Restriction Period, the Bank of England could not induce the private sector to hold more *BN* than permitted by demand. It is important to note, however, that this argument is different from the real-bills doctrine of the antibullionists. The modern bullionist approach is not antibullionist!

A second implication concerns revision of the formal bullionist model. With *BN* endogenous and determined by demand, ideally this demand would be proxied by the usual determinants: income and the interest rate, as well as by shocks causing shifts in the demand function. With the pertinent interest rate fixed for almost the entire period and absent continuous income data, only shock variables remain for inclusion. The obvious such variables are the very ones used as exogenous elements in the antibullionist model: *HR* (as affecting *PW*), *TI*, and *ME*. Then the 'modern bullionist model' has representation:

$$\begin{array}{l} \mathrm{HR}\rightarrow\mathrm{PW}\ \rightarrow\ \mathrm{BN}\rightarrow\mathrm{MS}\rightarrow\mathrm{PL}\rightarrow\mathrm{ER}^{-1},\ \mathrm{PG} \\ \qquad\quad\nearrow \\ \mathrm{TI,\,ME} \end{array} \tag{3}$$

Abstraction for Empirical Testing

For empirical testing, (1)–(3) are simplified by excluding variables for which data are unavailable or incomplete. The models remain theoretically robust. *PG* can be omitted, because it plays the same role as ER^{-1} in each system and the latter is the more pertinent variable, with *PG* of interest to the contemporary protagonists primarily as a measure of currency depreciation. Dropping MS as an intermediate variable, the bullionist system (1) reduces to

$$BN \rightarrow PL \rightarrow ER^{-1} \quad (4)$$

Omitting the non-measurable variables, *HR* and *TI*, and letting ER^{-1} represent *BP* and *PM*, the antibullionist system (2) becomes:

$$\begin{array}{l} PW \rightarrow PL \rightarrow BN \\ \quad \searrow \quad \uparrow \\ ME \rightarrow ER^{-1} \end{array} \quad (5)$$

Along the same lines, the modern bullionist model (3) is now:

$$\begin{array}{l} PW \rightarrow BN \rightarrow PL \rightarrow ER^{-1} \\ \quad \nearrow \\ \quad ME \end{array} \quad (6)$$

LESSONS FROM PREVIOUS EMPIRICAL TESTING

Results of Studies

Time-series investigations of the bullionist and antibullionist theories have been performed both by contemporary writers: Ricardo (1811, pp. 114–121), Galton (1813), and Anonymous (1819); and by historians: Silberling (1923, pp. 240–243, 246; 1924, pp. 230–232), Angell (1926, pp. 477–494), Viner (1937, pp. 142–144), Morgan (1943, pp. 30–47), GRS (1953, vol. 2, p. 932), Myhrman (1976, pp. 187–189), Arnon (1990, pp. 15–16), and Nachane and Hatekar (1995) [hereinafter Nachane–Hatekar].

Ignoring findings involving *PG* and considering first the bullionist model, Ricardo and Galton conclude, but Anonymous rejects, $BN \rightarrow ER^{-1}$, and Nachane–Hatekar reject $MS/YR \rightarrow ER^{-1}$, where *YR* is real output.[7] Galton shows $BN \rightarrow PW$ (representing *PL*). Silberling, Morgan and Mhyrman find little relationship between *BN* and *PL*; Arnon strongly supports $MS \rightarrow PL$; while Angell and Nachane–Hatekar reject $BN \rightarrow PL$ and $MS/YR \rightarrow PL$, respectively. Finally, Myhrman affirms, but Angell and Nachane–Hatekar deny, $PL \rightarrow ER^{-1}$.

In contrast to these mixed results for the bullionist model, testing of the antibullionist theories is uniformly supportive: $PW \rightarrow PL$ (Morgan and Arnon), $ER^{-1} \rightarrow PL$ (Nachane–Hatekar), $BP \rightarrow ER^{-1}$ (Morgan, GRS, and Nachane–Hatekar), $(ME + GM) \rightarrow ER^{-1}$ [where *GM* denotes the value of grain imports over a base level, in lieu of the pertinent causal variable, *PW*] (Anonymous, Silberling, Angell, and Viner), $PL \rightarrow BN$ (Angell), and $PL \rightarrow MS/YR$ (Nachane–Hatekar).[8]

Time Period and Frequency of Observations

It is logical that the time period for testing the bullionist and antibullionist models should be within 1797–1821, the Bank Restriction Period. This provides an insufficient number of annual observations for time-series analysis. One solution, adopted by Nachane–Hatekar, is to incorporate annual observations beyond the Bank Restriction Period; they select 1802–1838 as the time period for their analysis. Because the bullionist and antibullionist models pertain strictly to a paper standard and floating exchange rate—in British monetary history descriptive only of the Bank Restriction Period, until 1914—it is preferable to retain the 1797–1821 time period and move to higher frequency observations. Silberling and Morgan use quarterly data, a decision followed in this paper. The observation period is 2Q 1797–1Q 1821—the 96 complete quarters enveloped by the Bank Restriction Period.

Table 1. Granger-causality likelihood-ratio statistics

Variables	Explanatory variables				
	$\Delta \log(PL)$	$\Delta \log(ER)$	$\Delta \log(BN)$	$\Delta \log(ME)$	$\Delta \log(PW)$
$\Delta \log(PL)$	—	13.72*	11.35*	8.60**	14.87*
$\Delta \log(ER)$	5.41	—	8.29**	4.09	7.66
$\Delta \log(BN)$	11.35*	4.43	—	3.43	11.05**
$\Delta \log(ME)$	11.95*	1.05	1.05	—	11.95*
$\Delta \log(PW)$	3.76	2.76	5.41	6.38	—

*(**) Denotes rejection of no Granger causality at 1(5)% level.

Table 2. Correlation coefficients of VAR residuals

	$\Delta \log(ER)$	$\Delta \log(BN)$	$\Delta \log(PW)$	$\Delta \log(ME)$
$\Delta \log(PL)$	−0.08	0.06	0.83*	0.02
$\Delta \log(ER)$		0.06	0.02	−0.01
$\Delta \log(BN)$			0.09	−0.06
$\Delta \log(PW)$				0.08

* Denotes significantly different from zero at 1% level.

MULTIVARIATE EMPIRICAL TESTING

It is natural to apply multivariate time-series analysis to the logarithmically transformed variables of models (4), (5), and (6): $\log(ER)$, $\log(PL)$, $\log(BN)$, $\log(PW)$, $\log(ME)$.[9] To determine the lag length of the relationship among the five variables, VARs are fitted to the variables, with a constant term and three centered seasonal dummies as exogenous variables. Testing for a lag length up to eight quarters via a modified Tiao and Box (1981, p. 807) M-statistic, the result is a lag length of four quarters.[10] This implies three lagged first differences for cointegration analysis, or three lags for an unrestricted VAR in first differences.

Applying the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests for nonstationarity, a unit root unambiguously cannot be rejected for $\log(ER)$, $\log(PL)$, $\log(BN)$, and $\log(ME)$; but the tests conflict for $\log(PW)$.[11] Further testing leads to rejection of the existence of cointegration vectors, and therefore to estimation of a VAR in first differences—$\Delta \log(ER)$, $\Delta \log(PL)$, $\Delta\log(BN)$, $\Delta \log(PW)$, and $\Delta \log(ME)$ as endogenous variables, with a constant and three seasonals.[12] Granger causality testing is performed by re-estimating the VAR with the coefficients of the causal variable restricted to be zero in the equation for the affected variable and applying the system-wide likelihood ratio statistic (see, for example, Enders, 1995, p. 316). Results are shown in Table 1, which should be considered in conjunction with models (4), (5), and (6). Although Granger causality is not necessarily economic causality and although the variables are expressed in first differences, nevertheless the results are instructive.

Regarding bullionism, $BN \rightarrow PL$ is supported, but so is reverse causation (the antibullionist position). Rather than $PL \rightarrow ER$, the opposite is found (direct support for the antibullionist theory), though the roundabout causation $BN \rightarrow ER$ holds. Far from BN an autonomous variable, the $PL \rightarrow BN$ and $PW \rightarrow BN$ results justify the antibullionist real-bills doctrine. In sum, the bullionist position is subject to some serious contradictions. Regarding antibullionism, added to the positive results for BN are the impacts of PW, ME, and ER on PL. Only the negative findings for PW and ME on ER mar support for antibullionism. The modern bullionist model receives mixed results: $PW \rightarrow BN$ provides strong support, but $ME \rightarrow BN$ does not hold.

The ordering $\Delta \log(PW) \rightarrow \Delta \log(ME) \rightarrow \Delta \log(BN) \rightarrow \Delta \log(ER) \rightarrow \Delta \log(PL)$ is used for a Cholesky decomposition to orthogonalize the VAR residuals and obtain impulse response functions and variance decompositions of the variables. The ordering follows naturally from the Granger-causality results and methodological considerations. The only variable 'caused' by every other variable is $\Delta \log(PL)$; therefore it is last in the ordering. No variable 'causes' $\Delta \log(PW)$; so it is first. Both $\Delta \log(BN)$ and $\Delta \log(ER)$ cause $\Delta \log(PL)$, but $\Delta \log(BN)$ also causes $\Delta \log(ER)$; therefore $\Delta \log(BN)$ is third and $\Delta \log(ER)$ fourth. Methodologically, $\Delta \log(PW)$ and $\Delta \log(ME)$ are exogenous variables in the antibullionist and modern bullionist systems; therefore it is logical that $\Delta \log(ME)$ be second in the ordering. Fortunately, the correlations of the VAR residuals (Table 2) are so low that alternative orderings do not seriously affect the innovation accounting. The only exception is $\{\Delta \log(PW), \Delta \log(PL)\}$; but their ranks in the ordering are clearly determined by the Granger-causality results.

Impulse response functions for $\Delta \log(PL)$, $\Delta \log(ER)$, and $\Delta \log(BN)$ are graphed in Figures 1–3. The response (solid line), shown for 12 quarters, is to one standard deviation of the innovation and is bounded in each direction by two standard errors (dotted lines) of the response. Shocks in

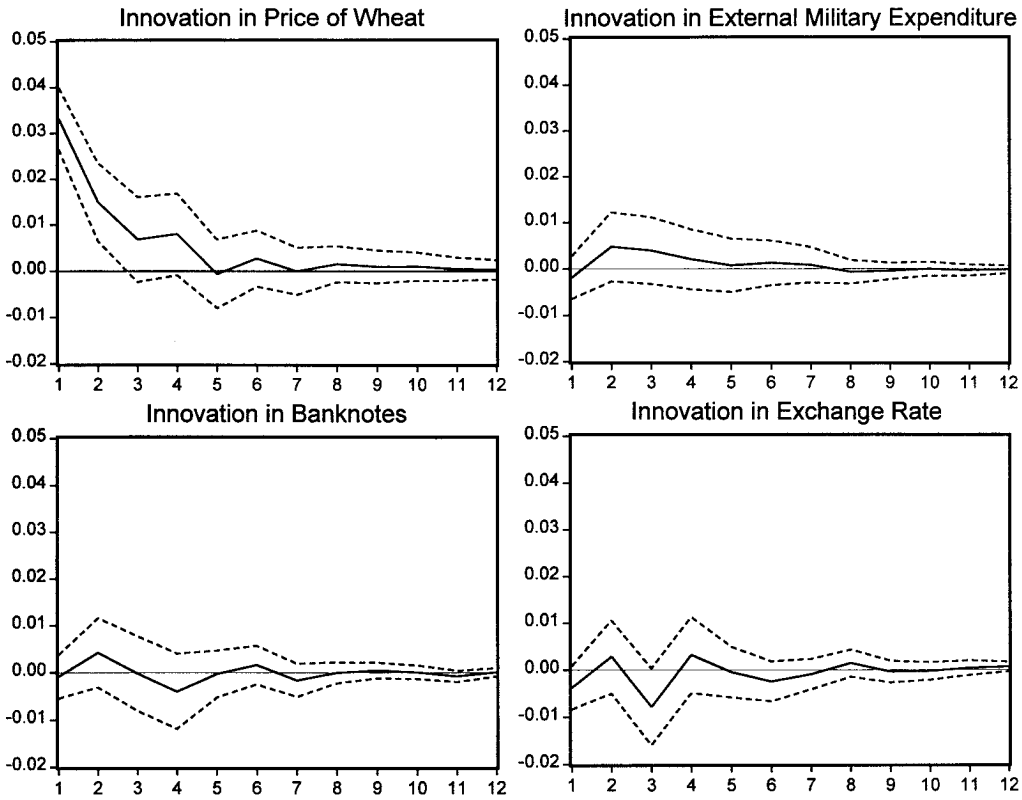

Figure 1. Impulse response functions of price level (first-differenced logarithms).

$\Delta \log(PW)$ and $\Delta \log(ME)$ increase $\Delta \log(PL)$, and the $\Delta \log(ER)$ innovation reduces it (with negative dominating positive multipliers through seven quarters), all in accordance with antibullionist theory. The $\Delta \log(BN)$ innovation initially increases $\Delta \log(PL)$, pleasing to the bullionists, but then decreases it by about the same magnitude.

All innovations have a negative effect on $\Delta \log(ER)$, that is, reduce the appreciation or increase the depreciation of the pound, which is consistent with both bullionist [for $\Delta \log(BN)$ and $\Delta \log(PL)$] and antibullionist theory [for $\Delta \log(PW)$ and $\Delta \log(ME)$]. However, the positive responses in some quarters make for relatively weaker bullionist support.

The impulse response functions of $\Delta \log(BN)$ are indicative of monetary policy. A shock in $\Delta \log(ME)$ lowers $\Delta \log(BN)$, suggesting that Bank of England private discounting is reduced to stabilize the monetary base (assuming the government expenditure is financed by the Bank of England); but it is not clear which side of the controversy is thereby enhanced. However, the modern bullionist position is not supported, because it would imply a positive rather than negative impact of $\Delta \log(ME)$ on $\Delta \log(BN)$. Innovations in $\Delta \log(PW)$ and $\Delta \log(PL)$ increase $\Delta \log(BN)$ (though the latter has an initial negative effect)—supporting the antibullionist real-bills theory of accommodating monetary policy, as well as modern bullionism. Further, an innovation in $\Delta \log(ER)$, which under an activist policy (the bullionist normative rule) would increase $\Delta \log(BN)$, has the opposite effect.

Especially relevant to the bullionist debate is the variance decomposition of the three variables (Table 3). That for $\Delta \log(PL)$ is devastating to the bullionist case: in every period the contribution of innovations in $\Delta \log(BN)$ is the smallest among the variables and is tiny relative to the summed contributions of the antibullionist variables [$\Delta \log(ER)$, $\Delta \log(PW)$, and $\Delta \log(ME)$]. The variance decomposition of $\Delta \log(ER)$ supports the bullionists; for

$\Delta \log(BN)$ makes the greatest contribution of innovations in the other variables and the sum contribution of innovations in bullionist variables [$\Delta \log(PL)$ and $\Delta \log(BN)$] exceeds that of antibullionist variables [$\Delta \log(PW)$ and $\Delta \log(ME)$] by about 45% in period 3, eventually settling to 25%. The variance decomposition of $\Delta \log(BN)$ supports the antibullionists—and, to some extent, modern bullionism—with $\Delta \log(PL)$ and $\Delta \log(PW)$ the most important other innovations. The antibullionist direction of causation $PL \rightarrow BN$ is confirmed.

CONCLUDING COMMENTS

Existing empirical investigations of the bullionist experience provide mixed results for the bullionist position but uniform fundamental support for the antibullionist side. Working from general models of each side of the debate, and using multivariate time-series analysis and superior data (see Appendix A), the findings of this paper are less extreme for the antibullionist model. However, the evidence remains preponderantly in favor of the antibullionist position. There is also support for a 'modern bullionist model', similar to the antibullionist system in the endogenous quality of the monetary base (BN). The support might be stronger given better data availability; but this would also enhance the evidence in favor of the antibullionist model. The dichotomy between bullionism and antibullionism is reduced if contemporary bullionism is replaced with modern bullionism.

The importance of the bullionist debate is shown by its recurrence throughout monetary history when a paper currency and floating exchange rate interrupt or replace a metallic standard: Sweden in 1745–1777, France in 1788–1797, Ireland along with England in 1797–1821, and European countries after World War I.

Monetarism sees its origin in the bullionist model; and the antibullionist approach to the exchange rate (a flow theory) and monetary policy

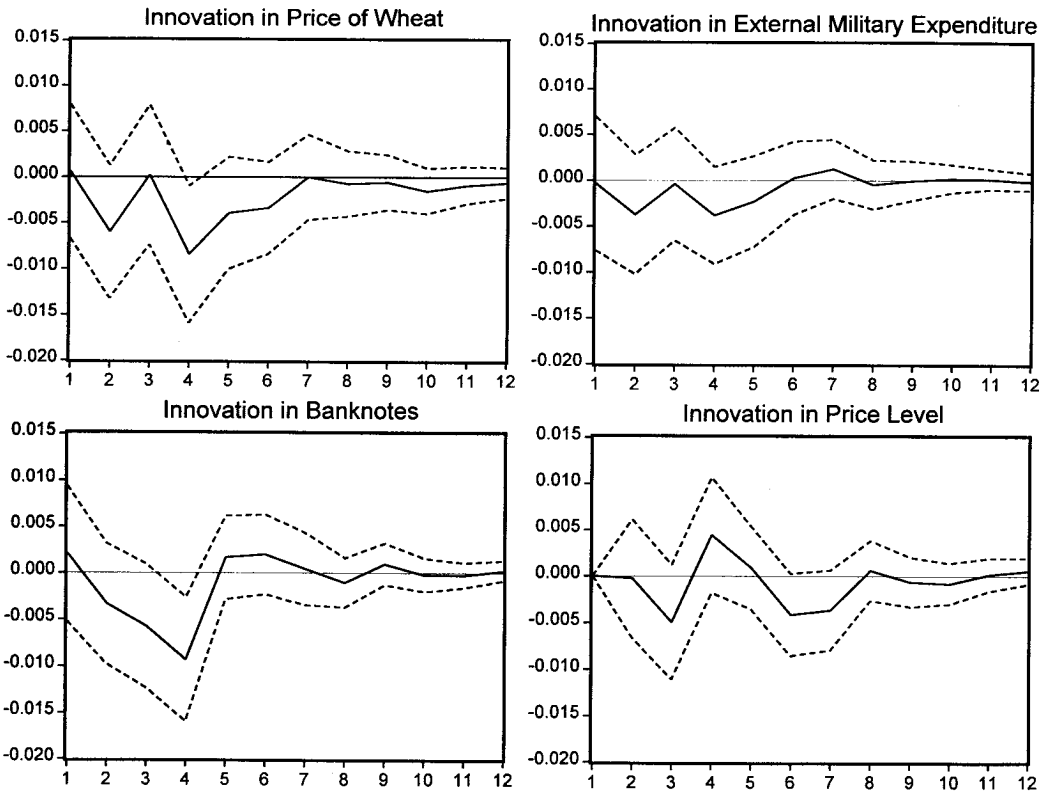

Figure 2. Impulse response functions of exchange rate (first-differenced logarithms).

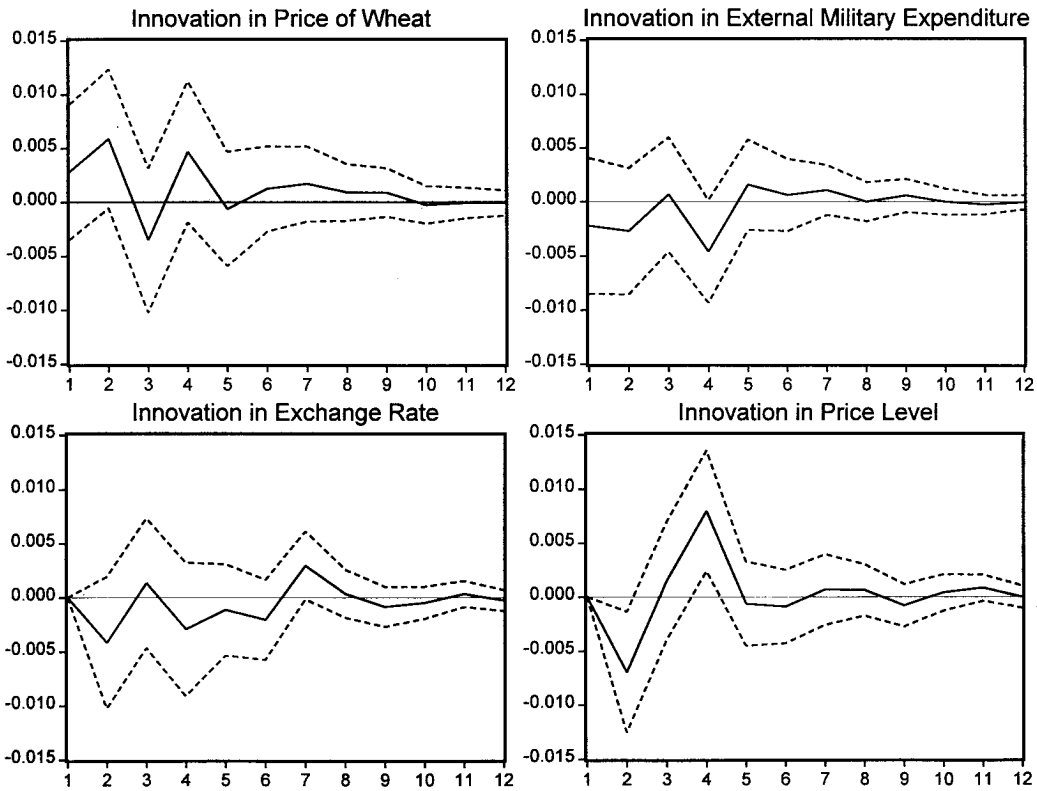

Figure 3. Impulse response functions of banknotes (first-differenced logarithms).

(passive, and accommodating to the price level) has gone out of fashion. It may be humbling to the macroeconomist that these theoretical developments are contravened by the preponderance of empirical results for the Bank Restriction Period.

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APPENDIX A

Exchange Rate (*ER*)

The exchange rate on Hamburg, the leading financial center of Europe during the Napoleonic Wars, is the only continuous London exchange rate series (apart from Lisbon, of lesser importance in trade and finance and of lower interest because also subject to a paper standard and floating rate). The exchange market instrument was the bill of exchange drawn on Hamburg and traded in London. The bill was denominated in schillings and grotes, Flemish banco. The 'Flemish' (vlamische, 'vls.') designation pertains to the Hamburg unit of account (1 pfund = 20 schilings-vls. = 240 grotes) that emanated from Antwerp. 'Banco' refers to 'bank money', transferable deposits at the Bank of Hamburg payable in silver bullion at a constant value, as distinct from various coined money that floated in value with respect to banco.[13] The schilling–pound exchange rate was given by the bill's schilling face value/pound market price ratio.

ER is taken from weekly tabulations in *Resumption Report (1819*, pp. 336–354) for 1797–1818 and *Bank Charter Report (1832*, pp. 98–100) for 1819–1821. The data are converted to schillings per pound and averaged quarterly; so generally there are 13 equally spaced underlying observations per quarter.[14]

Table 3. Variance decomposition of variables (%)

	$\Delta \log(PL)$	$\Delta \log(ER)$	$\Delta \log(BN)$	$\Delta \log(ME)$	$\Delta \log(PW)$
$\Delta \log(PL)$					
1	29.46	0.90	0.05	0.23	69.37
2	25.26	1.18	0.98	1.40	71.18
3	23.69	4.21	0.93	2.06	69.10
4	23.30	4.46	1.64	2.14	68.45
8	23.98	4.77	1.85	2.23	67.17
∞	23.97	4.80	1.89	2.25	67.09
$\Delta \log(ER)$					
1	0	99.61	0.35	0.01	0.03
2	0.01	94.87	1.20	1.10	2.82
3	1.80	90.89	3.58	1.05	2.68
4	2.83	79.71	8.70	1.86	6.91
8	4.58	76.42	8.65	2.18	8.17
∞	4.65	76.13	8.68	2.18	8.36
$\Delta \log(BN)$					
1	0	0	98.60	0.53	0.86
2	4.71	1.69	88.25	1.20	4.14
3	4.82	1.82	86.91	1.21	5.24
4	9.68	2.35	78.58	2.88	6.51
8	9.62	3.48	76.94	3.14	6.81
∞	9.72	3.57	76.69	3.16	6.86

Rows may not sum to 100.00, due to rounding.

Price Level (*PL*)

The GRS (1953, vol. 1, p. 468) monthly index number of the price of domestic and imported commodities is rebased to 1796 = 100 and averaged quarterly to obtain PL.[15]

Banknotes (*BN*)

A quarterly series for *BN*, in millions of pounds, is obtained as the average of weekly values, from *Bank Charter Report (1832*, pp. 74–75).[16]

Price of Wheat (*PW*)

A quarterly series is taken from Morgan (1943, p. 36) and rebased to 1796 = 100.

External Military Expenditure (*ME*)

Silberling's (1924, p. 227) annual *ME* series is the sum of (1) government expenditure on British armies in Europe and (2) government remittances abroad (subsidies, loans, and payments to foreign states and diplomatic agents). No one has attempted to improve Silberling's first component series; but the second has been superseded by the compilation of Sherwig (1969, pp. 365–368). This paper makes improvements to the Sherwig data.[17] The resulting series, expressed in millions of pounds, replaces (2) in Silberling's ME series. Log–linear interpolation is used to convert the series to quarterly frequency.[18]

Military expenditure abroad is so fundamental a driving force in the antibullionist model that the variable is included in synthetic quarterly form. The underlying assumption is that the known annual expenditures enter the quarterly balance of payments in an exponentially smooth fashion (consistent with transforming all variables into logarithms for empirical testing).

NOTES

1. See Clapham (1945, pp. 8–9, 50), Feavearyear (1963, p. 215), and Officer (1996, p. 39).
2. Excellent histories of the Bank Restriction Period are Acworth (1925, pp. 69–114), Canaan (1925, pp. vii–xxxiv), Viner (1937, pp. 122–124, 171–174), Morgan (1943, pp. 23–48), Clapham (1945, pp. 1–74), Hawtrey (1950, pp. 268–292), Gayer *et al.* (1953, vol. 1, pp. 47–53, 76–81, 103–107, 131–135, 159–165)

[GRS], Feavearyear (1963, pp. 173–224), and Deane (1979, pp. 183–194).

3. Useful surveys are Angell (1926, pp. 40–65), Viner (1937, pp. 119–160), Fetter (1965, pp. 26–54), Einzig (1970, pp. 202–207, 225–226), and Perlman (1986). The prominent bullionists were Walter Boyd, Francis Horner, William Huskisson, Peter King, Thomas Malthus, David Ricardo, Henry Thornton, and John Wheatley; while the leading antibullionists were Henry Boase, Charles Bosanquet, John Herries, George Rose, Thomas Smith, Coutts Trotter, and Nicholas Vansittart. Rare is the post-Restriction author, such as Acworth (1925, pp. 70–105), who supports the bullionist position; but many later writers follow the antibullionist line, for example: Tooke (1838, pp. 36–41, 156–170), Morgan (1943, p. 47), Clapham (1945, pp. 10–69), GRS (1953, vol. 1, pp. 59–163), and Deane (1979, p. 194). Some historians take an eclectic view, combining the bullionist and antibullionist positions: Pressnell (1956, pp. 448–449, 463–466), Feavearyear (1963, pp. 191–223), Einzig (1970, pp. 188–190, 225–226), Duffy (1982), and Vilar (1991, pp. 311–313).
4. In his estimates of M1, Cameron (1967, pp. 42–45) includes only 1/4 of total deposits in 1800–1801, 3/7 in 1811, and 5/7 in 1821; the remainder deemed to enter *M*2. The proportions should be even less, to eliminate interbank deposits. Britain's monetary system in the Bank Restriction Period is discussed in Morgan (1943, pp. 2–17), Fetter (1965), Coppieters (1955, pp. 28–55), Pressnell (1956, pp. 136–180, 190–207), and Cameron (1967, pp. 18–27, 49–51, 67–72).
5. On the usury laws and the market interest rate, see Tooke (1838, p. 159), King (1936, pp. 12, 27–29), Morgan (1943, p. 43), Clapham (1945, pp. 15, 61–62), Ashton (1959, p. 175), Homer and Sylla (1991, pp. 157, 163–164, 187, 205–206), and Duffy (1982, p. 79).
6. For the mainstream view, see Tooke (1838, p. 159), Morgan (1943, p. 47), Clapham (1945, p. 15), and Deane (1979, pp. 193–194). The contrary view is presented by Acworth (1925, pp. 145–46) and Duffy (1982).
7. Nachane–Hatekar are alone in measuring the money supply in ratio to output, which is antithetical to the literature. They measure output by the much-discredited Hoffman index of industrial production.
8. BP is proxied by the balance of trade; but there are two problems. First, the observation for 1813 is lacking, because of the records destroyed in the London Customs House fire of 1814. Second, the BP variable that fundamentally moves the exchange rate surely includes also services, income flows, transfer payments, and long-term capital movements. Only Morgan extends the *BP* proxy, by including Silberling's series on government remittances abroad (see Appendix A). It is arguable that the balance of trade is too limited a measure and that it is better to exclude the *BP* variable, a position taken in this paper.
9. Existing empirical investigations of the bullionist controversy are bivariate in nature; and, of the researchers, only Nachane–Hatekar use modern time-series analysis. They employ unit-root and cointegration tests, and then apply weak-exogenity and Granger-causality testing separately to the cointegrated and noncointegrated cases. However, their testing remains bivariate. Also, their *BP* variable is excluded from cointegration analysis, because it is found to be $I(0)$, whereas the other variables are $I(1)$. This is an outcome of bivariate modeling. Another consequence is the failure to perform innovation accounting.
10. The correction term 1/2 is removed from the *M*-statistic, to accord with the generally accepted measurement of the likelihood ratio. VARs are estimated for lag lengths 0–8 quarters for the sample 2Q 1799–1Q 1821. The *M*-statistic is nonsignificant for lag lengths 5–8 but significant at the 1% level for lag length 4. The VARs are refitted for lag lengths 0–4 for 2Q 1798–1Q 1821, with the same result for lag length 4.
11. Based on graphs of the variables, a constant is always included, and a trend is alternatively included and excluded for log(*BN*). Lag lengths 4, 8, 12 are applied to the ADF test and a truncation lag of 3 (from the Newey–West correction) for the *PP* test. Under a 5% level of significance, the PP test cannot reject a unit root for log(*PW*), while the ADF test rejects for lags 4 and 8 but not for lag 12.
12. With intercepts in the cointegrating equations and a 5% level of significance, the Johansen λ-trace test indicates two cointegrating vectors (CVs) but the λ-max test none. Estimating a VEC model, each CV exhibits a correlogram with substantial low-order autocorrelation and the *Q* test for white noise fails miserably. Similarly, in bivariate testing of four cases, Nachane–Hatekar find only one cointegration relationship. One can surmise that the upheavals of war and industrial revolution inhibited a long-term equilibrium relationship among nonstationary variables.
13. Information on the Hamburg monetary standard is in *Bullion Report (1810*, pp. 65, 73–75), Kelly (1811, 1821), Waterston (1847, p. 357), and McCusker (1978, pp. 62–63).
14. Silberling (1924, p. 231) regards the price of Spanish silver dollars in the London market 'as the most trustworthy single index, not only of the price of specie, but of the general drift of foreign exchange movements'. However, this statement is unacceptable, because (1) Britain was on a suspended gold, not silver, standard; and (2) the Spanish dollar was not equivalent to bank money and indeed was not even a circulating coin in Hamburg. Nachane–Hatekar use the exchange rate on Paris to represent *ER*. Their choice is unfortunate, because (1) there are no quotations on Paris during the Bank Restriction Period until April 1802, wherefore Nachane–Hatekar lose 5 years of good observation; (2) the

exchange on Paris was not representative during wartime, especially during Napoleon's Continental System (1806–1812); (3) the Nachane–Hatekar data source (Tooke and Newmarch's *History of Prices*) has only two daily observations per year—a poor underlay of an annual series of a floating exchange rate.

15. Incomprehensibly, Nachane–Hatekar use Silberling's (1923, pp. 223–233) obsolete price index, which has serious limitations, documented by GRS (1953, vol. 1, pp. 463–483).
16. Nachane–Hatekar use *BN* plus deposits at the Bank of England (*DB*), representing the money supply (*MS*). The evidence is that a superior proxy would be *BN* itself. First, only deposits of the non-bank public constituted part of *M*1, and they were a small part of the total during the Bank Restriction Period. Annual data for 1807–1821 (*Bank Charter Report, 1832*, pp. 35, 41) show that government deposits alone composed 72–89% of deposits at the Bank, and there were also London-private-bank deposits. Second, the money-supply estimates of Cameron (1967, pp. 42–46) made for three dates during the Bank Restriction Period show that $M1/(BN+DB)$ is a more-variable ratio than $M1/BN$, with a coefficient of variation of 8.36 versus 3.23. Also, Nachane–Hatekar use data that are annual averages of only two daily observations.
17. Sherwig places all subsidies to Sicily between 1804 and 1807 in the final year; instead, they are allocated equally to the four years. He excludes loans to the House of Orange and French Bourbons in 1813–1814 (see Clapham, 1917, p. 98; Silberling, 1924, p. 225); these loans are included here. He omits the Russian–Dutch loan contracted in 1815; the payment was an annual flow, included in 1816–1822 (see *Account, 1854*, p. 470; *Return, 1900*, p. 260; Clapham, 1917, pp. 499–500). For the purpose of quarterly interpolation, the annual series is obtained for 1796–1822.
18. The annual series, A_t, is transformed to $\log A_t/4$, $t=1796,\ldots,1822$. Then, centering the annual value in midyear, quarterly values are mid-quarter. Thus (1/8, 3/8) of the first-differenced series is *added* to the preceding year's value to obtain that year's (third, fourth) quarter and *subtracted* from the current year's value to yield this year's (second, first) quarter, with the resulting quarterly series denoted as B_{it}, $i=1,\ldots,4$. To obtain a quarterly series consistent with the log-linear interpolation process and summing annually to A_t, an annual series $k(t)$ is constructed by solving the following equation for $K(t)$: $\Sigma \exp(B_{it})^{K(t)} = A(t)$. The quarterly variable corresponding to *ME* is $\exp(B_{it})^{k(t)}$; its logarithm, corresponding to $\log(ME)$, is $k(t)B_{it}$. A listing of *ME* and the other variables is available from the author.

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