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In This Issue . . .

In the first article in this *Review*, "International Banking Facilities," K. Alec Chrystal gives a brief outline of the regulatory changes that permitted banking institutions in the United States to establish international banking facilities (IBFs) and conduct international banking business on terms similar to offshore financial centers.

Chrystal describes the location and growth of IBFs and details the extent to which business has been shifted from other accounts and other locations. In addition, he explains the nature of IBF business as an integral part of the eurodollar market. Chrystal concludes that, apart from a change in geographical location, the significance of IBFs in international banking is small.

In the second article, "A Private Central Bank: Some Olde English Lessons," G. J. Santoni investigates the proposition that central bankers respond systematically and predictably when faced with different incentives relating to monetary control.

The author focuses on the actions of the Bank of England from 1694 to 1930. The Bank of England provides both an interesting and an apt case study for two reasons. First, in contrast to modern central banks, England's central bank was a privately-owned, for-profit institution from its founding in 1694 until the early 1930s. Further, the bank was structured such that the wealth of the Bank's owners was inversely related to the rate of inflation. Second, the government seized the monetary control function from the private owners of the bank from 1793 to 1821. This period is important because it demonstrates clearly how different incentives produce different policy consequences, holding other important institutional factors roughly constant.

Santoni concludes that the incentives confronting England's *private* central bankers led them to choose relatively low rates of monetary growth and inflation; in contrast, the government chose significantly faster rates of monetary growth and inflation when it controlled the Bank of England.

In the third article, "Money Growth Variability and GNP," Michael T. Belongia explains the sequence of events through which short-run fluctuations in M1 growth make future economic conditions more uncertain and, thus, cause reductions in the growth of GNP.

Belongia investigates the impact of variable money growth on GNP by estimating a variant of the St. Louis equation that incorporates directly a measure of the variability of money growth. He finds that the effects of variable M1 growth were negative, but transitory in nature, prior to 1980. Since 1980, however, the variability of M1 growth has tripled, and its negative effects on the path of GNP have become permanent. In a simulation experiment, the author shows that the growth of nominal GNP would have been higher and more stable between 1979 and 1982 if M1 growth had been less variable over that period.

International Banking Facilities

K. Alec Chrystal

INTERNATIONAL Banking Facilities (IBFs) started operation in the United States in early December 1981. Since then, they have grown to the point where they now represent a significant part of the international banking business worldwide. The purpose of this article is to examine IBFs and to discuss their significance for international banking.

OFFSHORE BANKING

A substantial "offshore" international banking sector, often called the "eurocurrency" market, grew up in the 1960s and 1970s. Its key characteristic is that banking business is transacted in a location outside the country in whose currency the business is denominated. Thus, eurodollar transactions are conducted outside the United States, eurosterling transactions are conducted outside Britain, and so on. Much of this offshore business occurs in major financial centers like London, though some business is literally in islands offshore from the United States, such as the Bahamas or Cayman Islands.

Offshore banking business is somewhat different from that conducted onshore. Though, in both cases, banks take deposits and make loans, offshore banks have virtually no checking deposit liabilities. Instead, their deposits are typically made for specific periods of time, yield interest, and are generally in large denominations.

Offshore banking arose as a means to avoid a variety of banking regulations. For example, offshore banks that deal in eurodollars avoid reserve requirements on deposits, FDIC assessments and U.S.-imposed interest rate ceilings. The first two of these regulations increase the margin between deposit and loan rates. Avoiding these costs enables offshore banks to operate on much smaller margins. Interest ceilings, where binding, reduce the ability of banks subject to such ceilings to compete internationally for deposits.

Many "shell" bank branches in offshore centers, such as the Caymans and Bahamas, exist almost solely to avoid U.S. banking regulations. Shell branches are offices that have little more than a name plate and a telephone. They are used simply as addresses for booking transactions set up by U.S. banks, which thereby avoid domestic monetary regulations.

IBFs: ONSHORE OFFSHORE BANKS

IBFs do not represent new *physical* banking facilities; instead, they are separate sets of books within existing banking institutions — a U.S.-chartered depository institution, a U.S. branch or agency of a foreign bank, or a U.S. office of an Edge Act corporation.[1] They can only take deposits from and make loans to nonresidents of the United States, other IBFs and their establishing entities. Moreover, IBFs are not subject to the regulations that apply to domestic banking activity; they avoid reserve requirements, interest rate ceilings and deposit insurance assessment. In effect, they are accorded the advantages of many offshore banking centers without the need to be physically offshore.

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[1] As a result of a 1919 amendment to the Federal Reserve Act initiated by Sen. Walter Edge, U.S. banks are able to establish branches outside their home state. These branches must be involved only in business abroad or the finance of foreign trade. The 1978 International Banking Act allowed foreign banks to open Edge Act corporations which accept deposits and make loans directly related to international transactions.

The Establishment of IBFs

Three regulatory or legislative changes have permitted or encouraged the establishment and growth of IBFs. First, the Federal Reserve Board changed its regulations in 1981 to permit the establishment of IBFs. Second, federal legislation enacted in late 1981 exempted IBFs from the insurance coverage and assessments imposed by the FDIC. Third, several states have granted special tax status to the operating profits from IBFs or altered other restrictions to encourage their establishment. In at least one case, Florida, IBFs are entirely exempt from local taxes.

Restrictions on IBF Activities

While IBFs may transact banking business with U.S. nonresidents on more or less the same terms as banks located offshore, they may not deal with U.S. residents at all, apart from their parent institution or other IBFs. Funds borrowed by a parent from its own IBF are subject to eurocurrency reserve requirements just as funds borrowed from an offshore branch would be.

Four other restrictions on IBFs are designed to ensure their separation from domestic money markets. First, the initial maturity of deposits taken from nonbank foreign customers must be at least two working days. Overnight deposits, however, may be offered to overseas banks, other IBFs and the parent bank. This restriction ensures that IBFs do not create a close substitute for checking accounts.

Second, the minimum transaction with an IBF by a nonbank customer is $100,000, except to withdraw interest or close an account. This effectively limits the activity of IBFs to the "wholesale" money market, in which the customers are likely to be governments, major corporations or other international banks.[2] There is no restriction on the size of interbank transactions.

Third, IBFs are not permitted to issue negotiable instruments, such as certificates of deposit (CDs), because such instruments would be easily marketable in U.S. money markets, thereby breaking down the intended separation between IBFs and the domestic money market.

Finally, deposits and loans of IBFs must not be related to a nonresident customer's activities in the United States.[3] This regulation prevents IBFs from competing directly with domestic credit sources for finance related to domestic economic activity.

Where Are IBFs Located?

IBFs are chiefly located in the major financial centers (see table 1). Almost half of the nearly 500 IBFs are in New York; California, Florida and Illinois have the bulk of the rest. In terms of value of liabilities, however, the distribution is even more skewed. Of IBFs reporting monthly to the Federal Reserve (those with assets or liabilities in excess of $300 million), 77 percent of total liabilities were in New York, with California (12 percent) and Illinois (7.5 percent) a long way behind. It is notable that Florida, which has 16.5 percent of the IBFs, has only 2 percent of the liabilities of reporting banks.

While the distribution of IBFs primarily reflects the preexisting locations of international banking business, differences in tax treatment between states may have influenced the location of IBFs marginally. For example, the fact that Florida exempts IBFs from state taxes may well explain why it has the largest number of Edge Act corporation IBFs and ranks second to New York in terms of numbers of IBFs set up by U.S.-chartered banks.

Although Florida has the most advantageous tax laws possible for IBFs, it is not alone in granting them favorable tax status. Nine other states (New York, California, Illinois, Connecticut, Delaware, Maryland, Georgia, North Carolina and Washington) and the District of Columbia have enacted special tax laws that encourage the establishment of IBFs.[4]

The reason for the favorable tax treatment for IBFs in states like Florida is not clear. There is no doubt that Florida has tried to encourage its development as an international financial center.[5] The benefits from encouragement of IBFs per se, however, are hard to see. For example, the employment gains are probably trivial. Since IBFs are merely new accounts in existing institutions, each IBF will involve *at most* the employment of a handful of people. In many cases, there may be no extra employment.

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[2]Foreign governments are treated like overseas banks for purposes of maturity and transaction size regulations.

[3]"The Board expects that, with respect to nonbank customers located outside the United States, IBFs will accept only deposits that support the customer's operations outside the United States and will extend credit only to finance the customer's non-U.S. operations." See "Announcements" (1981), p. 562.

[4]These provisions vary from case to case. For a summary of the position in New York and California, see Key (1982).

[5]See "Florida's Baffling Unitary Tax" (1983).

Table 1
Location of International Banking Facilities

	Total IBFs	U.S.-chartered banks[1]	Agencies and branches of foreign banks	Edge Act corporations	Liabilities of Monthly Reporting IBFs, Other than to Parent Entity: Amount (billions of dollars)	Percent of total reported	Number of banks reporting
TOTAL	477	144	264	69	$173.43		
New York	208	38	154	16	133.8	77%	90
California	84	16	57	11	20.1	12	27
Florida	79	27	29	27	3.3	2	8
Illinois	30	6	17	7	13.1	7.5	11
Texas	20	14	0	6			
District of Columbia	11	8	3	0			
Pennsylvania	9	7	2	0			
Washington	7	3	4	0			
Georgia	6	4	1	1			
Massachusetts	5	3	1	1	3.1	1.8	10
New Jersey	4	4	0	0	(There are too few reporting banks in other states for a data breakdown to be made available.)		
Ohio	4	4	0	0			
Connecticut	2	2	0	0			
Kentucky	2	2	0	0			
Michigan	2	2	0	0			
N. Carolina	2	2	0	0			
Rhode Island	1	1	0	0			
Virginia	1	1	0	0			

NOTE: Figures for numbers of IBFs are as of September 28, 1983. Figures for liabilities are as of October 26, 1983. Monthly reporting banks are those with assets or liabilities of at least $300 million. SOURCE: Federal Reserve Board Release G.14(518)A and Federal Reserve Board unpublished data.

[1]One savings and loan association has an IBF that is in the Florida figure.

What Do IBFs Do?

The assets and liabilities of IBFs on December 30, 1981, December 29, 1982, and October 20, 1983, are recorded in table 2; as of October 20, 1983, over 98 percent of their liabilities were dollar-denominated.

The December 30, 1981, figures largely reflect business switched from other accounts either in the parent bank or an offshore branch. Operations of the IBFs themselves are reflected more clearly in the later figures. Consider the latest available figures in the third column of table 2. The most important aspects of these figures is the proportion of business with other banks vs. the proportion with nonbank customers. On the asset side, about one-sixth of total assets are "commercial and industrial loans" (Item 5a) and one-ninth are loans to "foreign governments and official institutions" (Item 5c). The remainder, over 70 percent, are claims on either other IBFs, overseas banks or an overseas branch of the parent bank. Claims on overseas banks (Items 3a and 5b) are largest, while claims on other IBFs (Item 2) and overseas offices of the parent bank (Item 1) are of broadly similar magnitude.

The liability structure is even more heavily weighted toward banks. Only about 16 percent of the liabilities of IBFs (as of October 26, 1983) were due to nonbanks. Of these, one-third was due to "foreign government and official institutions" (Item 10c) and two-thirds were due to "other non-U.S. addressees" (Item 10d). The latter are mainly industrial and commercial firms.

The high proportion of both assets and liabilities of IBFs due to other banking institutions reinforces the conclusion that they are an integral part of the eurodollar market. A high proportion of interbank business is characteristic of eurocurrency business in which

Table 2

Assets and Liabilities of International Banking Facilities (millions of dollars)

	December 30, 1981	December 29, 1982	October 26, 1983
ASSETS			
1. Gross Claims on Non-U.S. Offices of Establishing Entity	$7,188	$20,125	$30,322
(1) Denominated in U.S. Dollars	6,785	19,150	29,204
(2) Denominated in Other Currencies	403	975	1,118
2. Loans and Balances Due From Other IBFs	903	16,577	26,256
3. Gross Due From:			
A. Banks in Foreign Countries	8,470	26,666	29,093
B. Foreign Governments and Official Institutions	12	276	482
4. Securities of Non-U.S. Addressees	438	1,130	1,875
5. Loans To Non-U.S. Addressees			
A. Commercial and Industrial Loans	17,081	32,808	36,753
B. Banks in Foreign Countries	11,705	30,300	32,237
C. Foreign Governments and Official Institutions	7,791	16,960	22,348
D. Other Loans	1,164	1,070	958
6. All Other Assets in IBF Accounts	880	3,839	3,262
7. Total Assets Other Than Claims on U.S. and Non-U.S. Office of Establishing Entity	49,409	132,569	156,484
(1) Denominated in U.S. Dollars (Sum of Items 2 through 6)	48,445	129,626	153,264
(2) Denominated in Other Currencies	965	2,943	3,219
8. Total Assets Other Than Claims on U.S. Offices of Establishing Entity (Sum of Items 1 and 7)	56,597	152,694	186,806
(1) Denominated in U.S. Dollars	55,229	168,776	182,469
(2) Denominated in Other Currencies	1,368	3,917	4,337
LIABILITIES			
9. Gross Liabilities Due To Non-U.S. Offices of Establishing Entity	$29,091	$56,372	$69,756
(1) Denominated in U.S. Dollars	28,779	55,114	68,535
(2) Denominated in Other Currencies	313	1,258	1,221
10. Liabilities Due To:			
A. Other IBFs	1,009	17,382	28,803
B. Banks In Foreign Countries	10,127	37,045	42,446
C. Foreign Government and Official Institutions	2,834	7,439	9,115
D. Other Non-U.S. Addressees	952	13,816	19,073
E. All Other Liabilities in IBF Accounts	336	2,756	2,170
F. Total Liabilities Other Than Due To U.S. and Non-U.S. Offices of Establishing Entity	15,686	80,080	103,674
(1) Denominated in U.S. Dollars (Sum of Items 10.A Through 10.E)	15,258	78,439	101,608
(2) Denominated in Other Currencies	428	1,641	2,066
11. Total Liabilities Other Than Due to U.S. Offices of Establishing Entity (Sum of Items 9 and 10.F)	44,777	136,452	173,430
(1) Denominated in U.S. Dollars	44,037	133,552	170,143
(2) Denominated in Other Currencies	741	2,899	3,257
RESIDUAL			
12. Net Due From (+) / Net Due To (−) U.S. Offices of Establishing Entity (Item 11 Minus Item 8)	$−11,820	$−16,242	$−13,376
(1) Denominated in U.S. Dollars	−11,193	−15,224	−12,325
(2) Denominated in Other Currencies	−627	−1,018	−1,051
Number of Reporters	56	122	146

NOTE: Unless otherwise noted, figures include only amounts denominated in U.S. dollars. This report contains data only for those entities whose IBF assets or liabilities are at least $300 million, that is, for those entities that file a monthly report of IBF accounts on form FR 2072. SOURCE: Federal Reserve Board Release G.14 (518).

there may be several interbank transactions between ultimate borrowers and ultimate lenders.[6]

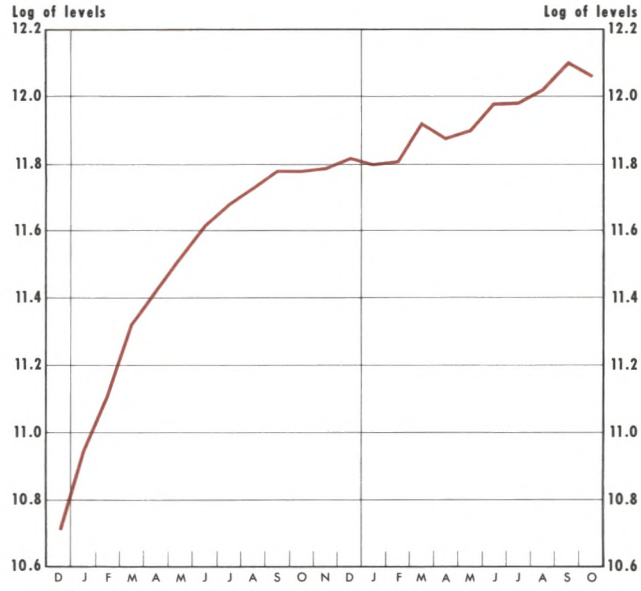
An important role for interbank transactions is to provide "swaps" that reduce either exchange risk or interest rate risk for the parties involved. Suppose, for example, an IBF has a deposit (liability) of $1 million that will be withdrawn in one month, and it has made a loan (asset) to a customer of $1 million that will be repaid in two months. There is a risk that when the IBF comes to borrow $1 million to cover the second month of the loan, interest rates will have risen, and it will incur a loss on the entire transaction. If, however, this IBF can find a bank that has the opposite timing problem (a deposit of $1 million for 2 months and a loan of $1 million outstanding for one month), the two banks could arrange a swap. The second bank would loan the IBF $1 million in one month and get it back in two months (with suitable interest). The interest rate involved will be agreed on *at the beginning*, so that neither bank would suffer if interest rates should change in the second month.

These swap arrangements enable banks to match the maturity structure of their assets and liabilities. The existence of such swaps explains the high levels of both borrowing and lending between IBFs and overseas branches of their parent bank.[7]

THE GROWTH OF IBFs

Chart 1 shows the growth of total IBF liabilities since the end of 1981. Although the most rapid growth occurred in the first six months of their operation, IBFs have grown considerably over a period in which international banking business in general has been stagnant.[8] Within two years, they have come to be a significant part of the international money market. The liabilities of IBFs as of October 1983 (other than to parent banks) represent about 8½ percent of gross eurocurrency liabilities (as measured by Morgan Guaranty) or about 7½ percent of total international banking liabilities (as measured by the Bank for International Settlements. This includes onshore bank lending).

Chart 1
Total Liabilities of IBFs



NOTE: Liability levels were $44,777 million on December 30, 1981, and $173,430 million on October 26, 1983. Figures exclude liabilities to parent entity.

Where did this growth come from? Has the creation of IBFs generated a large volume of new business or has business been shifted from elsewhere? The evidence is that IBF business has almost entirely been shifted from elsewhere. Terrell and Mills use regression analysis to test the hypothesis that the creation of IBFs has led to greater growth of external bank assets.[9] This hypothesis is decisively rejected.

Some evidence concerning the origins of business shifted to IBFs is available in Key.[10] It is convenient to consider separately shifts from existing institutions in the U.S. and shifts from overseas banking centers.

Shifts from Banks in the United States

Up until January 27, 1982, about $34 billion of claims on overseas residents were shifted to IBF books from other U.S. banking institutions. The bulk of this (85 percent) came from U.S. branches of foreign banks — especially Japanese and Italian. Foreign banks typically would have had a higher proportion of assets eligible for shifting to IBFs, while Japanese and Italian banks generally had not established shell branches in Caribbean offshore centers.

[6]See Niehans and Hewson (1976) for an explanation of the intermediary function of euromarkets. The interbank market is also discussed in Dufey and Giddy (1978), chapter 5.

[7]For a discussion of the role of swaps in foreign exchange markets, see Chrystal (1984).

[8]According to B.I.S. figures, international bank assets grew 8.8 percent in 1982 in nominal terms. This compares with figures typically in excess of 20 percent throughout the 1970s. The combined assets of overseas branches of U.S. banks declined by 0.6 percent in 1982 [see Press Release (1983)], though this partly reflects the growth of IBFs.

[9]See Terrell and Mills (1983).

[10]See Key (1982).

In the same period, shifts of liabilities (due to parties other than overseas branches of the parent bank) from books of parent entities were much smaller. These amounted to about $6 billion, of which 90 percent came from branches of foreign banks. The small shift of liabilities relative to assets was affected by several factors: the negotiable nature of some deposits (CDs); the existence of penalties for renegotiations before maturity; the delay in passing New York tax relief for IBFs until March 1981; the small proportions of short-term deposits unrelated to trade with the United States; and the availability of accounts with similar returns yet fewer restrictions as to maturity and denomination (such as repurchase agreements).

If only the domestic books of U.S.-chartered banks are considered, the shift to IBFs is extremely small. Key reports a shift of $4.3 billion (through January 27, 1982) of claims on unrelated foreigners and only $0.1 billion of liabilities to unrelated foreigners. An alternative figure for claims shifted to IBFs is obtainable by looking at the change in commercial and industrial loans to non-U.S. addressees plus loans to foreign banks (*Federal Reserve Bulletin*, table A18, for large weekly reporting banks with assets of $750 million or more). This indicates a decline of $3.3 billion in the same period.

Shifts from Other Offshore Centers

Whereas foreign banks were mainly responsible for shifts to IBFs from banks located in the United States, banks chartered in the United States were mainly responsible for shifts of business from offshore centers and other overseas banking locations. Key estimates that U.S.-chartered banks shifted about $25 billion in claims on unrelated foreigners and about $6 billion in liabilities due to unrelated foreigners (through January 27, 1982) to IBFs from overseas branches. The comparable figures for foreign banks were $5½ billion and $9 billion, respectively.

This difference in the propensity to shift assets to IBFs is probably explained by the differential tax incentives of U.S. and foreign banks. U.S. banks pay taxes on worldwide income and may benefit from tax advantages of IBFs. Foreign banks may increase their tax liability to the United States by establishing an IBF instead of operating in an offshore center.

The bulk of business shifted by U.S. banks from their overseas branches has come from the Bahamas and Cayman Islands (collectively called Caribbean). In the first two months of operation of IBFs (11/30/81–1/29/82), liabilities to unrelated foreigners of branches of U.S. banks located there fell by $6.8 billion, while claims on unrelated foreigners fell by $23.3 billion. Much of this shift reflected the redundancy of shell branches, at least for business with non-U.S. residents, once IBFs were permitted.

While much of the *raison d'être* of Caribbean branches for business with foreigners has been removed by the establishment of IBFs, these branches continue to be important for business with U.S. residents. Terrell and Mills report that the proportion of the liabilities of Caribbean branches due to U.S. residents rose from less than half in mid-1981 to about 70 percent by the end of 1982. However, the attraction of offshore deposits to U.S. residents is likely to decrease as interest regulations on domestic U.S. banks are relaxed, thereby narrowing the gap between domestic and offshore deposit rates.

Based on the figures of the Bank for International Settlements, Terrell and Mills estimate that the proportion of total international banking assets and liabilities due to U.S. banks' offshore branches declined by 4 percent in the first year of IBF operation. Another 3½ percent was lost by other overseas banking centers to IBFs.

THE SIGNIFICANCE OF IBFs FOR INTERNATIONAL BANKING

The primary significance of the experience with IBFs is that it enables us to better understand the forces that led to the growth of eurocurrency markets. In particular, the significant decline in business in Caribbean branches following the creation of IBFs suggests that the growth of business in this area was almost entirely intended to bypass U.S. monetary regulations. Deregulation of domestic banking in the United States will presumably have further effects, since much of the remaining business in Caribbean branches of U.S. banks is with U.S. residents.

The regulatory changes that permitted the establishment of IBFs were intended to ease the burden of domestic monetary restrictions on U.S. banks in the conduct of international banking business.[11] The extent to which this aim has been achieved is probably very limited. This is because IBFs play no role in financing either activities of U.S. residents or the U.S. activities of nonresidents.

Major U.S. banks that were involved in international finance to a significant degree had already found ways around U.S. banking regulations and were not restricted in their ability to compete internationally. The

[11] Ibid., p. 566.

fact that major U.S. banks have shifted business to IBFs from offshore centers means, of course, that there must be some benefit from having an IBF. This may result from lower transaction costs, some tax advantages or the greater attraction, from a risk perspective, of deposits located in the United States. However, the biggest gainers among U.S. banks may be medium-sized banks that were big enough to have some international business but not big enough to have an offshore branch.[12]

Other major beneficiaries from IBFs have been the U.S. branches and agencies of foreign banks. It is no accident that well over half of all IBFs have been established by these banks. The benefit to them arises from the high proportion of their existing business that is IBF-eligible, that is, the portion with nonresidents. Not the least of this would be transactions with their parent banks overseas.

CONCLUSIONS

The establishment of IBFs in the United States represents a change in the geographical pattern of international banking. It facilitates the conduct in the United States of some business that was previously conducted offshore. It also increases the ease with which foreign banks can operate branches in the United States. The creation of IBFs, however, does not seem to have increased the total volume of international banking business. Indeed, IBFs have grown at a time when international banking growth has been at its slowest for over two decades. This growth has been largely at the expense of banking offices in other locations.

For the U.S. and world economies, however, IBFs are not of great significance. There may be efficiency gains resulting from the relaxation of U.S. regulations that led to the establishment of IBFs. But such gains are small. Interest rates in world capital markets are unlikely to have been affected. Benefits that accrue to banks located in the United States from their IBF facilities are largely offset by losses in offshore banks, though in many cases the gainers and losers are both branches of the same parent bank.

[12]It is true that the largest banks have the largest IBFs. However, the cost saving at the margin from IBFs for a bank that had, say, a Caribbean shell operation is much smaller than for a bank that had no offshore booking location.

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A Private Central Bank: Some Olde English Lessons

G. J. Santoni

DISSATISFACTION with persistent and volatile inflation since the mid-1960s has led to numerous calls for a different approach to monetary policy. In some cases, people have suggested that monetary policy decisions be made more explicitly political, for example, subject to greater control by Congress via congressionally mandated monetary growth targets. In the same vein, Milton Friedman has proposed that monetary policy be set by the Treasury, thus making the President of the United States ultimately responsible for its conduct.

In contrast, some critics of the current system have argued for a return to the constraints of Bretton Woods or the even earlier classical gold standard. Some have suggested that the only lasting solution to the problem entails the private production of money.

Behind these different suggestions is the implication that central bankers will respond systematically and, hence, predictably to the different incentives embodied in these alternative programs of monetary control. If the incentives are changed, so the theory goes, better policy decisions will be made.

This paper focuses directly on the theoretical and empirical support for the claim that different incentives induce policymakers to choose different monetary growth rates. This paper does *not* advocate a particular set of incentives or form of organization for the central bank. Rather, it merely points out that the choices of monetary policymakers depend, as all choices do, upon the set of incentives the individual confronts.

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A verification of this proposition is sought by examining the behavior of the Bank of England over the period from, roughly, 1700 to 1930. This period, which encompasses two significant changes in the incentives facing England's central bankers, provides support for the view that policymakers, like other individuals, respond predictably to changes in the cost-reward circumstances facing them.

WHAT DISTINGUISHES CENTRAL BANKERS?

The central banker is the person (or group) holding the enforceable right to control the quantity of nominal money balances in circulation.[1] This right is valuable. Whoever holds it can, among other things, materially influence the rate of inflation and the flow of profits from money creation (seigniorage), as well as the present value of the right itself.

WHY THE BANK OF ENGLAND?

The Bank of England presents an interesting case in studying the effect of different incentives on the behavior of central bankers. There are two reasons for this. First, the original organization of the Bank differed from its modern counterparts in one fundamental respect: the Bank of England was a privately-owned-for-profit central bank from its inception in 1694 until the

[1]More precisely, they control the issuance of "high-powered money" or base money. Since the long-run link between base money and the transaction balances of the public (money) is so close, the paper treats the right to control base money as synonymous with the right to control money. See Balbach (1981); Johannes and Rasche (1979).

early 1930s. Further, the Bank was immersed in a set of institutional arrangements that related the wealth of the Bank's owners inversely to the rate of inflation. This paper shows that the costs and benefits of varying monetary growth rates were different for England's private for-profit central bankers than those typically taken into account by modern central bankers.[2] Consequently, a different monetary growth rate emerged.

A second reason for studying this particular case is that control of the money supply by the Bank's owners was interrupted from 1793 to 1821, when the government seized the Bank's monetary control function. For the purposes of this paper, the interruption is important because it allows a contrast of monetary growth outcomes produced by certain identifiable changes in the incentive structure, while other important institutional factors remained roughly constant.

A BRIEF HISTORY OF THE BANK OF ENGLAND: 1694–1832

Prior to 1694, England's money supply consisted mainly of coins. These coins were controlled by the government through regulation of the mint.

The coins were in a continually bad state because the populace persisted in clipping, sweating, filing, washing and boring them. Further, the government resorted to progressive debasement in the form of frequent recoinages, a practice that was particularly pronounced during the reigns of Henry VIII and Edward VI.[3]

In some cases, the government expropriated monetary wealth outright. In 1640, Charles I closed the London Mint and confiscated the funds of private citizens that had been stored there for safekeeping. Later, in 1672, Charles II expropriated funds deposited with the Treasury by London goldsmiths.[4] This irresponsible behavior had important consequences when, in 1692 and 1693, William III floated long-term loans to finance a war with France. Because of the earlier debasements and expropriations, the interest rates demanded for long-term loans to the Crown contained a substantial premium.[5]

Establishment of the Bank

William's war with France was a costly affair. When additional funds were required in 1694, a proposal that twice previously had been put forward by William Paterson was adopted in the Ways and Means Act of that year. The Act provided that those who subscribed

> for and towards the raising and paying into the receipt of the Exchequer the said sum of twelve hundred thousand pounds part of the sum of fifteen hundred thousand pounds were to constitute jointly the Company of the Bank of England.[6]

The loan was a perpetuity, paying interest at the rate of 8 percent. This was considerably below the interest rates that previously had been charged the Crown. The subscribers, however, received additional rights to 1) form a joint stock banking company, 2) deal in bills of exchange, gold and silver, 3) grant advances on security, and 4) issue promissory notes transferable by endorsement in an amount not exceeding the Bank's capital.[7]

These terms apparently were very attractive. The entire loan was subscribed within 12 days. Every sub-

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[2]Alchian (1977), pp. 127–50.

[3]Kemmerer (1944), pp. 34–36.

[4]Charles finally acknowledged one-half the debt, but the promise to pay was never kept. Payments, at the rate of 6 percent, were made only during the period 1677–83. Charles explained the reason for his action as follows:

> Whereas since the time of our happy Restoration We have been involved in great Forreigne Warrs as well for the Safety of our Government as the vindication of the Rights and Privileges of our Subjects, In the prosecution whereof we have been constreyned for some years past, contrary to our Inclinacions, to postpone the payment of the moneys due from Us to several Goldsmiths and other upon Tallys struck . . . , And although the present Posture of Our affaires cannot reasonably spare so greate a sum as must be applied to the satisfaction of those debts, Yet considering the great difficulty which very many of our Loving Subjects (who putt their moneys into the hands of those Goldsmiths and others from whom we received it) doe at present Lye under, almost to their utter ruine for want of their said moneys, We have rather chose out of our princely care and compassion towards Our people, to suffer in Our owne Affaires than that our loving subjects should want soe reasonable a Reliefe.

Bisschop (1967), p. 48. Incidentally, tallys were pieces of wood upon which government indebtedness was recorded. The government issued tallys when it borrowed from individuals. Goldsmiths regularly accepted these tallys and credited the accounts of the depositors.

[5]Homer (1977), p. 126. Both loans were of 1 million pounds. The first was a life annuity paying interest of 10 percent until 1700 and 7 percent thereafter on a semitontine basis (surviving subscribers split one-half the proceeds due decedent subscribers). The second loan paid interest at the rate of 14 percent.

[6]Bisschop, p. 74, and Clapham (1958), vol. 1, pp. 16–20.

[7]Bisschop, pp. 70–71, and Macleod (1897), pp. 773 and 776. The Bank employed three methods of accounting for the transaction accounts ("running cash") of its depositors and these methods define how the balances were transferred in the exchange process. The methods were by "Notes payable to Bearer, to be endorsed," by "Books or Sheets of Paper, wherein their Account to be entered," or by "Notes to persons to be accomptable." The first method was the forerunner of central bank notes. The third was essentially equivalent to a present-day checking account. The second was much like modern passbook accounts. See Clapham, vol. 1, p. 21.

scriber became a shareholder of the Bank to the extent of his subscription, and all or any fraction of his share could be sold to others.[8]

The Bank opened for business on July 27, 1694, in Mercers' Chappell. From its inception, every effort was made by the Governor and Court of Directors (Board of Directors of the Bank) to attract depositors and to promote the circulation of its "running cash notes."[9] These notes were convertible into legal tender money, gold coins, at a fixed exchange rate upon demand at the Bank.[10]

Subsequent legislation strengthened the Bank's position. The Bank was granted a monopoly in joint stock banking in early 1697.[11] In 1708, the Bank obtained a monopoly in the issue of joint stock bank notes.[12] Later, in 1742, Act 10 and 11 George II., C. 13 (par. 5), reaffirmed the earlier rights granted to the Bank. Each of these pieces of legislation was accompanied by an additional Bank loan to the government. The Bank subscribed an additional 1,001,017 pounds for loan to the government at 8.0 percent in 1697. In 1707, it extended a 1,500,000 pound loan at 4.5 percent to the government and, in 1742, another 1,600,000 pounds at 3.0 percent.

No further significant legislative changes regarding the Bank's position occurred until 1826. In that year, the Bank's monopoly on joint stock banking was limited to within a 65-mile radius of London.[13] Seven years later, in 1833, its monopoly of joint stock bank note issue was also limited to the same area. However, Bank of England notes were made legal tender at this time.[14] This legislation provided legal force to the practice that had already been adopted by other banks of maintaining their reserves in the form of Bank of England notes.

The Government Steps In: 1793–1821

The Napoleonic Wars between England and France began in 1793. With the exception of a minor truce, the war continued until Napoleon's abdication on April 6, 1814.[15] Government demands from the Bank for financing rose substantially during the war. Of course, the Bank's contract with its depositors to redeem its notes at a fixed price in terms of gold got in the way of the government's interest and, on February 26, 1797, the King and Privy Council ordered the Bank to suspend specie payments, a suspension that was to last for more than 20 years.[16]

During the suspension, control of the money supply, which had rested with the Bank's owners, was largely usurped by the government. Clapham notes that

> The minutes of the Court and those of the Committee of Treasury are full of . . . . . requests for help from Perceval, and of the Bank's reluctant but invariable acquiescence.[17]

The Bank apparently acquiesced because of an "understanding, a gentleman's understanding . . . to do this business and to do it in the way most convenient to the Treasury."[18]

Given the transfer of monetary control to the government, it is, perhaps, not surprising that the Bank's Board of Directors became unusually lackadaisical in their attention to duties. As a result of absenteeism, the Bank Court experienced difficulty in maintaining a quorum. Letters were sent to a number of directors that "pointedly asked 'when their attendance could be depended upon'" for "too much of the business had

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[8] Bank shares exchanged hands regularly and, in 1747, *Gentleman's Magazine* began publishing daily price quotes for Bank of England shares of stock. In 1773 New Jonathan's Coffee House printed the words, "The Stock Exchange" over its door and admittance was permitted only by fee.

[9] Clapham, vol. 1, pp. 20–23.

[10] It is interesting to note that an *official* (established by law) gold standard was not enforced in England at this time. The Bank's commitment to redeem its notes at a fixed price in terms of gold was not foisted upon the Bank by the government. Rather, this was a voluntary contract established by the Bank with its customers. England's official gold standard was not established until 1821 (more than 100 years later) and then only as a result of the Bank's insistence.

[11] Clapham, vol. 1, pp. 46–50.

[12] Bisschop, pp. 82–83. Act 7 Anne, C.7, provides "that during the continuance of the said corporation of the Governor and Company of the Bank of England, it shall not be lawful for any body politic or corporate whatsoever, created or to be created (other than said Governor and Company of the Bank of England), or for any other persons whatsoever, united or to be united in covenants, or partnership, exceeding the number of six persons, in that part of Great Britain called England, to borrow, owe, or take up any sum or sums of money on their bills or notes payable at demand, or at a less time then six months from borrowing thereof."

[13] Bisschop, p. 198.

[14] Andreades (1924), p. 261; Bisschop, p. 198.

[15] There was, of course, Napoleon's "Campaign of 100 Days" between his escape from Elba on March 1, 1815, and his defeat at Waterloo on June 18, 1815. Due to its brevity, it is ignored in this analysis.

[16] The wording of the order ran as follows: The Bank will "forbear issuing any Cash in Payment until the Sense of Parliament can be taken on that Subject." Clapham, vol. 1, p. 272.

[17] Clapham, vol. 2, p. 33; see, as well, Viner (1937), p. 122; Cannan (1919), p. xi.

[18] Clapham, vol. 2, p. 11.

[19] Clapham, vol. 2, p. 31.

been done 'by a Single Director with the assistance of the Head of the Discount Office'."[19]

Return to Private Control

The suspension played an important role in the government's effort to wrest control of the money supply from the Bank. In the absence of suspension, "control" of the stock of money would have meant little to the government since the requirement to redeem notes at a fixed price in terms of specie eventually would have (and did during 1790–96) placed an effective constraint on note issue.

The public was never keen on the suspension, and the Bank made this the political issue in its fight to regain control of the money supply. In October of 1797, six months after it was ordered to suspend payments, the Bank indicated that it could "with safety resume its accustomed functions (payment of specie), if the political circumstances of the country do not render it inexpedient."[20] The Bank's report was virtually ignored by government. In June of 1810, the "Report from the Select Committee on the High Price of Bullion" recommended to Parliament that the resumption of specie payments (at the old par) begin within two years. The issue was not even taken up for discussion until July of the following year.[21] A vote on the recommendation was taken in the House of Commons in 1811. The House voted 180 to 45 against the issue.

On its own initiative, the Bank began partial resumption of specie payments for notes of 5 pounds or less in January of 1817. Early in 1819, however, Parliament required the Bank to discontinue the practice.[22] Parliament had promised on five different occasions to eventually return to specie payments, but continued to drag its feet on fixing a date. Finally, on July 2, 1819, the House of Commons passed an act permitting the resumption of cash payments (bullion *and* coin) after May 1, 1822. At the request of the Bank, this date eventually was moved forward to May 1, 1821.[23]

SOME IMPORTANT OBSERVATIONS

There are a number of important points to draw from the previous discussion in analyzing the incentives faced by the central bankers. First, given the one exception noted, the right to control the money supply was held privately. This right, in the form of ownership shares in the Bank, was traded in an organized market. Any expected changes in the future profits of the Bank would be reflected by changes in the price of Bank shares and would immediately affect the wealth of Bank owners.

Second, the owners of the Bank had loaned considerable sums to the government in perpetuity at fixed rates of interest. By 1743, the sum was well in excess of nine million pounds.

Finally, the Bank's contract with its customers to redeem its notes at a fixed price in terms of gold was a voluntary arrangement. An official (established by law) gold standard did not exist in England until 1821. In fact, the gold standard came about largely as a result of the Bank's continuous prods to an unwilling Parliament.

The following discusses how this unique incentive structure faced by England's central bankers influenced the monetary growth rate.

THE PROFITS FROM THE RIGHT TO CONTROL MONEY

Like the right to control the production of any commodity, the right to control the production of money is valuable. The central bank, at the cost of a few cents worth of paper and ink, can produce a $100 bill (or a 100-pound note) that can be exchanged in the market for $100 worth of resources.

The Flow of Profits

The central bank introduces money into circulation by exchanging units of money (which it prints) for commodities. These commodities may be either real or financial assets. Since the bank buys these assets at market prices, the expected flow of nominal profits generated by the purchase of the assets is equal to the nominal interest rate times the price of the assets purchased. This is equivalent to the nominal interest rate multiplied by the quantity of money exchanged for the assets. The flow of real revenue is simply the nominal flow divided by the price level ($i \times M/P$).

Since we are interested in relating the bank's real revenue flow to the rate of money production, account must be taken of the fact that, at higher rates of money production (higher rates of inflation), people will want

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[20]Clapham, vol. 1, p. 272. See, as well, Cannan, p. xi.

[21]Viner, p. 171.

[22]Viner, p. 172.

[23]Viner, pp. 172–73.

Table 1
The Revenue From Money Production

(1) π	(2) M/P	(3) $i=r+\pi$	(4) $R=i(M/P)$
.50	0	.60	0.00
.45	1	.55	.55
.40	2	.50	1.00
.35	3	.45	1.35
.30	4	.40	1.60
.25	5	.35	1.75
.20	6	.30	1.80*
.15	7	.25	1.75
.10	8	.20	1.60
.05	9	.15	1.35
0.00	10	.10	1.00

where:

π = the rate of inflation (rate of monetary growth)

M/P = the stock of real purchasing power demanded

i(M/P) = the profit from monetary production (inflation)

*indicates maximum profit

to hold less of their wealth in the form of real purchasing power (M/P). Other things unchanged, the flow of real revenue would decline at higher rates of money growth because M/P declines. Even though M is rising, the price level rises faster. However, other things are not unchanged. Faster money growth increases the rate of inflation and this raises the nominal interest rate (i).

Faster money production exerts two opposing forces on the bank's real revenue. One force tends to reduce revenue, while the other tends to increase revenue. In general, there is a unique rate of money growth (and rate of inflation) that will maximize the flow of real revenue.

A Simple Example

Table 1 presents a hypothetical example relating different rates of inflation (or rates of monetary growth), π, to the public's demand for real purchasing power, M/P. In order to facilitate the calculation of the rate of inflation that maximizes the bank's revenue flow, suppose that the public knows the rate of inflation with certainty (extreme rational expectations), that changes in the monetary growth rate affect only the rate of inflation and the public's desire for real purchasing power but no other real variables, that the cost of producing nominal units of money is zero (so revenue and profits are identical), that real output and population are stationary, that the real interest rate is 10 percent, and that the nominal interest rate is equal to the sum of the real interest rate and rate of inflation ($i = r + \pi$).

The numbers in the first two columns of table 1 indicate that, as the rate of inflation rises (falls), the public's demand for real purchasing power falls (rises). The third column indicates the nominal rate of interest at the various rates of inflation. The fourth column indicates the profit stream at the different rates of inflation.

As the rate of inflation falls from very high rates, the bank's profit from inflation initially rises because people choose to hold a greater amount of real purchasing power. Reducing the rate of inflation increases total profits up to a point (1.80 real goods per unit of time in this example), after which further reductions in the rate of inflation cause profits to fall. In this example, the profit-maximizing rate of inflation (monetary growth rate), which is the one the central bankers will choose, is 20 percent.[24]

THE BANK OF ENGLAND'S UNIQUE CONSTRAINTS

The Flow of Profits

Among other things, the above result depends upon the particular set of operating rules the bank faces. Apart from the particular assumptions expressed above, the foregoing example does not constrain the bank in any way. If additional rules were imposed, the profit function *may* change. As a result, the central bankers would be confronted with different incentives, causing them to select a different monetary growth rate.

The Bank of England was founded on the condition that the stockholders grant a substantial loan to the

[24]Since $R = i \times (M/P) = (r + \pi)(M/P)$, real profits are maximized when

$$\frac{dR}{d\pi} = \frac{M}{P} + \frac{d(M/P)}{d\pi}(r + \pi) = 0, \text{ or}$$

$$\frac{d(M/P)}{d\pi}\,\frac{\pi}{M/P}\,\frac{(r+\pi)}{\pi} = -1.$$

Hence, $n_m\left(\frac{r}{\pi} + 1\right) = -1,$

where n_m = the elasticity of demand for real purchasing power with respect to the rate of inflation. When $r = 0$, this result reduces to $n_m = -1$ which is the familiar result obtained by others.

See Friedman (1953), pp. 251–62; Friedman (1971), pp. 846–56; and Bailey (1956), pp. 93–110.

government at a fixed rate of interest. By 1743, that loan amounted to almost 10 million pounds. At the point when these loans were made to the government, the interest rate charged was below the market rate. (Recall the 1694 loan at 8 percent when the market rate on long-term loans to the Crown was 14 percent.) This subsidized loan rate is a payment made by the Bank to the government for the lease rights to the production of money. The right was never granted to the Bank in perpetuity. Rather, as indicated above, the Bank's charter came up for review periodically.

The cost to the Bank of its government loan depends upon the market rate of interest. If the coupon rate is c and the amount loaned is L, the nominal value of the lease payment per unit of time is $(i - c)L$. The real value is the nominal amount divided by the price level, $(i - c)L/P$. The higher the nominal rate of interest, i, relative to the coupon rate, c, the larger the cost of the lease to the Bank.

An additional constraint is relevant. The quantity of notes the Bank could issue was restricted by law to an amount less than or equal to the capital invested by stockholders. Since the capital represented the loan to the government, M must be less than or equal to L. Given this constraint, the Bank's owners will choose $M = L$ because the flow of real profit is highest in this case, other things the same (see insert). Consequently, the Bank's profit is simply the coupon rate earned on the loan, c, times the loan (which is equal to the quantity of notes issued, M), divided by the price level, P.

Table 2 illustrates the effect of this set of rules on the profit-maximizing rate of inflation for the Bank. The first three columns of table 2 simply reproduce the first three columns of table 1. Column 4 calculates the real profits of the Bank under the new set of rules where the coupon rate, c, is assumed to be 10 percent. Note that profits are maximized at a zero rate of inflation rather than the 20 percent rate obtained previously.[25]

Table 2
An Example of the Bank's Profit Function

(1) π	(2) M/P	(3) $i = r + \pi$	(4) $R' = c(M/P)$
.50	0	.60	0.00
.45	1	.55	.10
.40	2	.50	.20
.35	3	.45	.30
.30	4	.40	.40
.25	5	.35	.50
.20	6	.30	.60
.15	7	.25	.70
.10	8	.20	.80
.05	9	.15	.90
0.00	10	.10	1.00*

*indicates maximum profit

The Role of Specie Payments: A Contract for Price Level Stability

It is in the interest of Bank owners to inform the public of their intention to maintain a relatively low inflation rate. Demand for the Bank's product does not rise until the anticipated rate of inflation declines. This eventually will result from the Bank's policy of maintaining a relatively low monetary growth rate. The owners of the Bank, however, chose to hurry the adjustment of expectations by "marketing" their bank notes in a particular way.

In marketing its notes, the Bank guaranteed its customers a low rate of price inflation. This guarantee took the form of a contract to redeem Bank notes at a fixed price (a fixed weight of gold). The contract can be thought of as insurance against the overissue of Bank notes, because it pledged the original investment of the Bank's stockholders as surety for meeting the contract.[26] If bank notes were issued in such quantity as to

[25] This result is completely general as long as the demand for real purchasing power is inversely related to the rate of inflation. In this case,

$$\frac{dR}{d\pi} = c\frac{d(M/P)}{d\pi} < 0$$

Since the derivative of the profit function with respect to the rate of inflation is negative, it does not pay the Bank to generate an inflation by *continuously* expanding M and, of course, the constraint that $M \leq L$ will eventually become binding. Given that profit maximization requires $M = L$ from expression 1, a deflation would not benefit the Bank because it would require M to fall below L. As a result, the Bank will choose a zero rate of inflation.

In addition, the Bank's owners tended to be net monetary creditors as a class and this further reduced their incentive to inflate. There were about 1,300 original subscribers to the Bank stock. Many of them were London businessmen who were "linked sneeringly with the rather ill-famed money-lending scriveners." Others were Gentlemen and Esquires, "people who . . . live idly as 'gentlemen'." See Clapham, vol. 1, pp. 273–89.

[26] "That double event, (1) a low identification cost to everyone about the intermediate commodity *and* (2) specialist-experts who provide quality assurance and information more cheaply than novices can provide for themselves, explains the use of a low identification cost commodity as a general intermediary medium of exchange-money. It permits purchase of information from lower cost sources, a cost reduction that exceeds the added cost of using an intermediary good for indirect exchange." Alchian, pp. 117–18.

The Profit Function and Sharing Arrangement

BANK PROFITS

The Bank's flow of real profit is i(M/P), as before, minus the opportunity cost of the government loan, (i − c)L/P.

$$(1)\quad R' = i\frac{M}{P} - (i-c)\frac{L}{P} = i\frac{M}{P} - i\frac{L}{P} + c\frac{L}{P}$$

Given the constraint that $M \leq L$, it is clear from expression 1 that the Bank's owners will choose $M = L$. The Bank's profits are highest in this case, other things the same. As a result, the profit function reduces to

$$(2)\quad R' = c\frac{L}{P} = c\frac{M}{P}.$$

SHARING THE GAIN FROM MONEY PRODUCTION

The capitalized value of the nominal profit stream is

$$(3)\quad \frac{PR}{i} = \frac{c}{i}L.$$

Since the above expression takes account of the opportunity cost of issuing the government loan, expression 3 is the net increase in stockholder wealth that derives from the right to issue money. The increase is proportional to the loan (L) where the proportion is determined by the ratio c/i. The higher is c relative to i, the greater is the stockholders' share and the lower is the government's share. For the initial loan of 1,500,000 pounds, the stockholders' share was 857,142 pounds (1,500,000 × .08/.14) in terms of the prices that existed in 1694. The government's share was 642,857 pounds.

Long-term interest rates fell dramatically after the formation of the Bank.[1] In part, this was due to the eventual effect of the Bank's choice of a zero rate of inflation on price expectations. Of course, the decline in the nominal interest rate had the effect of raising the Bank's share of the net wealth derived from issuing money (c/i in expression 3 rises as i falls). As noted above, the government renegotiated c downward each time the Bank's charter was renewed in an effort to maintain the relative shares.

[1]See Homer, pp. 131 and 161; Martin (1865), pp. 24–25; and Rogers (1887), p. xiv.

cause their market price in terms of gold to fall below the price promised by the Bank, people would arbitrage the difference by trading gold for notes in the market at the low price and exchanging the notes for gold at the Bank for the higher price. In the process, wealth would be transferred away from stockholders to those engaging in the arbitrage. The guarantee was believable because customers knew that stockholders would lose wealth if the Bank overissued its notes relative to the supply of goods in general and gold in particular.[27]

[27]Of course, the guarantee is not perfect. New gold discoveries or improvements in mining technology would cause the price of gold *and* Bank notes to fall in terms of, say, a standard commodity basket. However, the guarantee, while imperfect, was operational. It provided a relatively low-cost method of metering the Bank's rate of note production and policing the guarantee.

DIFFERENT CONSTRAINTS FOR THE GOVERNMENT

When, for all practical purposes, the government took control of the money supply in 1793, the constraints facing the decisionmakers changed substantially. Recall that the government did not expropriate ownership rights in the Bank outright. Had they done so, it would have been a clear (and, possibly, politically unsavory) transfer of wealth from stockholders to the government. The government, however, did the next best thing from its point of view. It expropriated the wealth of the stockholders by a more circuitous route.

When the government took over, the Bank held a loan which, while an asset to the Bank, was a liability to the government. In terms of the example used here, an increase in the rate of inflation increases the nominal

interest rate, i, and increases the Bank's opportunity cost of the government loan, $(i-c)L/P$. In effect, accelerating the rate of inflation raised the lease payment the Bank made to the government.

Further, during its period of control, the government continuously violated the constraint that the quantity of notes in circulation not exceed the capital of the Bank. The government did not wish to be bound by the same rule that it believed appropriate in regulating the behavior of the Bank's stockholders.

As a result of the different constraints faced by Bank owners vs. the government, we should expect to observe relatively low rates of monetary growth and inflation during periods when the money supply is controlled by the private owners of the Bank of England and more rapid rates of monetary growth and inflation during the periods of government control. In addition, the demand for real purchasing power should be lower during the period of government control and the price of Bank stock should decline.

EVIDENCE

The Behavior of English Prices

One of the more interesting pieces of evidence concerning the effect of different incentives is England's history of inflation during the period of private monetary control. England's money supply was under private control for almost 200 years, and the rate of inflation during this period was statistically indistinguishable from zero.

From the establishment of the Bank in 1694 until the beginning of the Napoleonic Wars in 1793 when the government usurped control of the money supply, the annual average rate of inflation in England was .01 percent. In 1821, after the Napoleonic Wars, the government returned control of the money supply to the Bank and, at the Bank's insistence, established an official gold standard. Private control continued until 1913. During this period, 1822–1913, England's annual average rate of inflation was .42 percent which, again, is statistically indistinguishable from zero. In contrast, by 1931, the English government had taken complete control of the money supply. Since that date, the annual average rate of inflation has been significantly positive at 6.47 percent.[28]

[28]This period includes the Depression and World War II. If these years are excluded and the inflation rate is calculated over the period 1946–82, the mean rate of inflation is 6.87 percent (t-score = 9.10). The t-scores for the periods 1694–1793, 1822–1913 and 1931–82 are .145, .489 and 6.62, respectively.

Table 3

The Real Price of Bank Stock, 1780–1832[1]

Estimate[2]

$$P_S/P = \underset{(7.40)^*}{1.375} - \underset{(8.22)^*}{.232r} + \underset{(7.27)^*}{.005RW} - \underset{(2.21)^*}{.141D_0}$$

$$\text{Rho} = \underset{(7.02)^*}{.70}$$

$$\bar{R}^2 = .72$$

$$DW = 2.02$$

where: P_S/P = the real price of Bank stock.

r = the yield on 3 percent consols.

RW = real weekly earnings.

D_0 = a dummy variable for the period subsequent to government's seizure control. $D_0 = 1$ for the years 1793–1832 and zero otherwise.

[1]The price of Bank stock is the annual average calculated from the daily price quotes reported in *Gentleman's Magazine* for the years 1780–1832.

[2]Corrected for first-order autocorrelation. t-values in parentheses.

[3]The E. W. Gilboy series for average weekly earnings is spliced to the A. L. Bowley and G. H. Wood series by a factor which is the ratio of the average levels of the two indexes over the years 1791–93 and then divided by the price level. See R. B. Mitchell, *Abstract for British Historical Statistics* (Cambridge University Press, 1962), pp. 347–48.

*Significantly different from zero at the 5 percent level.

The Napoleonic Wars: Additional Evidence

The above data regarding the history of English inflation are consistent with one of the implications of the theory. Other aspects of the theory can be examined by considering data from the period immediately before, during and after the Napoleonic Wars. The war is important because the transfer of control of the money supply during the war was accomplished through a "gentleman's understanding" rather than an outright government expropriation of Bank ownership. As a result, ownership shares in the Bank continued to be exchanged by private individuals, and changes in the value of these shares along with changes in the demand for real purchasing power provide further evidence in regard to the theory.

The Market Price of Bank Stock

Table 3 presents an estimate of the effect of the government takeover and suspension of specie payments on the real price of Bank stock. The estimate

controls for the effect of business cycles (proxied by average annual real weekly earnings of men in full-time employment) and the interest rate, and includes a dummy variable for the period subsequent to the suspension. The coefficients of the business cycle proxy and the interest rate are significant and have the expected sign. The coefficient of D_0 is negative and significant. Its magnitude implies that the government takeover caused the real price of Bank stock to fall "permanently" by about 11 percent.[29] In short, the government chose a rate of inflation that was inconsistent with maximizing the real flow of Bank profits (from all sources) and this was reflected in the price of Bank stock.

The price of the stock did not return to its original level when monetary control was returned to the stockholders in 1819.[30] This was tested by including a second dummy variable that assumes the value of 1 for the period 1793–1818 and zero otherwise, along with D_0 that assumes a value of 1 for the period 1793–1832 and zero otherwise. The coefficient of the second dummy is insignificant, indicating that the variable is redundant. That is, singling out the 1793–1818 period adds nothing to the explanatory power of the equation.

In addition to this evidence, monthly data for the price of Bank and India Company stock are available for the period 1780–1801.[31] There appears to be a break in the ratio of the price of Bank stock to India Company stock in 1793. Before then, the mean of the ratio was .93 with a standard deviation of .11. After 1793, the mean fell to .83 with a standard deviation of .03. The decline in the ratio is statistically significant.[32] The price of Bank stock apparently declined relative to India Company stock by about 11 percent, virtually identical to the estimated decline produced by the regression in table 3.

Disgruntled Stockholders

Understandably, the stockholders were restive during the suspension. In 1801, Alexander Allardyce, spokesman for the critics, moved that a complete accounting of the Bank's financial condition be presented to the stockholders so that the Court might "declare a dividend of the whole profits, the Charges of Management only excepted, as the Law directs."[33]

Real dividend payments, inclusive of bonuses, did not increase during the suspension and the real value of Bank stock declined. These two factors along with interest-free loans made by the Bank to the government must have appeared to critics as a thinly veiled expropriation of wealth.[34] They no doubt recognized the spirit of Charles II lurking in the government.

Prices

As was the case for the more extended period discussed above, the rate of inflation is indistinguishable from zero (see table 4) in the years immediately preceding the government takeover and those following resumption of specie payments in 1821. In contrast, the price level rose significantly (at an average annual rate

Table 4

Growth of Bank Money and Inflation, 1780–1832

Time period	Money growth[1]	t-score	Inflation[2]	t-score
1780–1792	1.96	.41	.72	.60
1793–1813[3]	4.04*	2.20	4.85*	2.67
1814–1821	−2.95	1.05	−6.99	2.06
1822–1832	.47	.16	−.87	.41

[1]B. R. Mitchell (1962), pp. 442–43.

[2]*Ibid.*, pp. 469–70. The Schumpeter index for consumer goods is spliced to the Gayer, Rostow, Schwartz index of domestic and imported commodities by a factor which is the ratio of the average levels of the two indexes over the years 1821–23.

[3]The period of the Peace of Amiens (the year 1802) is excluded from this period.

*Significantly different from zero at the 95 percent confidence level.

[29]The estimates are adjusted for first-order autocorrelation. They were checked for second-order autocorrelation with the result that Rho 2 was insignificant.

[30]During the later part of the suspension, various moves to resume specie payments were afoot. As early as 1810, the Bullion Report advocated a return to specie payments in 1812. In addition, the Bank had begun a partial resumption in 1817, and in 1819 Parliament finally committed itself to a specific date for resumption. For purposes of the following test, I terminate the period in 1818, the year prior to Parliament's decision to return control to the Bank.

[31]See Sinclair (1803), pp. 22–48.

[32]The t-score = 10.78.

[33]Clapham, vol. 2, p. 40.

[34]In 1799, when the market rate of interest stood at 5.07 percent on long-term securities, the Bank made a "loan" to the government of 3 million pounds interest-free for six years. The present value of this gift was, roughly, 770,000 pounds. In addition, when the loan came due in March of 1806, the government asked that the loan be renewed until a point in time six months after a "Definitive Peace." The government offered to pay 3 percent interest. At the time, the long-term interest rate was considerably higher and 3 percent consols were selling at about a 40 percent discount.

[35]The years 1814–21 are treated separately in table 4. During this period, various steps were being taken to return to specie payment (see footnote 30).

Table 5

The Demand for Real Purchasing Power, 1780–1832

Estimate[1]

$$M/P = \underset{(.08)}{-1.535} + \underset{(5.88)^*}{2.002t} + \underset{(5.00)^*}{.573RW} - \underset{(1.88)^*}{18.678D_0}$$

$$Rho = \underset{(3.92)^*}{.56}$$

$$\bar{R}^2 = .70$$

$$DW = 1.97$$

where: M/P = the stock of real purchasing power.

t = time in years.

RW = real weekly earnings.

D_0 = a dummy variable for the period subsequent to government's seizure of monetary control. $D_0 = 1$ for the years 1793–1832 and zero otherwise.[2]

[1]Corrected for first-order autocorrelation. t-values in parentheses.

[2]Since the hypothesis excludes positive values for D_0, a one-tailed t-test is employed.

*Significantly different from zero at the 5 percent level.

of 4.85 percent) during the years 1793–1813.[35] This was a result of a significant increase in the monetary growth rate. Note that the rate of inflation closely corresponds to the rate of growth in the money supply during this period.[36]

The Real Value of Bank Money

The theory implies that the demand for real purchasing power will fall if the guarantee regarding the low rate of inflation is broken.[36]

Table 5 presents a regression that estimates the effect of the government's seizure of control over the money supply on the demand for real purchasing power by controlling for the effect of business cycles, population and the alternative cost of holding money. Annual population data are not available back to 1780, so time is used as a rough proxy to control for population growth. The interest rate on 3 percent consols was included as a measure of the alternative cost of holding wealth in the form of money. In addition, a dummy variable is included to test for a shift in the relationship in the period subsequent to the government takeover.

The coefficients of the proxies for the business cycle and population are significant and have the expected signs. The interest rate proved insignificant and was excluded from the estimate. The coefficient of D_0 is negative and significant. Its magnitude implies that the demand for real purchasing power fell by about 12 percent when the government seized control of the Bank.[37]

CONCLUSION

The above analysis suggests that decisions regarding the control of money depend more on the incentives individuals face in making choices than on the particular individuals who make the choice. Various methods of organizing monetary control produce distinct policy outcomes insofar as they confront policymakers with different incentives. Since it is unclear, for example, that the incentives confronted by the policymaker would be much different if monetary control were placed in the hands of Congress or the Treasury instead of the Board of Governors, it is unclear that the adoption of either of these alternatives would cause a noticeable change in policy. Additional research along these lines may prove helpful in suggesting a system of incentives that will induce the present-day equivalents of the Court of Directors to assign the desired weights (whatever they happen to be) to present and future consequences in reaching decisions regarding monetary control.

[36]The issue of private vs. government control of the money stock might seem to be a red herring since the money supply and price level always rise during wars. This, however, was not the case in two previous instances. During the Seven Years' War (1755–63), the government did not tamper with the Bank's control over the money supply, and the mean rates of growth in money and prices were 2.94 and 1.18 percent, respectively. Neither of these magnitudes differs significantly from zero. Similarly, during the War of Jenkin's Ear (1739–43), the mean rates of growth in money and prices were −1.62 and .66 percent, respectively. Again, neither of these differs significantly from zero.

[37]Exactly when the public became aware of a break in the trust is problematical. They certainly were aware of it by 1797 when the government ordered the Bank to suspend specie payments. The data, however, suggest an earlier date. Prices began rising rapidly in 1790 and, shortly afterwards, the public began arbitraging the difference between the price of gold in terms of notes at the Bank and its price in the foreign market. The Bank's bullion account began to decline in 1791, then fell substantially in 1792. The following assumes the public became aware of the break in 1793 when the war with France began.

[38]As was the case with the price of Bank stock, the demand for real purchasing power did not return to its original level when the government returned monetary control to the Bank and the guarantee was reinstated. This was tested by the same procedure as that employed in the case of the price of Bank stock. The results were the same. The coefficient of the second dummy was insignificant, indicating that it is redundant.

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Money Growth Variability and GNP

Michael T. Belongia

RECENTLY, a number of economists have argued that sharp fluctuations in the short-run growth rate of M1 since 1979 have reduced GNP growth, raised interest rates and generated expectations of higher future inflation. Milton Friedman, for one, has concluded that variable money growth — by producing these conditions — was responsible for the shorter and more abrupt cycles in real income experienced over that period.[1] Based on slightly different analyses, Bomhoff, and Mascaro and Meltzer also have concluded that variable money growth has tended to lower the level of output.[2] Finally, a recent conference sponsored by The Cato Institute was devoted entirely to the adverse effects of variable money growth and methods by which money growth could be made more stable.[3]

Economic theory implies that variable money growth could lower the level of GNP by reducing its short-run growth rate, if this variability were associated with certain changes in money demand and velocity. This article reviews the theoretical case for such a link and provides empirical evidence on the existence of this relationship. The results support the notion that variable money growth — by increasing money demand and reducing velocity — has had significant negative effects on both the level and the growth rate of nominal GNP in recent years.

THEORETICAL RELATIONSHIPS

The most common approach to constructing a link between variable money growth and GNP is based on intermediate relationships involving money demand. Although the theory behind these relationships suggests that more variable money growth will increase uncertainty about future economic conditions and increase the demand for money, the empirical evidence on this hypothesis has been mixed.[4] The discussion that follows, however, proceeds with a standard model of money demand and shows how more variable money growth — by increasing uncertainty — can be linked to a decline in the level of income and, possibly, the long-run growth rate of GNP. Since the expected effects of variable money growth on inflation are assumed to be small, the conclusions that follow apply to real GNP as well.[5]

The Basic Tobin Model

A money demand model derived by Tobin suggests that there is an explicit relationship between uncer-

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[1]Friedman (1983).

[2]Bomhoff (1983); Mascaro and Meltzer (1983).

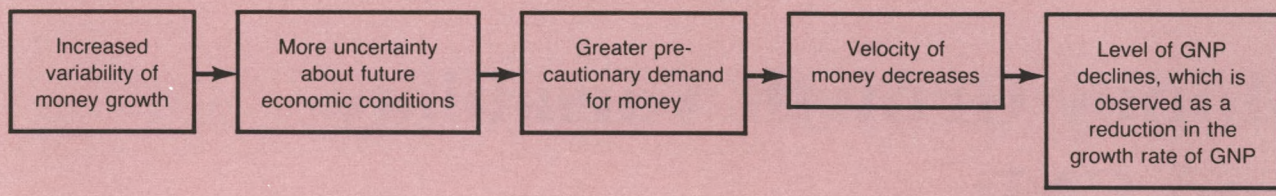
[3]See *The Search for Stable Money* (1983).

[4]One statement of uncertainty's effect on money demand and interest rates is found in Friedman and Schwartz (1982), p. 39:

> Another variable that is likely to be important empirically is the degree of economic stability expected to prevail in the future. Wealth holders are likely to attach considerably more value to liquidity when they expect economic conditions to be unstable than when they expect them to be highly stable. This variable is likely to be difficult to express quantitatively even though the direction of the change may be clear from qualitative information. For example, the outbreak of war clearly produces expectations of instability, which is one reason war is often accompanied by a notable increase in real balances — that is, a notable decline in velocity.

[5]For one argument to support this assumption, see Friedman.

Figure 1
The Links Between Variable Money Growth and GNP



tainty about future values of interest rates and money demand.[6] In its most basic form, the model assumes that an individual can hold both money and government bonds in his portfolio. Moreover, if the yield on money is zero, both the expected return of the portfolio and its variance depend on only the bond yield and the proportion of the total portfolio held in bonds. Therefore, in this simple world, an individual who seeks to maximize utility by holding some combination of cash balances and bonds in his portfolio faces a tradeoff between return and risk. That is to say, he can hold more bonds and increase the return on his portfolio only at the cost of increased risk: if the interest rate rises, the value of his bonds will fall. He can reduce risk, however, only by holding more cash balances, which reduces earnings.

This model implies that risk and money demand are negatively related.[7] If more variable money growth increases uncertainty about future values of interest rates, greater money growth variability will result in an increase in money demand. This inverse relationship has been supported empirically in several studies.[8] What remains to be seen, however, is whether this type of shift in money demand can be linked to a decrease in the level of GNP.

Money Demand, Velocity and GNP

The sequence of events depicted in figure 1 illustrates the first-round effects of greater money growth variability on uncertainty, money demand, velocity and GNP.[9] Reading from the figure's left side, more variable money growth is hypothesized to cause greater uncertainty about future economic conditions. Increased uncertainty increases the precautionary demand for money. A higher level of money demand implies lower velocity (V). From the equation of exchange, $MV = Y$, lower velocity clearly implies a lower level for GNP (Y). Because GNP will shift to a lower level with some lag, this level shift will be observed as a temporary decline in the growth rate of GNP. After the adjustment process is complete, the growth of GNP should return to its long-run equilibrium path unless further changes in uncertainty and risk premia (or other exogenous shocks) set off another round of shifts in the levels of money demand and velocity.

Theoretical Indeterminacy: Several Paths for GNP Are Possible

Whether increased uncertainty about future money growth has any effect on GNP, however, is an empirical issue. Moreover, if increased uncertainty does have some effect on these variables, the nature of its effect could cause GNP to follow one of several different paths. For example, if the effect of greater uncertainty is a once-and-for-all shift in money demand, the level of

[6]Tobin (1958).

[7]Some economists disagree with this conclusion. For discussions of the theoretical indeterminacy of a sign relating uncertainty to money demand and supporting evidence, see Blejer (1979), Levi and Makin (1979), Smirlock (1982), Fieleke (1982), and Berson (1983).

[8]Klein (1977), Slovin and Sushka (1983), and Mascaro and Meltzer.

[9]This figure is adopted from a similar figure in Bomhoff, p. 98.

Table 1

Estimates of a Reduced-Form GNP Equation Adding a Measure of Money Growth Variability

$$\dot{Y}_t = a_o + \sum_{i=0}^{n} b_i \dot{M}_{t-i} + \sum_{j=0}^{p} c_j (\dot{EP} - \dot{P})_{t-j} + \sum_{k=0}^{q} g_k \, VARM_{t-k} + d_o S_t + e_t$$

	Sample: II/1962–IV/1983		Sample: II/1962–III/1979	
a_o	5.536	(6.06)[1]	3.002	(1.77)
b_o	0.373	(3.70)	0.448	(2.62)
b_1	0.164	(1.48)	0.244	(1.18)
b_2	0.499	(4.63)	0.347	(2.03)
Σb	1.036	(0.26)[2]	1.039	(0.23)
c_o	0.000	(0.00)	−0.047	(1.26)
c_1	0.064	(1.45)	0.114	(2.12)
c_2	−0.081	(1.85)	−0.085	(1.55)
c_3	−0.011	(0.28)	−0.012	(0.23)
c_4	−0.022	(0.60)	−0.007	(0.13)
c_5	0.035	(0.97)	0.035	(0.68)
c_6	0.099	(3.25)	0.059	(1.54)
Σc	0.084	(2.38)	0.057	(1.28)
g_o	0.529	(1.22)	1.596	(2.05)
g_1	−0.341	(0.58)	−1.794	(1.87)
g_2	−1.675	(3.03)	−1.034	(1.16)
g_3	1.577	(2.55)	2.541	(2.76)
g_4	0.826	(1.21)	0.590	(0.58)
g_5	−2.311	(5.06)	−1.894	(2.38)
Σg	−1.395	(4.75)[3]	0.005	(0.00)
S	−0.621	(3.36)	−0.634	(3.05)
$\bar{R}^2$	0.62		0.58	
DW	2.33		2.14	
SE	2.692		2.646	

[1]Absolute values of t-statistics in parentheses.

[2]This t-statistic applies to the null hypothesis $\sum_{i=0}^{2} b_i = 1$.

[3]The F-statistic for the null hypothesis $g_o = g_1 = \ldots = g_5 = 0$ is 10.09, which is greater than the critical value of $F_{6,\,69} \simeq 2.22$.

GNP will be permanently lower, but its growth rate eventually will return to its former path. If the shift in money demand is transitory, however, there will be a short-run decline in the growth rate of GNP, but neither the level nor the growth rate of income will be affected permanently. A third possibility is that greater uncertainty will alter investment decisions in a manner that also changes the economy's long-run capital-labor ratio; in this case, both the level and growth rate of GNP would be permanently lower. Finally, money growth variability may have no observable effect on uncertainty, money demand and velocity; in this event, neither the level nor the growth rate of GNP would be affected. Hypotheses concerning the impact of increased money growth variability and these alternative paths for GNP are tested in the next section.

SOME TESTS OF THE HYPOTHESES RELATING MONETARY VARIABILITY TO INCOME

The effects of variable money growth on GNP can be tested by adding a measure of money growth variability to a basic reduced-form monetarist model of nominal GNP growth. The general reduced-form GNP equation to be estimated is shown at the top of table 1. This equation expresses nominal GNP growth ($\dot{Y}$) as a function of the growth rate of M1 ($\dot{M}$), the relative price of energy ($\dot{EP} - \dot{P}$), the variability of money growth (VARM) and S, a variable that denotes periods of major strikes; the strike variable is defined as the change in the quarterly average of days lost due to strikes, deflated by the size of the civilian labor force.[10]

The measure of money growth variability chosen is the square root of a four-quarter moving average of squared errors of money growth forecasts over the I/1950–IV/1983 sample period.[11] The errors then were used to construct a measure of error variability meant to represent changes in the risk or uncertainty faced by economic agents as the pattern of money growth changes. Intuitively, one might conclude that risk has

[10]The model chosen is discussed in Tatom (1981). The initial specification of the equation in table 1 also includes high-employment government expenditures as a right-hand-side variable. Pre-test statistics, however, indicated no significant marginal contribution to the model's explanatory power from this variable. This pre-test result is consistent with earlier studies that have found no long-run effect of government spending on GNP growth. See, for example, Andersen and Jordan (1968); Carlson (1978); and Hafer (1982). For these reasons, the variable was omitted from the equation estimated in this paper.

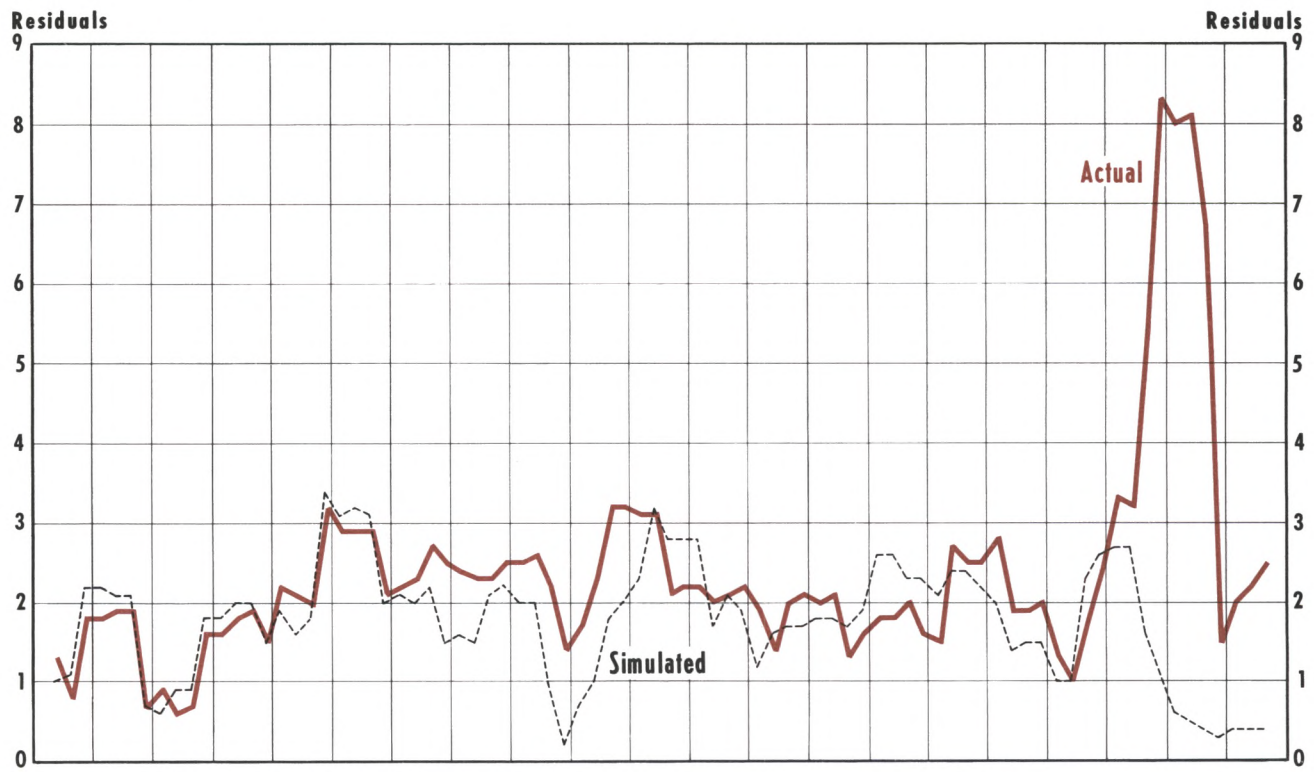
[11]See Berson on the construction of a similar measure. The transformation is defined as:

$$[(\dot{UM}^2_{t-1} + \dot{UM}^2_{t-2} + \dot{UM}^2_{t-3} + \dot{UM}^2_{t-4}) \div 4]^{1/2},$$

where UM represents unanticipated money growth, i.e., the residuals from an autoregressive model of money growth. Errors were generated by fitting a sixth-order autoregressive model to the growth rate of M1.

Chart 1

Estimates of Monetary Uncertainty Under Actual and Simulated M1 Growth



increased if forecasting errors begin to fall over an increasingly wider range. After all, the probability of making an incorrect economic decision increases with the probability of making a large forecasting error. This measure of money growth variability, represented by the solid red line in chart 1, shows that forecast errors for M1 growth have been considerably more variable since 1979.

Pre-Test Estimation and Lag Length Selection

The unknowns to be determined in this equation prior to estimation are the lag lengths for money growth, relative energy prices and money growth variability (i.e., the n, p and q shown in table 1). These values were chosen following procedures discussed recently by Batten and Thornton.[12] Pre-testing indicated the use of contemporaneous and two lagged quarterly values of the growth rate of M1, contemporaneous and six lags for the relative price of energy, and contemporaneous and five lags for the measure of money growth variability.[13]

The choice of five lags for the measure of money growth variability reflects the lagged responses of money demand, velocity and GNP suggested by theory and depicted in figure 1. That is to say, increased variability in money growth is expected to affect GNP only after some lag; economic agents require sufficient time both to discover the wider band of errors on money growth forecasts and to adjust their behavior accordingly. To test whether increased uncertainty

[12]Batten and Thornton (1983a, b) summarize an approach to the selection of lag length and polynomial degree based on the work of Geweke and Meese (1981); Mallows (1973); Schwartz (1978); Akaike (1969); and Pagano and Hartley (1981).

[13]The Pagano-Hartley t-ratios, final prediction errors and Mallows' test statistic all suggested these lag lengths. These lag lengths were fitted and chosen using ordinary distributed lag models without polynomial smoothing.

Table 2

Implications of Alternative Pairs of Test Results for Estimated Coefficients on Monetary Variability

Practical Implication	Individual Coefficients	Sum of Coefficients
1) Neither the level nor the growth rate of GNP is affected	each equals zero	equals zero
2) The level of GNP is temporarily or permanently lower but its long-run growth rate is unaffected	some initial coefficients are significantly negative	equals zero
3) Both the level and long-run growth rate of GNP are permanently lower	some initial coefficients are significantly negative	is significantly negative

has an effect on the level of income, the relevant null hypothesis is $g_0 = g_1 = ... = g_5 = 0$, as shown in table 2. Failure to reject this hypothesis would imply that money growth variability had no effect on GNP.

If one or more individual coefficients indicate a statistically significant *negative* relationship between GNP growth and money variability, the second issue of interest is whether this effect on the level and the growth rate is transitory or permanent. In other words, it is important to know whether greater money growth variability causes a temporary or permanent reduction in the level and growth rate of GNP. This result can be determined by testing the null hypothesis that $\sum_{k=0}^{5} g_k = 0$. If this sum is not significantly different from zero but some individual coefficients are significantly negative, the results would imply a transitory decline in the growth rate of GNP and either a temporary or permanent reduction in its level. If this hypothesis also is rejected, however, it can be determined that both the level and growth rate of GNP are permanently lower. Implications of possible test results are summarized in table 2.

TESTING THE IMPACT OF VARIABLE MONEY GROWTH

The results of estimating the augmented GNP equation over the II/1962–IV/1983 sample period are given in the first column of table 1. The results reject each of the null hypotheses discussed above: some initial individual coefficients for money growth variability are significantly negative and their sum is significantly negative. Within the context of the specified equation, these results indicate that greater short-term variations in the rate of money growth tend to increase uncertainty and money demand; as a result, permanent reductions in both the level and the growth rate of nominal income are produced.

It also is important to note that the sum of the coefficients on money growth $(\sum_{i=0}^{2} b_i)$ is not significantly different from one after the addition of a direct measure of money growth variability. This shows that the one-to-one long-run correlation between the growth rates of money and nominal GNP remains, even after the effect of variable money growth is directly taken into account.[14]

The significance tests on the other variables included in the regression indicate that the strike variable has negative effects on income growth. Also, changes in the relative price of energy have exhibited some significant positive long-run effects on GNP growth. This latter result is not surprising; the impacts of short-run changes in relative energy prices are usually measured as changes in inflation. Thus, the relative energy price effect shows up in nominal GNP (via the price change); and this explains the positive sum coefficient for relative energy prices in this model.

[14]These results hold for a variety of variability measures, including a moving standard deviation of money growth, squared money growth rates and a multi-state Kalman filter estimate of the variance of errors associated with one-quarter-ahead forecasts of money growth. Unlike the criticisms of Allen with regard to uncertainty results for money demand, these results for a GNP equation appear to be robust with respect to the measurement of money growth variability. See Allen (1982).

Robustness

As a check of the model's robustness, the equation in table 1 was re-estimated over a shorter II/1962–III/1979 sample period. This period was chosen for two reasons. First, the Federal Reserve changed its operating procedures in October 1979. Second, as shown in chart 1, there was a sharp increase in money growth variability after IV/1979. The results of re-estimating the GNP equation over the shorter sample period with new values for VARM are given in the second column of table 1.[15]

The results for the shorter estimation period still indicate that variable money growth temporarily lowers the growth rate of GNP. The long-run impacts on the level and growth rate of GNP, however, are no longer significantly different from zero. Apparently, the considerably lower variability of money growth that existed prior to 1980 did not produce any long-run impact on the growth of GNP. Or, viewed differently, even though variable money growth has a significantly negative effect on GNP in both periods, permanent reductions in its level and growth rate are found only after 1980, when the variability of money growth tripled.

The effects of money growth and relative energy prices also follow lag patterns similar to those for the longer sample period. However, the long-run effect of relative energy prices is no longer significantly positive.

The only other apparent change from the full period estimation to this restricted one is a decline in the estimated growth rate of velocity (the model's constant term) to 3.0 from 5.5. However, since the growth rate of velocity in this model is really $a_o + \sum_{k=0}^{5} g_k$, the implied velocity growth for the full-sample model is actually 4.14, which is not significantly different from 3.0.[16] In all other respects, the results for both models are qualitatively similar and would seem to indicate that the addition of a money variability measure is robust with respect to choice of sample period.

[15]To reflect the less volatile pattern of money growth that prevailed prior to 1980, the autoregressive model of money growth used to generate values for the money variability measure was re-estimated. An AR(1) model was found to whiten the residuals for a model of money growth estimated over the pre-1980 sample.

[16]The F-statistic for H_o: $a_o + \sum_{k=0}^{5} g_k = 3.0$ is 1.83, less than the critical value for $F_{1, 60} = 4.00$.

SOME IMPLICATIONS OF REDUCED MONETARY VARIABILITY FOR MONETARY POLICY

The estimates reported in table 1 support the hypothesized negative relationship between variable money growth and GNP discussed elsewhere.[17] However, the statistical measure of money growth variability is not expressed in units that have a clear economic meaning. Therefore, the results in table 1 may be difficult to interpret directly, especially for policy purposes. It may be useful to illustrate more intuitively why some economists are concerned about the potential negative effects of money volatility. This is done below by using the equation in table 1 to repeat an experiment recently suggested by Friedman.[18]

Friedman asked what the path of GNP would have been in recent years if the money stock had grown at the following rates over these intervals: 7.1 percent from III/1979 to III/1980; 6.1 percent from III/1980 to III/1981; and 5.1 percent from III/1981 to III/1982.[19] The 6.1 percent three-year average growth rate described above is equal to its actual average over the same period. The plots of both actual M1 growth and Friedman's smoothed money path are shown in the upper panel of chart 2.

While maintaining the same average growth rates of money over four quarters, the Friedman scenario significantly reduces the large quarter-to-quarter variations in M1 growth that actually occurred over this period. This result is shown clearly by the sharp decline in money growth variability that is generated by these data; this new measure of monetary uncertainty is represented by the dashed line in chart 1. Over the III/1979–III/1982 period, the more stable path of M1 growth would have produced — in terms of Friedman's analysis — a longer but less severe recession in 1980 and, beginning around mid-1981, an expansion typical of the postwar period (lasting about three years). The projected path of GNP under stable M1 growth is contrasted in the lower panel of chart 2 with the projected path of GNP under actual money growth.

The solid black line in the lower panel of chart 2 is the path of GNP produced by a simulation of the model reported in the second column of table 1 based on the

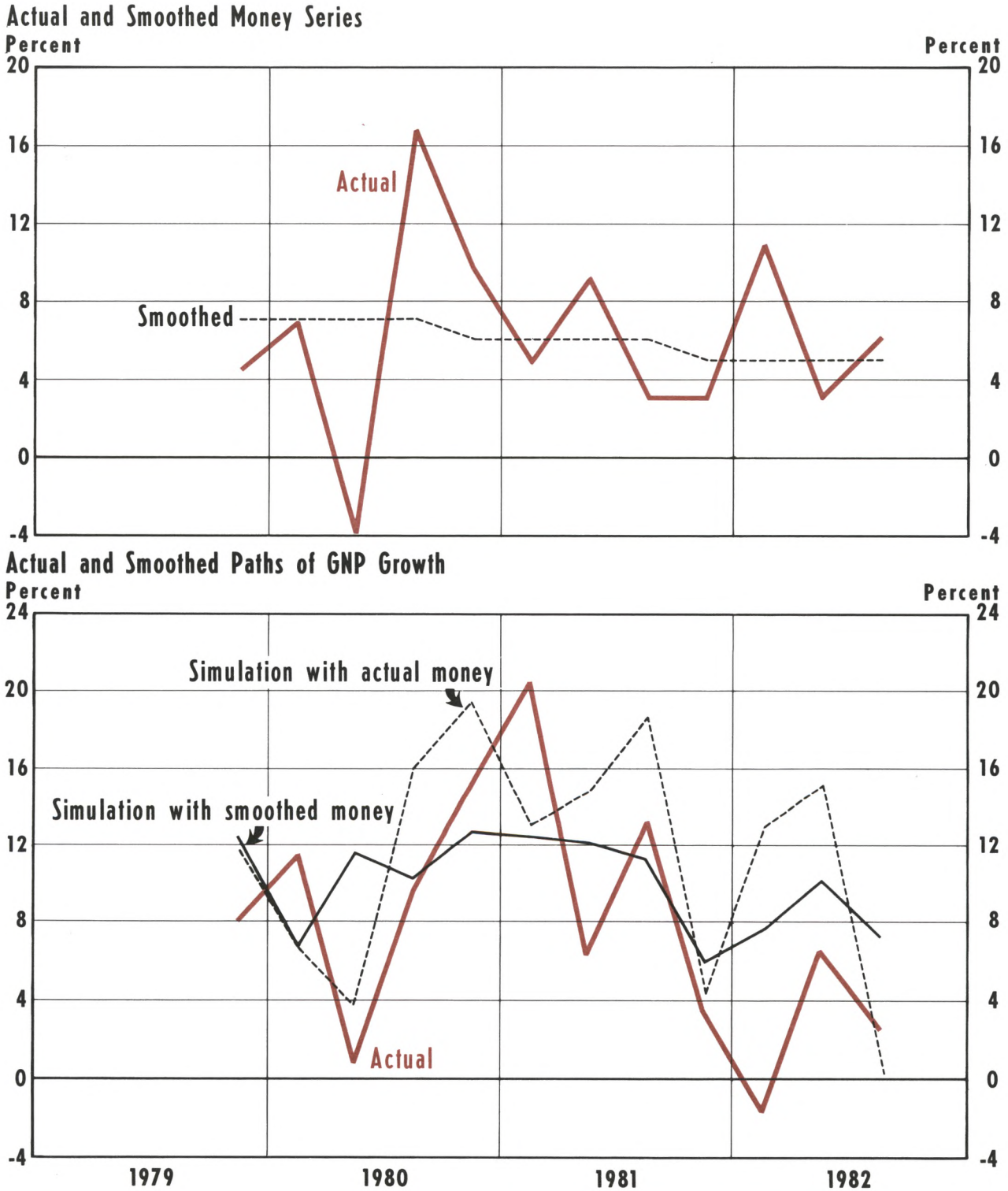
[17]For example, Friedman and Schwartz (1963b); Friedman; *The Search for Stable Money*.

[18]Friedman.

[19]The experiment stops at this point because money growth accelerated sharply and varied substantially over subsequent quarters.

Chart 2

GNP Growth and Alternative Money Growth Paths



smoothed money growth figures listed above.[20] The results are quite similar to Friedman's conjecture; moreover, they depict clearly what some economists claim are the prospective benefits of more stable money growth. The simulated path of GNP growth — under reduced quarter-to-quarter variation in M1 growth — shows higher average growth and much narrower variation than does actual GNP growth over this period. For example, actual GNP growth ranged between −2 and 20 percent; under more stable money growth, however, the simulated rates of growth in GNP vary between 7 and 12.5 percent. Moreover, while simulated GNP growth using actual money growth rates fell to zero in III/1982 and was 5 percent or below in three of the 12 quarters shown, the simulated path of GNP growth under less variable money growth fell below 7.5 percent on only one occasion. In summary, the contrasting results shown in chart 2 suggest that more stable money growth could promote a higher average level of GNP growth and reduce the range in which GNP growth fluctuates.

CONCLUSIONS

A number of recent studies have argued that variability in the quarter-to-quarter growth rate of money has increased money demand and, therefore, decreased the growth rate of GNP in the short run. This article investigates the link between variable money growth and GNP by adding a measure of money growth variability to a specific model of GNP.

The results suggest that increased quarter-to-quarter variation in the growth rate of M1 has some transitory negative effects both on the level and growth rate of nominal GNP; moreover, in more recent years, when the variation in money growth has increased nearly threefold, there is some evidence that the effects on the level and growth rate of GNP have been permanent reductions. If the effect of money variability on inflation is small, as is generally thought, these results imply a permanently lower level and, perhaps, smaller growth rate of real GNP.

A simulation experiment based on these results illustrates the potential benefits of more stable money growth. Within the context of the model used, growth in nominal GNP would have been higher, on average, and more stable since 1979 if the quarter-to-quarter growth in M1 had been substantially less variable than it actually has been since then.

[20]The dashed line was derived by using actual money growth rates and the errors from an autoregressive model fit to actual money data. These data provided the basis for projected GNP growth from III/1979–III/1982 under actual monetary conditions. Actual M1 data then were replaced with Friedman's figures for the III/1979–III/1982 interval. The autoregressive model for money growth then was re-estimated over I/1960–III/1982 to generate a new error series and a new measure of money growth variability. The coefficient estimates reported in the second column of table 1 were used to re-simulate GNP growth over 1979–82 in an environment of more stable money growth. These simulated results are shown by the solid black line in chart 2.

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