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Volume Author/Editor: Milton Friedman and Anna J. Schwartz

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Chapter Author: Milton Friedman, Anna J. Schwartz

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5 Movements of Money, Income, and Prices

Table 5.1 summarizes the changes that have occurred in the United States and the United Kingdom over the longest period for which we have data on money and income for both the United States and the United Kingdom. As it happens, both the initial and the terminal phases for this common period are contraction phases for both countries: the initial phase is 1873–78 for the United States, 1874–79 for the United Kingdom; the terminal phase is 1973–75 for both. The interval between the midpoints of the initial and terminal phases is just short of a century: 98.5 years for the United States, 97.5 for the United Kingdom.

Though our United States data on money are available for three additional early phases (1867–69, 1869–70, and 1870–73), and on income for two, we shall generally treat 1873–78 as if it were the initial phase for the United States in order to maintain comparability with the United Kingdom.[1]

5.1 United States and United Kingdom Money Balances at the Beginning and End of a Century

In the 1873–78 phase, the quantity of money in the United States was $1.7 billion, or $36 for each of its nearly 46 million residents. In the roughly contemporaneous United Kingdom phase, 1874–79, the quantity of money in the United Kingdom was £0.6 billion or £19 for each of the more than 31 million residents. This cyclical phase is centered two years before the resumption of gold payments by the United States at the

1. We have consistently made computations for the longer period parallel to these for the shorter period to assure ourselves that we are not biasing the results by omitting the first two or three United States phases.

prewar parity, so that the market rate of exchange between the dollar and the pound sterling had not yet reached $4.8665, the parity rate that prevailed from 1 January 1879 until the outbreak of World War I in August 1914. The exchange rate averaged $5.242 for the United Kingdom phase 1874–79, so cash balances per capita in the United Kingdom were the market equivalent of $100, or nearly three times as large as in the United States.

This difference reflects primarily the greater financial sophistication of the United Kingdom at the time, not greater affluence. Per capita income in the United States was $173, in the United Kingdom almost exactly the same, $171, at the market rate of exchange.

In 1776 Adam Smith was able to write, "England is certainly, in the present times, a much richer country than any part of North America. The wages of labour, however, are much higher in North America than in any part of England. . . . But though North America is not yet so rich as England, it is much more thriving, and advancing with much greater rapidity to the further acquisition of riches."[2]

A century later, at the beginning of the period we study, the part of North America that had become the United States had a population 46 percent larger than the United Kingdom. Wages remained much higher than in England,[3] and the United States remained "much more thriving." In Adam Smith's time, the higher *wages* in North America may not have produced a higher *income* per capita because of the much larger capital accumulation in England. A century later, as just noted, our data indicate that per capita income was almost identical in the two countries. Aggregate United States income at the beginning of our period was therefore nearly 1.5 times aggregate United Kingdom income.[4]

2. Adam Smith, *The Wealth of Nations* (1776), Cannan ed. (London: Methuen, 1930), pp. 71–72.

3. According to Lebergott, average annual earnings of United States nonfarm employees (when employed) was $466 in 1873 (United States Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*, bicentennial edition, part 1 (Washington, D.C., 1975, series D-735). According to Feinstein, United Kingdom aggregate income from employment was £547 million in 1874, or £38 per capita working population, or $217 at the exchange rate current that year (C. H. Feinstein, *National Income, Expenditure and Output of the United Kingdom, 1855–1965* (Cambridge: Cambridge University Press, 1972), table 21 for income, table 57 for working population, and table 4.9, above, for exchange rate.

4. A caveat is in order that the market exchange rate is not wholly satisfactory for converting United Kingdom incomes to comparable United States incomes. The United Kingdom was at the time a capital exporter, the United States, a capital importer. On this score, domestic prices might be expected to be higher relative to international prices in the United States than in the United Kingdom. On the other side, the United Kingdom had much capital already invested abroad and was receiving a large income as return on capital and other "invisibles"; the United States was in the reverse position. This would work in the opposite direction: that is, a net capital *exporter* tends to have domestic prices that are low in relation to international prices while a *creditor* country tends to have domestic prices that

Table 5.1 **Secular Changes in Money Stock, Income, Velocity, Prices, and Population, United States (1873–1975) and United Kingdom (1874–1975)**

	United States (All Monetary Items in Dollars)				
	Average Value		Ratio of	Rate of Change (Annual Percentage)	Slope
	Initial Reference Phase (1873–78) (1)	Terminal Reference Phase (1973–75) (2)	Terminal to Initial Value (3)	from Initial to Terminal Phase (4)	of Semilog Trend (1873–1975) (5)
1. Nominal income (billions of dollars or pounds per year)	7.870	1056.9	134.3	4.97	4.91
2. Money stock (billions of dollars or pounds)	1.660	594.31	358.0	5.97	5.87
3. Velocity of money (ratio per year)	4.742	1.778	.375	−1.00	−0.96
4. Implicit price deflator (1929 = 100)	61.18	321.15	5.25	1.68	1.77
5. Real income (billions of 1929 dollars or pounds per year)	12.864	329.09	25.58	3.29	3.14
6. Population (millions)	45.564	211.935	4.65	1.56	1.50
7. Per capita nominal income (dollars or pounds per year)	172.7	4987.	28.9	3.41	3.41
8. Per capita real income (1929 dollars or pounds per year)	282.3	1553.	5.50	1.73	1.64
9. Per capita nominal balances (dollars or pounds)	36.4	2804.	77.03	4.41	4.37
10. Per capita real money balances (1929 dollars or pounds)	59.6	873.	14.65	2.72	2.60

Source: Lines 1, 2, 4–6: See source notes to table 4.8 and 4.9. Line 3 is line 1 divided by line 2. Line 7 is line 1 divided by line 6. Line 8 is line 5 divided by line 6. Line 9 is line 2 divided by line 6. Line 10 is line 9 divided by line 4.

United Kingdom (All Monetary Items in Pounds Sterling)				
Average Value		Ratio of	Rate of Change (Annual Percentage)	Slope
Initial Reference Phase (1874–79) (6)	Terminal Reference Phase (1973–75) (7)	Terminal to Initial Value (8)	from Initial to Terminal Phase (9)	of Semilog Trend (1874–1975) (10)
1.016	67.914	66.84	4.31	4.04
.594	32.515	54.74	4.10	3.97
1.709	2.089	1.22	0.21	0.068
57.16	646.67	11.31	2.49	2.34
1.778	10.502	5.91	1.82	1.69
31.172	55.952	1.795	0.60	0.575
32.6	1213.8	37.23	3.71	3.46
57.0	187.7	3.29	1.22	1.12
19.1	581.1	30.42	3.50	3.39
33.3	89.9	2.69	1.02	1.05

Allowing for the difference in per capita income increases a trifle the difference in money-holding propensities: the average United States resident held cash equal to not quite eleven weeks' income (see table 5.2); the average United Kingdom resident held cash equal to more than thirty weeks' income—striking testimony to the importance of the financial and economic structure for the demand for money. It produces here a nearly three to one difference in velocity.

Like money in total, the amount held as currency rather than deposits was also much greater relative to income in the United Kingdom than in the United States, 7.0 versus 3.6 weeks' income. However, the greater financial sophistication of the United Kingdom meant that the difference in currency holdings was less than in money in total—two to one rather than three to one—so that currency was a decidedly higher percentage of the money stock in the United States than in the United Kingdom.

The next century brought vast changes to both countries, but much greater changes to the United States. The population of the United States nearly quintupled; the population of the United Kingdom less than doubled. United States per capita income was destined to pass United Kingdom income decisively in a very few years, and to remain higher, except briefly during the United States Great Depression of the 1890s. United States per capita income in dollars multiplied twenty-nine-fold—or at the rate of 3.4 percent per year; United Kingdom per capita income in pounds multiplied thirty-seven-fold but, converted into dollars, seventeen-fold—or at the rate of 2.9 percent per year—because in 1973–75 the now floating exchange rate of the pound sterling averaged $2.34 rather than $5.24. By this measure, per capita income in comparable terms rose 1.76 times as much in the United States as in the United Kingdom, a difference produced by a half of one percentage point higher annual rate of growth through the miracle of compound interest. At the end of the

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are high in relation to international prices. The two would just offset if the foreign yield on capital just equaled net export of capital; that is, if on balance all foreign income were reinvested abroad. In this case the trade account would balance.

Some indication of the margin of error is given by converting directly computed real per capita incomes in the two countries in 1929 prices (line 3 in table 5.2) into the same currency at the 1929 exchange rate (which was the same as the 1879 rate). This gives essentially the same result at the beginning of our period as the comparison of nominal incomes—roughly equal incomes in the two countries, implying that Britain's creditor status roughly balanced its status as a capital exporter. However, the same problems bedevil the calculation at the 1929 exchange rate. In addition, real income series constructed over such a long period are neither strictly comparable nor without significant error. Indeed, the closeness of the two estimates is rather surprising.

Jacob Viner's analysis of the role of changes in relative price levels in the mechanism of adjustment of international balances of indebtedness is the classic source on this subject. See *Canada's Balance of International Indebtedness, 1900–1913* (Cambridge: Harvard University Press, 1924), pp. 145–46, 191–255; also Paul Wonnacott, *The Canadian Dollar, 1948–1962* (Toronto: University of Toronto Press, 1965), p. 44.

Table 5.2 **Money-Holding Propensities in the United States and United Kingdom over a Century (All United Kingdom Nominal Figures Converted to Dollars at Prevailing Exchange Rates; United Kingdom Real Figures Converted to Dollars at 1929 Exchange Rate)**

	Initial Phase		Terminal Phase		Annual Percentage Change, Initial to Terminal Phase	
Per Capita	United States 1873–78	United Kingdom 1874–79	United States 1973–75	United Kingdom 1973–75	United States	United Kingdom
1. Nominal money balances	36.4	100.1	2804.	1358.0	4.41	2.67
2. Nominal income	172.7	170.9	4987.	2836.7	3.41	2.88
3. Real income	282.3	277.1	1553.	912.6	1.73	1.22
4. Number of weeks' income in the form of money	10.96	30.47	29.24	24.89	0.996	−.21
5. Number of weeks' income in the form of currency	3.57	7.01	3.19	3.57	−.11	−.69
6. Number of weeks' currency as a percentage of money	32.54	23.01	10.91	14.34	−1.11	−.49

period, United States per capita income was 76 percent higher than United Kingdom per capita income at the exchange rate than prevailing.[5]

The quantity of money in the United States rose much more than nominal income—to 358 instead of 134 times its level in 1873–78. This is the counterpart of the long-term downward trend in velocity so often noted. In the United Kingdom, on the other hand, the rise in money was less than the rise in income: fifty-five fold compared with sixty-seven-fold.

These divergent trends show up sharply in table 5.2. About 1876, the average United States resident held just under eleven weeks of income in money, the average United Kingdom resident just over thirty weeks; by 1974 the order was reversed, over twenty-nine weeks in the United States, under twenty-five weeks in the United Kingdom—a change in the United Kingdom–United States ratio by a factor of more than three to one.

Four items presumably explain the reversal in the recorded figures: differential changes in statistical errors, financial sophistication, real income, and cost of holding money.

5.1.1 Statistical Errors

The recorded figures overstate the size of the change that has occurred in the relative money-holding propensities of residents of the two countries. In both countries, the figures on the quantity of money (1) include domestic money held by foreigners as well as by residents, and (2) exclude foreign money held by residents.

Defect 1 makes all the recorded money figures too high. However, sterling was internationally held in the 1870s to a far greater extent than dollars were, whereas the reverse is almost surely true for recent years, so the overstatement on this score has risen for the United States and declined for the United Kingdom.

5. All rates of change cited throughout the book assume continuous compounding. The entries in columns 4 and 9 of table 5.1 are equal to 100 times the difference between natural logarithms of variables at terminal and initial dates divided by the number of years separating those dates. These continuously compounded rates of change are directly comparable (except for interest rates) to the rates of change computed from triplets of phases, since they are calculated from the slope of a least-squares line fitted to natural logarithms. The reason we make an exception for interest rates is discussed in section 6.6.1.

Note that the change in the exchange rate over the period is slightly greater than the difference in the movement of the price indexes used to deflate nominal income. As a result, the directly measured changes in real income differ a trifle less between the United Kingdom and the United States. Per capita real income, as measured directly, rose 5.5-fold in the United States from 1873–78 to 1973–75, or at the annual rate of 1.7 percent, and 3.3-fold in the United Kingdom between the corresponding phases, or at the annual rate of 1.2 percent. As a result, real income per capita in 1929 prices, converted to a common currency at the 1929 exchange rate, was only 1.70 times as high in the United States as in the United Kingdom, rather than the 1.76 times at the market exchange rate.

Defect 2 makes all the recorded money figures too low. However, United States residents undoubtedly held currency other than dollars (particularly of course sterling) in the 1870s to a far greater extent than United Kingdom residents held currency other than sterling, whereas the reverse is almost surely true for recent years, so the understatement on this score has declined for the United States and increased for the United Kingdom. Hence both defects make the recorded figures exaggerate the rise in United States money holdings relative to United Kingdom money holdings. We have no evidence on the precise size of this statistical error, but it can hardly account for more than a minor part of the major shift in the recorded figures.

5.1.2 Financial Sophistication

In the 1870s the United Kingdom was the world's financial center. It had the most sophisticated and well-developed financial institutions and was the world's banker. The world was said to be on a gold standard; it could better have been described as on a sterling standard. The United Kingdom was largely industrialized, and its agriculture was highly commercial. Only a bit over one-sixth of the male working force and one-eighth of the total working force, both male and female, was recorded as in agricultural occupations.[6] The "money economy" had spread widely if not yet to its outer limits.[7]

6. For percentage of males in agriculture in 1871, see B. R. Mitchell and Phyllis Deane, *Abstract of British Historical Statistics* (Cambridge: Cambridge University Press, 1962), p. 60; for percentage of labor force in agriculture in 1871, see Phyllis Deane and W. A. Cole, *British Economic Growth, 1888–1959: Trends and Structure* (Cambridge: Cambridge University Press, 1962), table 30, p. 142.

7. See Anand G. Chandavarkar, "Monetization of Developing Economies," *IMF Staff Papers* 34, no. 3 (November 1977): 665–721, for an extensive discussion of the role of monetization in the process of economic development, and for a survey of the literature and the empirical evidence on the subject.

Unfortunately, he devotes little attention to the aspect of monetization that is of primary interest for our purposes, namely, its effect on the demand for money. He devotes only one paragraph and one chart to the subject. In that paragraph, he fails to distinguish changes in the nominal quantity of money from changes in the real quantity of money, even though the paragraph is headed "Ratio of Money Supply to Nominal Income," and he dismisses the subject by asserting, "There is, in fact, no systematic observed relationship between money supply and the levels and rates of monetization or of development and national income. Thus, there is a valid distinction between an increase in the quantity of money and an enlargement of the sphere of money transactions" (p. 677). The second sentence is certainly correct, but its validity does not depend on the first, which is itself an ambiguous statement—though the accompanying chart does record the ratio of money supply to gross national product rather than simply money supply. In any event, the subject deserves much more careful study, which allows simultaneously for the effect of monetization and other variables and is careful to assure the comparability among countries of the aggregates labeled money supply.

It seems clear, on purely theoretical grounds, that, the relevant other things the same, in particular, the efficiency of the items included in "money" in rendering monetary services, the extension of the money economy will increase the real quantity of money demanded.

The United States, by contrast, though wealthier and more populous, was still financially backward, conducting its international trade largely in sterling. Nearly three-quarters of the population was classified as residing in rural areas, and half the working force (male and female) was still in agriculture.[8] Production for own use was widespread, and the "money economy" was still limited in scope.

These differences meant a much higher demand for money relative to income by United Kingdom than by United States residents.

By the 1970s the situation was very different. New York had become the financial capital of the world, and while the world had moved from what was said to be a gold exchange standard to what was said to be a regime of floating exchange rates, it could almost as well, and perhaps better, be described as on a dollar standard. London was still an extremely important financial center, but it had declined greatly in importance. The sterling area was a pale and rapidly disappearing reflection of the nineteenth-century British Empire.

Industrialization and the money economy had swept the United States. Only a quarter of the population was classified as residing in rural areas, and less than 5 percent of the working force was in agriculture.[9]

The changes in the United States raised the demand for money, perhaps substantially. The effects of the changes in the United Kingdom are less clear. As noted, the alteration in its international position clearly lowered demand—at least as reflected in the kind of figures we have available. But domestically the remaining pockets of nonmoney activity must have shrunk, and the banking system continued to spread—by the 1970s there were five times as many bank branches as in the 1870s.[10]

The changing relative financial sophistication of the United States and the United Kingdom must have had its major effect during the first part of the century our data cover. World War I was a major watershed. The United States banking system had been growing rapidly before World War I. The war added a further fillip and in addition produced a major expansion in the role of the United States in the world's financial system. From 1880 to 1910, United States population nearly doubled, but the number of banks multiplied more than sevenfold.[11] The fraction of the population residing in rural areas had declined from over two-thirds to only a bit over one-half; the fraction of the work force in agriculture had

8. *Historical Statistics*, ser. A-57, A-69, D-167, D-170.

9. *Historical Statistics*, ser. A-57, A-69; United States Bureau of the Census, *Statistical Abstract*, 100th ed. (1979), p. 403.

10. Estimate for 1870s based on sources for column 1, table 4.9 above; for 1970s, see *Britain 1979: An Official Handbook*, Central Office of Information (London: HMSO, 1979), p. 344.

11. Number of United States banks in 1880 was 3,355; in 1910, 25,151 (*Historical Statistics*, ser. X-580, pp. 1019–20).

declined from one-half to less than one-third.[12] The United States was still far less urbanized and far more rural than the United Kingdom—which by 1911 had only 8 percent of its working force in agriculture[13]—but the difference was much smaller than in the 1870s.

This judgment is supported by the behavior of velocity in the United Kingdom and the United States over the century—plotted in Chart 5.2 and discussed at greater length in section 5.2. The wide difference in velocity in the 1870s was largely erased by 1905, and thereafter velocity is not very different in the two countries until after World War II. Put in the terms we have been using, in the cycle phase 1904–7, which is dated the same in the two countries, money balances amounted to 23.6 weeks' income in the United States, to 28.3 weeks in the United Kingdom—far closer together than thirty years earlier. In the cycle phase 1920–21, after the end of World War I, the difference was much the same: 25.7 weeks' income in the United States, 31.3 in the United Kingdom.

In both 1906 and 1920, real income in the United States was higher than in the United Kingdom. One would expect on this score that real balances expressed in weeks of income would be higher in the United States than in the United Kingdom if financial sophistication were the same, since most of the evidence suggests that the elasticity of demand for money with respect to real per capita income in the United States has been greater than unity. In 1906 interest rates were decidedly higher in the United States than in the United Kingdom, which would tend to offset the effect of higher income, but in 1920 there was not much difference in interest rates. The lower cash balances in the United States than in the United Kingdom, both in 1906 and 1920, even if by nothing like so much as in 1880, presumably means that there was still some residual difference in financial sophistication between the two countries.

Nonetheless, the more than doubling of real balances expressed in weeks of income in the United States in the course of the three decades from 1876 to 1906, during which United Kingdom balances fell by 7 percent, suggests that the change in relative financial sophistication of the United Kingdom and the United States from 1880 to 1906 was probably by all odds the single most important factor accounting for the divergent trends in real balances.

5.1.3 Real Income

Our earlier research indicates that the real quantity of money demanded generally rises in greater proportion than real income—the income elasticity of demand for money is greater than unity—and this conclusion is on the whole confirmed for the United States by the analysis

12. See footnote 8, above.

13. Deane and Cole, *British Economic Growth*, p. 142; Feinstein, *National Income*, table 60, p. T131, gives figures for 1911 that amount to 11 percent in agriculture.

in chapter 6 below, though not for the United Kingdom. If this is so, the rise in per capita real income in both countries should have raised the level of money balances relative to income in the United States but not in the United Kingdom.

5.1.4 Cost of Holding Money

The cost of holding money instead of holding other assets expressed in nominal terms tends to be higher, the higher are interest rates on such other assets. Here there is a sharp contrast between the United States and the United Kingdom, itself one of the consequences of changes discussed in section 5.1.2. In 1876 the United States was a debtor and borrowing country and the United Kingdom was a creditor and lending country; accordingly, interest rates were relatively high in the United States and relatively low in the United Kingdom. In 1974 the situation was reversed. Figures extracted from tables 5.7 and 5.8 for the initial and terminal phases (table 5.3) highlight this contrast. Interest rates were two to four percentage points higher in the United States in the initial phase than in the United Kingdom, two to six percentage points lower in the terminal phase. Interest rates were higher in both countries at the terminal than at the initial phase, but the difference was far greater in the United Kingdom than in the United States.[14]

These interest rate changes presumably lowered the level of money balances demanded relative to income in both countries, but more so in the United Kingdom than in the United States. The interest rate changes therefore reinforced the effect of differential changes in statistical errors, financial sophistication, and real income. All four factors worked to raise United States real money balances relative to United Kingdom real money balances.

This comparison between the United States and the United Kingdom and this interpretation of their differential experience helps resolve a major problem that has arisen about the interpretation of the secular decline in velocity in the United States: how much of that decline, if any, to attribute to the corresponding rise in real income, and how much to

14. These results indicate that the change in the international position of the two countries was more important than their different price experiences. In 1876 the United States had experienced a much sharper price fall in the preceding fifteen years than the United Kingdom, and in 1974, a slower rate of price rise in the preceding two decades. Hence at both dates the expected rate of price rise might have been expected to have been lower in the United States than in the United Kingdom. By itself this would be expected to make interest rates lower in the United States at both dates, whereas they were decidedly higher in 1880. Of course, the change in the international position of the two countries reflects partly a change in the internal productivity of capital. In 1876 the real yield of capital in the United States was presumably very high, much higher than the United Kingdom at the time and probably higher than in the United States in 1974.

For a more detailed analysis of the relation between United States and United Kingdom interest rates before 1914, see section 10.4.

Table 5.3 **United States and United Kingdom Interest Rates in Initial and Terminal Phases**

	Interest Rates					
	United States				United Kingdom	
Phase	Call Money Rate	Commercial Paper Rate	Basic Yield on Long-Term Bonds	Yield on High-Grade Corporate Bonds	Rate on Three-Month Bank Bills	Yield on Consols
Initial phase[a]	4.60	5.86	5.59	7.05	2.89	3.16
Terminal phase[b]	9.56	8.54	7.79	7.97	11.79	13.85

[a]1873–78 for United States; 1874–79 for United Kingdom.
[b]1973–75 for both United States and United Kingdom.

attribute to the changing financial structure. In the absence of any quantitative estimate of the latter effect, we have tended to attribute the decline in velocity to the rise in income.[15] But this interpretation yields elasticities of demand for money with respect to real per capita income for the earlier decades that are higher than for later decades and that are generally higher than the values obtained for other countries or from cross-sectional data.[16]

The comparison with the United Kingdom suggests that our earlier work overestimates the income elasticity for the earlier periods because we did not allow for the effect of the changing financial structure of the economy.[17]

In chapter 6 we explore the effect of increasing financial sophistication in more detail and devise a procedure for adjusting our money estimates for the United States for this effect. The adjusted money stock figures are given in table 5.7, though for the balance of this chapter we use the unadjusted figures.

The magnitude of the effect can be seen by a comparison of real per capita money balances on an unadjusted and adjusted basis in the 1873–78 phase with the single estimate for 1973–75:

Period	*Real per Capita Money Balances*	
	Unadjusted	*Adjusted*
1873–78	$60	$118
1973–75	$873	
Percent per year change	2.72	2.03

15. M. Friedman, *The Demand for Money: Some Theoretical and Empirical Results*, NBER Occasional Paper 68 (New York: NBER, 1959), p. 3 (reprinted from *Journal of Political Economy* 67 (August 1959):327–51; reprinted in *The Optimum Quantity of Money* (Chicago: Aldine, 1969), pp. 111–39); M. Friedman and A. J. Schwartz, "Money and Business Cycles," *Review of Economics and Statistics* 45, suppl. (February 1963): 44; idem, *A Monetary History of the United States, 1867–1960* (Princeton: Princeton University Press for NBER, 1963), pp. 679, 682.

16. E. L. Feige, *The Demand for Liquid Assets: A Temporal Cross Section Analysis* (Englewood Cliffs, N.J.: Prentice-Hall, 1964); idem, "Alternative Temporal Cross-Section Specifications of the Demand for Demand Deposits," in *Issues in Monetary Economics*, ed. H.G. Johnson and A. R. Nobay (London: Oxford University Press, 1974); D. Laidler, "The Influence of Money on Economic Activity: A Survey of Some Current Problems," in *Monetary Theory and Policy in the 1970s*, ed. G. Clayton, J.C. Gilbert, and R. Sedgwick (London: Oxford University Press, 1971), pp. 75–135; J. V. Deaver, "The Chilean Inflation and the Demand for Money," in *Varieties of Monetary Experience*, ed. D. Meiselman (Chicago: University of Chicago Press, 1970), pp. 16–21. See also M. D. Bordo and L. Jonung, "The Long-Run Behavior of Money in Five Advanced Countries, 1870–1975," *Economic Inquiry* 19 (January 1981): 96–116.

17. This suggestion has been made before by a number of reviewers of our *Monetary History*. In particular, see the comment by James Tobin, "The Monetary Interpretation of History," *American Economic Review* 55 (June 1965): 464–85.

About one-quarter of the annual rate of change over a century can apparently be accounted for by an improvement in financial sophistication over roughly the first quarter of that century—since we have not adjusted our monetary estimates after 1903. Clearly, improved financial sophistication was of major significance.

One minor but rather interesting feature brought out by table 5.2 is the divergent behavior of currency. In both the United Kingdom and the United States, the ratio of currency to the stock of money declined, but the decline was much sharper in the United States than in the United Kingdom—in the United States, from 33 percent in 1873–78 to 11 percent in 1973–75; in the United Kingdom, from 23 percent in 1874–79 to 14 percent in 1973–75. In the United States, the decline was produced primarily by a rapid increase in deposits relative to income. The amount of currency expressed in weeks of income declined only slightly from 3.6 weeks' income to 3.2. In the United Kingdom, by contrast, the amount of currency declined substantially, from 7.0 weeks to 3.6 weeks.

The sharper decline in the ratio of currency to money in the United States than in the United Kingdom is presumably another aspect of the growing financial sophistication of the United States relative to the United Kingdom. The spread of banking in the United States, the greater accessibility of banks, and the greater familiarity with their use enabled the public to satisfy its increased money-holding propensities entirely with deposits. This development reached its zenith in 1929, when currency had fallen to 2.4 weeks' income. The subsequent bank failures, and then the war, caused a return to wider use of currency until currency rose to nearly 8 weeks' income at the end of World War II, nearly twice the highest level ever attained before 1929. Currency holdings then declined back to 3.2 weeks' income by 1973–75.

A more puzzling feature is that both at the beginning and the end of the period, the use of currency was higher in the United Kingdom than in the United States—nearly twice as high at the beginning, 12 percent higher at the end. The lower interest rates in the United Kingdom than in the United States at the beginning of the period would make for higher currency holdings, but if this were the whole of the explanation the higher interest rates in the United Kingdom than in the United States at the end of the period should have produced the opposite result. The changing interest rates may explain why the differential between the United States and the United Kingdom narrowed; it cannot explain the consistently higher level in the United Kingdom.

This subject needs much more attention than we have given it. Our offhand inclination is to attribute the difference between the United Kingdom and the United States to two major factors: (1) the greater social stratification in the United Kingdom than in the United States, which produces a corresponding stratification of individuals having and

using checking accounts; (2) different legal arrangements that make the penalty for writing a "bad" check less stringent and sure in the United Kingdom.[18]

So far we have compared the state of affairs in the two countries at the beginning and end of the century we cover. Another way to summarize the developments during that period is in terms of average rates of change as measured by the slopes of semilog trends fitted to the phase averages.

We can use the framework of the quantity equation for this purpose, as expanded by expressing real income as the product of population and real income per capita, or, to repeat equation (4) of chapter 2,

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

where M is the aggregate nominal amount of money; V is velocity; P, the price level; N, population; and y, real income per capita.

Taking logarithms of both sides of equation (1) gives

$$\log M + \log V = \log P + \log N + \log y. \tag{2}$$

Differentiate with respect to time:

$$\frac{1}{M}\frac{dM}{dt} + \frac{1}{V}\frac{dV}{dt} = \frac{1}{P}\frac{dP}{dt} + \frac{1}{N}\frac{dN}{dt} + \frac{1}{y}\frac{dy}{dt}\,, \tag{3}$$

or in the notation introduced in chapter 2,

$$g_M + g_V = g_P + g_N + g_y \,.$$

We thus add rates of change, instead of multiplying levels. In these terms we have

18. We have observed that there is a fairly clear demarcation between countries in which checks are and countries in which checks are not widely used by people in many walks of life. This demarcation is not by stage of economic development. For example, checks are little used in Greece and Japan, widely used in Thailand, Israel, and Taiwan. One conjecture that we have formed is that the difference reflects a different legal situation with respect to "bad" checks. In the United States, trying to "pass" a "bad" check is a criminal offense. This encourages the widespread use of checks since, in effect, it reduces the risk and cost of collection. In countries like Greece, passing a bad check is a civil offense. The writer of the check can be sued for damages but is not liable to criminal prosecution. This discourages the use of checks and encourages the use of cash.

Our impression is that the legal situation in the United Kingdom is closer to that described as applying to Greece than to that in the United States. But whether this be the explanation or not, it is clear that checks are much less widely used in the United Kingdom than in the United States. In 1978 fewer than half of United Kingdom adults had any kind of account at a commercial bank; in the United States, 75 percent had checking accounts in 1970. George Katona et al., *1970 Survey of Consumer Finances*, University of Michigan Survey Research Center, Institute for Social Research, table 6-1, p. 98; article by Robert D. Hershey, Jr., *New York Times*, 28 January 1978.

Percent per year change in	*United States*	*United Kingdom*
M	5.87	3.97
V	−0.96	+0.07
Y = nominal income	4.91	4.04
P	1.77	2.34
N	1.50	0.58
y	1.64	1.12

In both countries, the change in the quantity of money clearly dominated the change in nominal income—exceeding the income change in the United States because of the sizable decline in velocity; differing trivially in the United Kingdom because of the trivial change in velocity. Both money change and income change were decidedly higher in the United States than in the United Kingdom.

On the other side of the quantity equation, the similar rate of change of prices reflects the international linkage between the two countries and the constant rate of exchange for about half of the period (1879–1914, 1925–31). The faster rise in the United Kingdom than in the United States is the counterpart of the depreciation of the pound sterling relative to the dollar after 1931, and then again after World War II. Both population and real income grew less rapidly in the United Kingdom, much more than offsetting the more rapid rate of price rise, so nominal income rose only four-fifths as fast—4.0 compared with 4.9 percent.

As noted, the differential behavior of velocity reinforced the effect of the slower rate of rise in nominal income in the United Kingdom, so that the quantity of money rose only two-thirds as rapidly (instead of four-fifths, like income) in the United Kingdom as in the United States.

The changes we have summarized in this section did not of course proceed evenly. Section 5.2 describes the fluctuations of the levels of the various series around their trends, and section 5.3, of the rates of change.

5.2 Long Swings in the Levels of Money, Income, and Prices

Chart 5.1 plots the phase values of the nominal money stock at the middates of the corresponding phases for the United States and the United Kingdom. (The numerical values except for the United States money stock before 1902 are given in tables 5.7 and 5.8, sec. 5.5.)

For both countries, the phase values for the nominal money stock show long undulating movements about the semilog straight-line trends plotted on the chart.

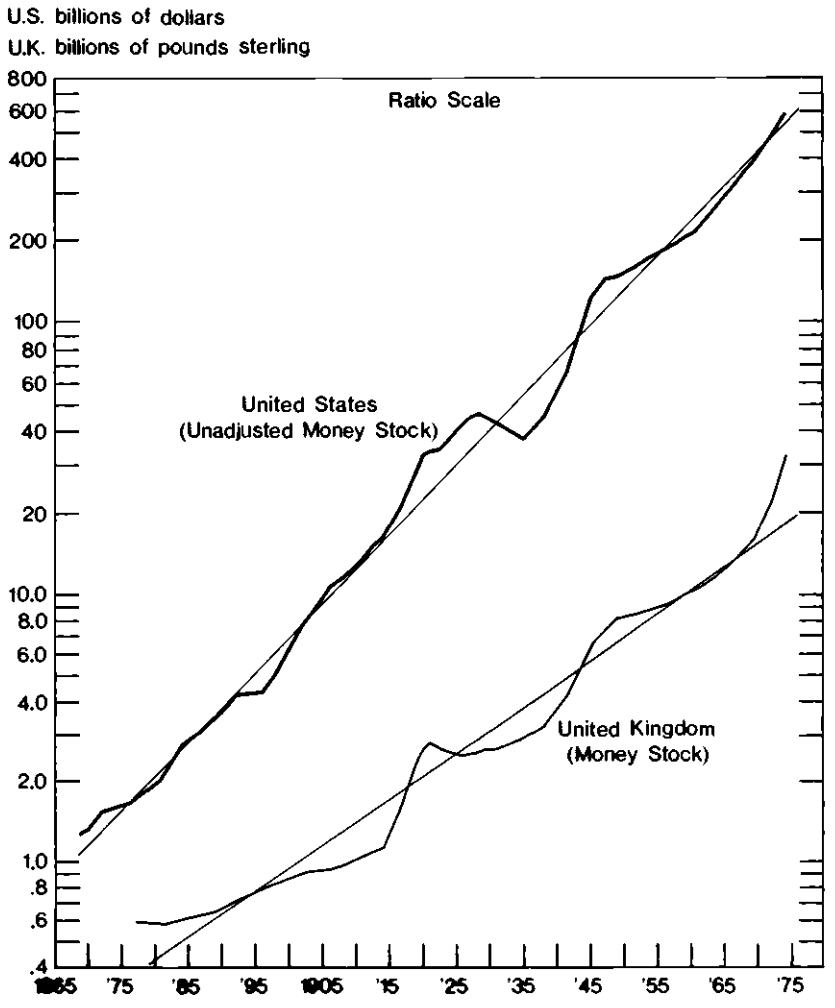


Chart 5.1 Phase values of United States and United Kingdom nominal money stock.

For the United States, we have discussed in detail in *A Monetary History* the proximate reasons for these movements in the stock of money: the initial relatively slow rate of growth and the speeding up around 1880 reflect preparation for resumption and then the aftermath of resumption; the sharp retardation in the 1890s reflects the monetary disturbances associated with the agitation for free silver; the subsequent acceleration beginning around 1895 is partly a reaction to these disturbances, partly a result of the worldwide expansion in gold supplies following new discoveries and the practical application of the cyanide process in

extracting gold from low-grade ore; the mild retardation after about 1905 reflects the end of the reaction to the earlier stagnation in an environment in which gold production continued at a fairly rapid rate; the rapid acceleration after 1913 and then sharp retardation reflect World War I monetary expansion and the postwar tight money policy that the Federal Reserve System imposed in 1920; the absolute decline after 1928 reflects the monetary collapse associated with the Great Contraction that terminated in the banking holiday of 1933; the subsequent rapid rate of growth was speeded up even more by the financing of World War II, which was followed by a distinct slowing up until about 1960, when monetary expansion accelerated.

It is a striking sign of the close financial links among major countries that the United States and United Kingdom figures show such similar patterns. World Wars I and II and their postwar aftermaths leave a similar imprint on the charts for the two countries and produce undulations that have a close family resemblance. Yet there are also important differences that mirror the different internal experiences of the two countries.

1. The sharp retardation of growth in the United States money stock in the 1890s has no counterpart in the United Kingdom data, just as the agitation for free silver that produced the United States retardation had no counterpart in the United Kingdom.

2. Despite the worldwide expansion of gold production after the 1890s, United Kingdom monetary growth slows down in the early 1900s and only starts accelerating after about 1907. This reversal of the United States pattern is almost certainly a consequence of that pattern, though it very likely was reinforced by the effect of the Boer War on the United Kingdom balance of payments. As the rapid United States expansion generated balance of payments surpluses and attracted gold, the United Kingdom had to surrender gold—or, more accurately, was able to attract an inordinately small share of newly mined gold. The resulting retardation in United Kingdom monetary growth is the other side of the acceleration in United States monetary growth. Then, as the United States experienced retardation, the United Kingdom was able to join the worldwide acceleration.

3. In World War I, the money stock rose slightly less in the United States than in the United Kingdom—from the phase centered on 1914 to the phase centered on 1920 the stock of money rose 105 percent in the United States and 126 percent in the United Kingdom. There was no corresponding difference in the growth of nominal income, which rose 125 percent in the United States and 123 percent in the United Kingdom. However, the further breakdown between prices and output was very different. In the United States, prices rose 81 percent and output rose 25

percent; in the United Kingdom, prices rose 141 percent, while output actually fell by 8 percent.

4. The much greater rise in United Kingdom than in United States prices plus the determination of the United Kingdom to return to gold at the prewar parity produced a striking difference in the postwar behavior of the money supply. After a mild retardation attributable to the immediate postwar deflation, the United States money stock continued to rise at roughly its long period trend rate until the onset of the Great Depression. The United Kingdom money stock declined sharply until 1925 as part of the deflationary policy that preceded Britain's return to gold. It then started to rise, though at a very slow rate, until 1930.

This pattern in the United Kingdom reproduces, though on a condensed time scale and about a much flatter trend, the behavior of the United States money stock after the Civil War. The decline relative to trend in the United States money stock from 1865 to 1879,[19] when the United States returned to gold at the pre–Civil War parity, is the counterpart of the absolute decline in the United Kingdom money stock from 1920 to 1925, when the United Kingdom returned to gold at the pre–World War I parity. The acceleration of monetary growth in the United States after 1879 is the counterpart of the slower acceleration in the United Kingdom after 1925.

5. The United States money stock falls sharply from the phase centered on 1928.5 to the phase centered on 1935.0. The United Kingdom money stock accelerates its rate of growth after the phase centered on 1931. The reason is clearly that the United Kingdom departed from gold in September 1931 and the United States not until March 1933. As a result, the contraction came to an end in the United Kingdom earlier than in the United States and was nothing like so severe (as we shall see below, the behavior of income parallels that of the money stock in both countries).

6. In World War II, the money stock rose more rapidly in the United States than in the United Kingdom—the opposite of the relation in World War I. From the phase centered on 1938 to the phase centered on 1949, the money stock rose 224 percent in the United States and only 152 percent in the United Kingdom. Nominal income shows a parallel difference, rising by 174 percent in the United States and by 111 percent in the United Kingdom. This time the whole of the difference in the rise in nominal income is accounted for by a different behavior of real income, and none by prices. In both countries, prices rose by nearly 80 percent, but this price rise was accompanied by a more than 50 percent increase in

19. Though we have reasonably accurate estimates only from 1869 on, other evidence suggests that the decline dates from 1865.

output in the United States and by less than a 20 percent increase in the United Kingdom.

7. The most fascinating feature about the post–World War II behavior is the close similarity in the rate and pattern of monetary growth, except for the much sharper acceleration in the final phases in the United Kingdom than in the United States. In both countries, monetary growth accelerated slightly in the early fifties during the Korean War, then slowed down, then speeded up appreciably after 1960. For a time this final acceleration was more marked in the United States than in the United Kingdom, but then the United Kingdom took the lead—if that is the right word—with a decisive spurt at a rate comparable to the prior record in World War I.

The main postwar pattern in both countries, as table 5.4 brings out, is an acceleration in money in the double sense of a rising rate of growth and also a shortening of the length of the successive step-ups in growth, though the first step does average out the acceleration and retardation associated with the Korean War. In both countries, nominal income at first rose more rapidly than money—the counterpart of the postwar rebound in velocity—but then, in the third period, the reverse occurred as velocity fell. The result was a less rapid acceleration in nominal income growth than in money growth, but a decided acceleration nonetheless, except only between the first two periods for the United Kingdom.

The most interesting feature of the postwar experience is the division of the nominal change between prices and output. The percentage absorbed by prices was consistently higher in the United Kingdom. In both countries it was roughly the same in the first two periods, but it rose even more sharply in the final period than did the rate of growth of nominal income, with the result that while output growth rose between the first two periods, it fell between the second and third. This is the much discussed postwar shift in the empirical Phillips curve, to which we shall return in chapter 9.[20]

Given the appreciable differences between the two countries in the long-term movement of the nominal money stock, do these differences leave their imprint on the long-term movements of nominal income? Panel 1 of chart 5.2 gives a clear affirmative answer. The striking feature of this chart is that the movements in nominal income differ between the two countries in the same way as the movements in money. In each country separately the undulations in nominal income mirror to a remarkable degree the undulations in the stock of money.

In the United States, the trend in money is steeper than in income; in the United Kingdom they are roughly the same. However, this apparent

20. M. Friedman, "Inflation and Unemployment" (Nobel Lecture), *Journal of Political Economy* 85 (June 1977): 451–72.

Table 5.4 **Rates of Change of Money, Income, Prices, and Output in Three Post–World War II Periods, United States and United Kingdom**

Period	Duration (in Years)	Rate of Change (Annual Percentage)				Percentage of Nominal Income Change Accounted for by Price Change
		Money g_M	Nominal Income g_Y	Price Level g_P	Output $g_{y'}$	
			United States			
1948–60	12	3.62	5.90	2.20	3.71	37.3
1960–69	9	6.96	7.20	2.73	4.47	37.9
1969–75	6	8.39	7.92	5.80	2.12	73.2
			United Kingdom			
1951–60	9	2.12	6.42	4.05	2.37	63.1
1960–68	8	4.39	6.37	3.72	2.65	58.4
1968–75	7	12.31	10.87	8.95	1.92	82.3

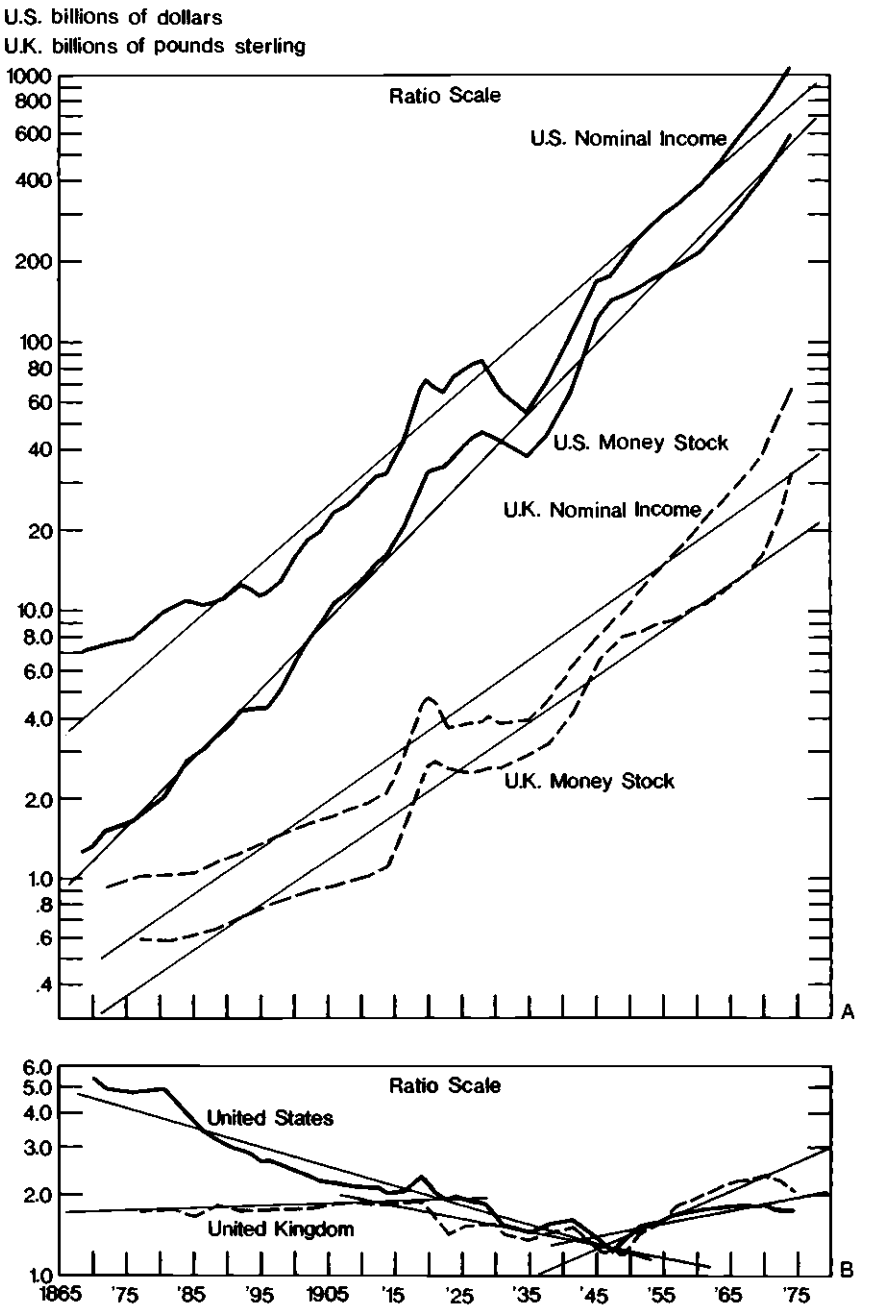


Chart 5.2 Phase values of United States and United Kingdom nominal income and nominal money stock and velocity.

difference conceals a similarity. In both countries, the trend in money is steeper than that in income from World War I to the end of World War II, and much less steep thereafter. This is the phenomenon discussed in section 5.1; it is reflected in the downward trend in United States velocity to the end of World War II, and the upward trend thereafter (panel 2 of chart 5.2), and in the roughly horizontal trend in United Kingdom velocity to World War I, the downward trend to the end of World War II, and the upward trend thereafter.

The undulations about the trends are, however, common to money and income, as is clear from the greater steadiness of the velocity series in each country than of either the money or the income series. In neither country does either the money or the income series have an appreciable movement that does not have a counterpart in the other—with one possible exception, already referred to, which interestingly enough is the same for the two countries. That exception is for roughly the decade of the 1950s. In both countries, income rose decidedly faster during the 1950s than money—that is, velocity rose sharply rather than falling as it had for most of the prior seven decades in the United States and rather than remaining stable or falling as it had for the prior eight decades in the United Kingdom. But this exception is temporary. In the decade of the sixties, money and income resumed their parallel movement in the United States and came much closer to parallelism in the United Kingdom.

The velocity series highlights the discrepancies between the undulations in the money and income series. One fascinating feature of the velocity series for the two countries is their extraordinary similarity, especially after 1905, when the sharp fall in United States velocity relative to United Kingdom velocity came to an end (see panel 2 of chart 5.2).

From 1905 on, a single description will suffice for both countries: velocity rose in the later stages of the World War I period, then declined, recovering slightly in the 1920s; velocity fell sharply in the Great Contraction, rose again at the beginning of World War II, fell sharply during the war, rose sharply thereafter to the middle or late sixties, then fell moderately. The only major difference after 1905 is the greater amplitude of the post–World War II movements in the United Kingdom than in the United States.

The two war periods are especially intriguing—in the first, velocity rose and in the second velocity fell, alike in the two countries. Presumably, this reversal must have reflected other differences that were also common to the two countries. Similarly, velocity rose sharply after World War II in both countries. One explanation offered for the United States has been the rapid growth of shares in savings and loan associations, which nearly quadrupled between 1950 and 1960, going from a total equal to about 9

percent of the money stock to nearly 30 percent.[21] The United Kingdom experienced a similar phenomenon: building societies' shares and deposits roughly tripled over the corresponding period, rising from a total equal to 14 percent of the money stock to 35 percent.[22] This common rapid expansion may have had different sources in the two countries (e.g., there was no development in the United Kingdom comparable to the extension in the United States in 1950 to savings and loan shares of insurance provisions identical with those for commercial bank deposits), but the occurrence of the same phenomenon in both, along with a similar behavior of velocity, adds to the evidence that this explanation has merit. We analyze these features of the behavior of velocity in greater detail in chapters 6 and 7 below.

The changes in the money and income series in chart 5.2 can be regarded as the composite of changes in prices and in real magnitudes, and the latter, in turn, of changes in population and per capita real magnitudes. Of these three components, population behaves most smoothly (see chart 5.3 and table 5.5). For both countries, population accounts for an appreciable part of the trend in the aggregate series but for a trivial part of the undulations about the trend.

The trend of prices is very different before and after 1914. The period before 1914, taken as a whole, is a period of roughly stable prices in both countries, though of course with considerable variation about the trend. The period after 1914, on the other hand, is a period of rising prices in both countries, interrupted only during the interwar period. For the post-1914 period as a whole, the rate of rise averages over 2 percent in the United States, 3 percent in the United Kingdom. This post-1914 price trend accounts for less than 40 percent of the total trend in nominal income and the nominal money stock in the United States, but for more than 60 percent in the United Kingdom, the steeper United Kingdom price trend being reinforced by a flatter trend in both population and per capita real magnitudes.

The different trend in prices before and after 1914 is not matched by any corresponding difference in the trend of real output per capita. In both the United Kingdom and the United States, per capita output has a slightly higher trend rate after 1914 than before: in the United States, 1.8 versus 1.6; in the United Kingdom, 1.5 versus 1.2. Because population grew more slowly in both countries after 1914, the slightly more rapid trend rate of growth in per capita output is converted into a slower rate of growth in total output in both countries after 1914 than before.The most

21. M. Friedman and A. J. Schwartz, *Monetary Statistics of the United States*, table 1, cols. 7 and 10, pp. 40–47.

22. D. K. Sheppard, *The Growth and Role of U.K. Financial Institutions, 1880–1962* (London: Methuen, 1971), table (A)2.4, p. 151, and table 4.9, above.

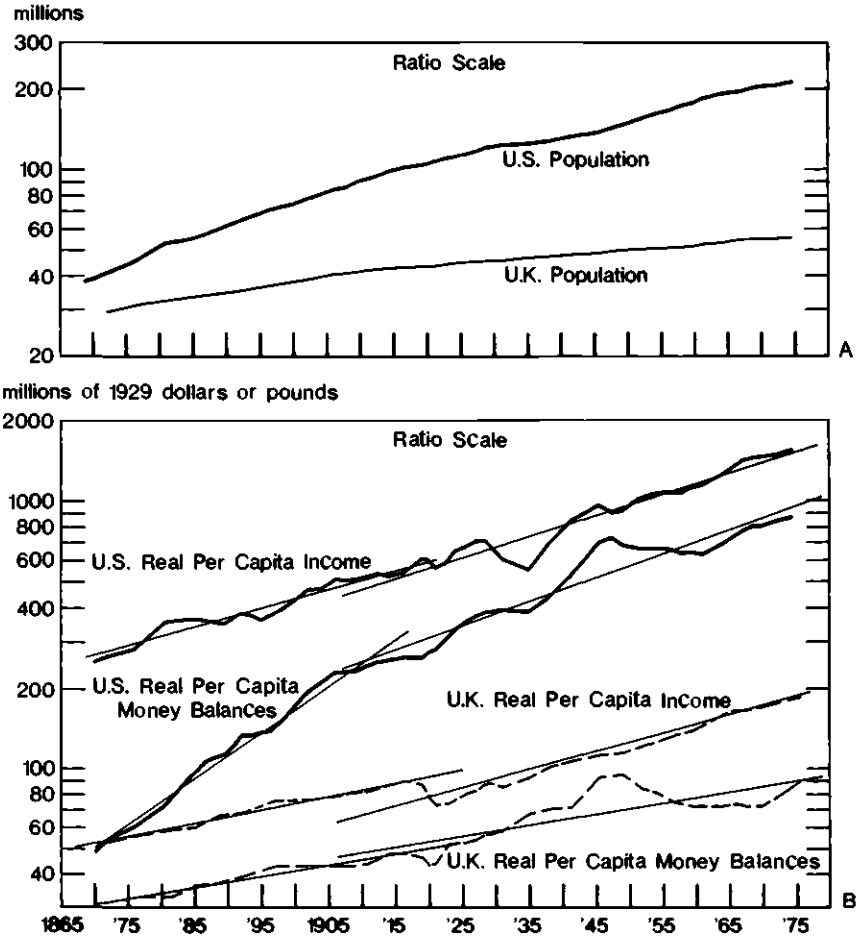
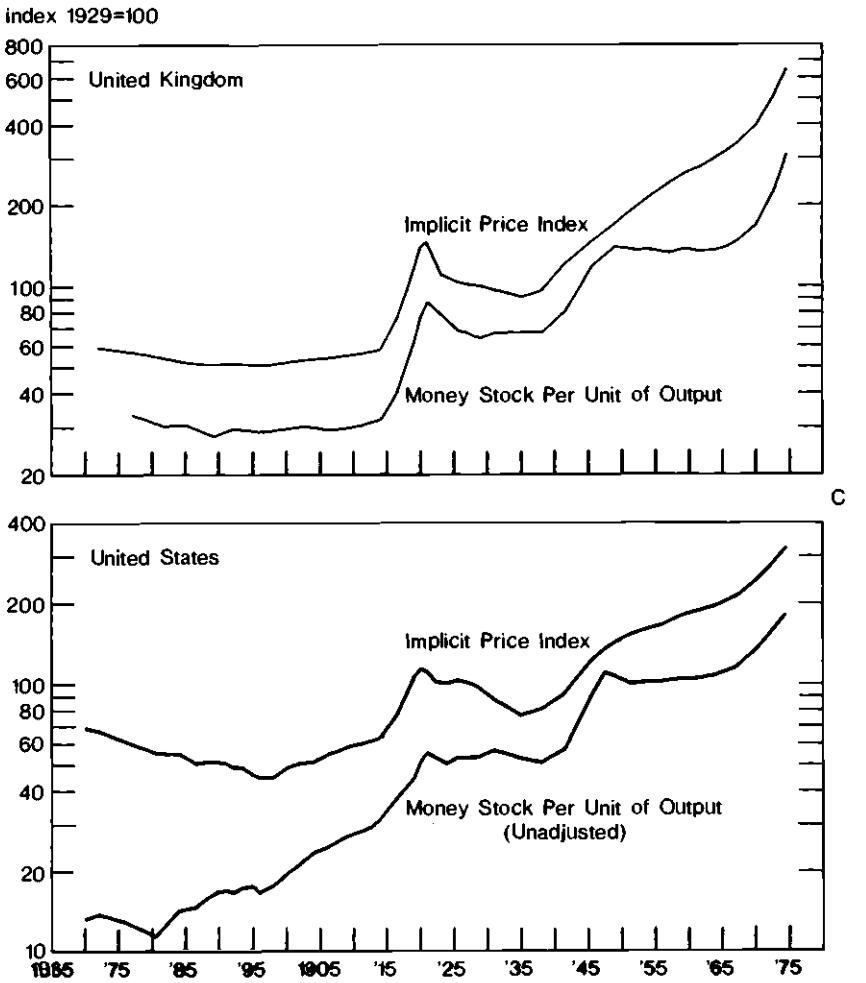


Chart 5.3 Phase values of United States and United Kingdom population, per capita real income and money, and prices and money stock per unit of output.

interesting feature of chart 5.3 and table 5.5, however, is what they say about the variability of various magnitudes about the trend.

Most important, nominal money is, with one exception (pre-1914 for the United Kingdom), less variable than nominal income, though per capita real money is uniformly more variable than per capita real income. This apparent contradiction is in fact wholly consistent with the theoretical analysis of chapter 2—as reflected for example in chart 2.3. That analysis suggests that a maintained change in the rate of change of money will ultimately produce an equal maintained change in the rate of change of nominal income and prices, but that, in the transition, the rate of



change of both nominal income and prices must overshoot in order to raise nominal income and prices to new levels consistent with an altered desired velocity—a higher rate of monetary growth raising desired velocity, a lower rate lowering desired velocity.

The effect is to produce a wider amplitude of movement in nominal income and prices than in nominal money—which is precisely what table 5.5 shows, with two minor exceptions (the lower variability of income than of money in the United Kingdom pre-1914 and of prices than of money in the United States after 1914). The wider fluctuations in prices than in money produce a negative relation between fluctuations in nomi-

nal balances and real balances—which is precisely what is required for the standard deviation of the fluctuations about the trend to be smaller for the logarithm of money than for one or more of its components, the logarithm of real balances and the logarithm of prices.[23] Because they can be reflected positively in nominal income as well as negatively in real income, the wider fluctuations in prices than in money need not produce as numerically large a negative correlation between the fluctuations in prices and output as between fluctuations in nominal and real balances, and may even be consistent with a positive correlation between prices and output; hence the standard deviation of the nominal income fluctuations can be larger than in any of its components, as it is except for the United Kingdom before 1914. Finally, the same reasoning explains why real balances uniformly fluctuate more widely about trend than output.

Another striking feature of the measures of variability in table 5.5 is that every magnitude is more variable for both countries after 1914 than before. This feature is closely related to the preceding. First, price fluctuations play a dominant role in the long-period undulations of the nominal magnitudes about trend. Population and output are constrained by physical limits. There are no such limits for prices—as has been demonstrated most dramatically in hyperinflations when prices have risen astronomically. That is why commodity standards such as gold or silver standards have emerged or been adopted—to provide physical limits to the stock of money. Second, price fluctuations have indirect effects that infect real magnitudes, both real balances, for reasons already indicated, and output, because wider price fluctuations increase uncertainty and instability. Third, from 1879 to 1914, the gold standard operated largely unchecked in both the United States and the United Kingdom. It limited the range of fluctuations in prices and hence in all magnitudes in table 5.5—though even then prices varied more than either real balances or output per capita. The widest fluctuations in prices in both the United States and the United Kingdom occurred when the physical limit imposed by a gold standard was absent or relatively ineffective—the sharp collapse in prices in in the United States from the Civil War to 1879 and the major rises in both countries during the two world wars, and in the United Kingdom after World War II. The post-1914 period is more variable than the pre-1914 period because it is the period when commodity standards were replaced by fiduciary or fiat standards and no effective substitute developed for the physical limits imposed by a commodity standard.

23. Recall that

$$\sigma^2_{X+Y} = \sigma^2_X + \sigma^2_Y + 2r_{XY}\sigma_X\sigma_Y ,$$

so that unless r_{XY} is negative, σ^2_{X+Y} must be larger than either σ^2_X or σ^2_Y; and it may be larger even though r_{XY} is negative, provided the absolute value of the correlation is low enough.

Insofar as the quantity of money demanded is negatively affected by the variability of prices (see sec. 2.4.1, point 4), the shift from a commodity to a fiduciary or fiat standard presumably was a factor tending to raise velocity in both countries, but it clearly was not a dominant factor, at least between the two wars.

The importance of prices for the long-period undulations in nominal magnitudes is of great significance for the understanding of economic developments. In particular, it means that the long swings in monetary magnitudes to which so much attention has been devoted are largely a price phenomenon, which has important implications for their explanation. We shall return to this matter in chapter 11.

Chart 5.3 contains one series not so far discussed; money stock per unit of output, a ratio of money stock to real income in 1929 dollars. If the quantity theory held in its most rigid and extreme form, so that the velocity of money was numerically an unchanging constant, prices and the quantity of money per unit of output would be strictly proportional to one another, the proportionality factor being the reciprocal of the velocity of money.[24] Except for the differences in the trend of prices and of the quantity of money per unit of output, the rigid relation comes very close indeed to being realized for both countries. The movements in the two series about their trends mirror one another faithfully, except for the one episode referred to earlier—the decade of the 1950s, when the sharply rising velocity in both countries is reflected in the opening up of a widening gap between prices and money per unit of output.

5.3 Rates of Change of Money, Income, and Prices

As we noted in chapter 3, rates of change provide an alternative, and frequently superior, way to isolate fluctuations about trends.

Chart 5.4 is the counterpart of chart 5.2, except that it plots rates of change rather than absolute levels. (Except for the United States money stock and velocity before 1902, the numerical values are given in tables 5.9 and 5.10.) It brings out even more strikingly the high degree of consilience between the movements in the quantity of money and in nominal income we remarked on in discussing chart 5.2. Rates of change are notoriously erratic. Yet there is scarcely a movement of any size in the money series that does not have its counterpart in the income series, and conversely. Out of forty-eight successive movements in the rates of

24. From equation (4) in chapter 2,

$$\frac{M}{y'} = \frac{1}{V} P,$$

where $\frac{M}{y'}$ is the quantity of money per unit of output.

Table 5.5 **Components of Trends and Fluctuations about Trend in Money Stock and Income United States: 1873–1975, 1873–1914, and 1914–75 United Kingdom: 1874–1975, 1874–1914, and 1914–75**

	Trend					
	United States Annual Percentage					
	1873–1975		1873–1914		1914–75	
Component	Money	Income	Money	Income	Money	Income
1. Population	1.50		2.01		1.29	
2. Real magnitude per capita	2.60	1.64	4.01	1.57	2.07	1.83
3. Prices	1.77		0.039		2.08	
4. Nominal aggregate	5.87	4.91	6.06	3.62	5.44	5.20
	Fluctuations about Trend					
	United States Standard Deviation of Deviations from Trend (Percentage)					
	1873–1975		1873–1914		1914–75	
	Money	Income	Money	Income	Money	Income
5. Population	5.20		1.16		2.30	
6. Real magnitude per capita	16.34	8.60	6.50	5.78	11.76	9.31
7. Prices	20.78		10.47		18.60	
8. Interaction among components	[−20.86]	[6.79]	[−9.46]	[3.59]	[−11.08]	[16.13]
9. Nominal aggregate	17.05	24.06	7.98	12.54	19.15	26.42

Sources:
Lines 1, 2, 3, 4: Slopes of semilogarithmic trends fitted to indicated magnitudes.
Lines 5, 6, 7, 9: Standard deviations of the deviations of the logarithms of the magnitudes in question from a semilogarithmic trend.
Line 8: If $U = X + Y + Z$ (e.g., log money = log population + log per capita real money + log prices), then

$$\sigma_U = [\sigma_X^2 + \sigma_Y^2 + \sigma_Z^2 + 2r_{XY}\sigma_X\sigma_Y + 2r_{XZ}\sigma_X\sigma_Z + 2r_{YZ}\sigma_Y\sigma_Z]^{1/2}.$$

change for the United States and thirty-four for the United Kingdom, forty-one in the United States and twenty-five in the United Kingdom are in the same direction in both series, some of the exceptions involve movements that are small in magnitude, five of the seven exceptions for the United States and five of the nine exceptions for the United Kingdom are during World War II and the early postwar period, and two of the remaining four exceptions for the United Kingdom are connected with

Trend

United Kingdom
Annual Percentage

1874–1975		1874–1914		1914–75	
Money	Income	Money	Income	Money	Income
	0.58		0.87		0.45
1.05	1.12	0.97	1.16	0.98	1.50
	2.34		0.049		3.00
3.97	4.04	1.90	2.08	4.42	4.95

Fluctuations about Trend

United Kingdom
Standard Deviation of Deviations from Trend (Percentage)

1874–1975		1874–1914		1914–75	
Money	Income	Money	Income	Money	Income
	2.85		0.29		0.49
11.65	9.30	4.08	3.22	14.23	7.53
	26.50		4.80		23.11
[−19.31]	[3.46]	[−4.51]	[−4.31]	[−20.17]	[6.86]
21.75	28.44	4.41	3.86	18.17	25.26

Because the sum in the bracket is based on a sum of squares, it must be positive. The square root of that sum (times 100) is given in line 9. Similarly, the first three terms in the bracket must also be positive, and their square roots are given in lines 5, 6, and 7. However, the remaining terms may be positive or negative, and so may their sum. Strictly speaking, when it is, its square root is imaginary. Instead, in order to indicate the size and the direction of the interaction, we have changed the sign of such negative sums, extracted the square root, and then designated the square root by a minus sign. That is why we have entered the numbers in the table in brackets.

World War I. In both countries, once the wartime readjustments were completed, the relation returned to its prewar closeness.

For the United States, the first sizable discrepancy in movement is from the triplet of phases centered on 1878–82 to the triplet centered on 1882–85, when the money series rises and the income series declines. We are inclined to attribute this discrepancy to the effect of resumption which, by linking the dollar to gold, presumably raised the demand for

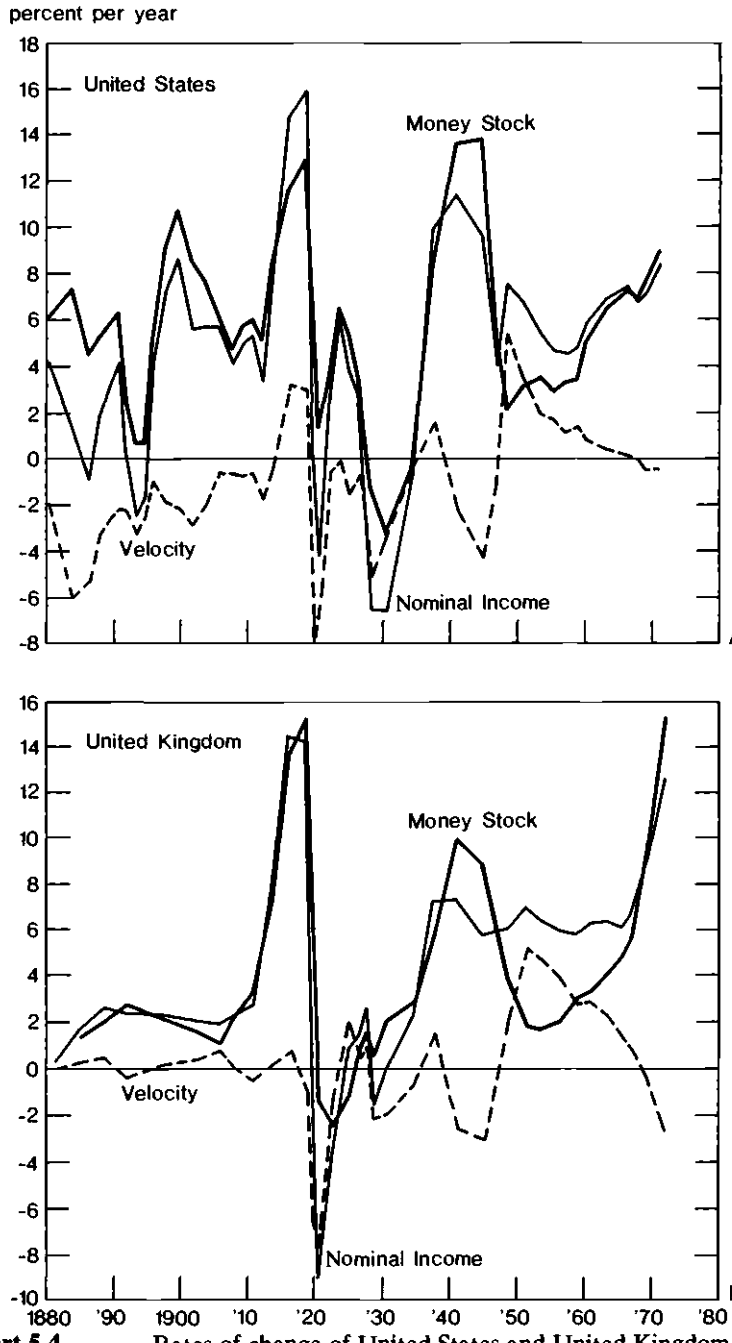


Chart 5.4 Rates of change of United States and United Kingdom nominal income, nominal money stock, and velocity.

dollars, in particular by leading to the substitution of dollars for foreign currencies by persons and firms engaged in foreign trade. For nearly a half-century thereafter there is no appreciable discrepancy, only one minor difference in direction (from the triplet centered on 1892–94 to that centered on 1894–95), though there are some sizable differences in amplitude of movement associated with World War I. The second sizable discrepancy in amplitude, though not in direction of movement, occurs in the period of the Great Contraction, when the rate of change in income fell to much lower levels than the rate of change in money. We are inclined to believe that the widespread bank failures in 1931, 1932, and early 1933 made this deviation smaller than might have been anticipated. The bank failures reduced the attractiveness of money as an asset and so moderated the sharp reduction in velocity that might have been expected as a result of the rapid rate of fall of prices, the decline in interest rates, and the great uncertainty about future economic developments. It is noteworthy that velocity fell much more sharply in Canada, where there were no bank failures, than in the United States, although economic conditions were otherwise very similar.[25] The remaining discrepancies all come during and after World War II, the opposite movements in the rate of rise in money and in income reflecting first the wartime decline in velocity and then the postwar reaction of velocity.

For the United Kingdom, the first sizable discrepancy is between the triplet of phases centered on 1888.5 and the second succeeding triplet centered on 1897, when the rate of rise of nominal income first decreases then increases slightly, while that of money first increases then decreases.

During and after World War I, there are two discrepancies in the direction of movement of the rates of change of money and income, one minor, the other appreciable. The larger discrepancy reflects the postwar reaction to the wartime rise in velocity, which produced a larger decline in income than in money—essentially the same pattern as in the United States.

The remaining discrepancies in movement are all for the World War II period, which again duplicates the United States pattern: the rate of change of money first overshoots the rate of change of income, then declines substantially below the rate of change of income, then closes the gap as the two rates of change come together. The only difference in the patterns for the two countries is that it took longer in the United Kingdom than in the United States for the rates of change of money and income to come back together. In the United States, the discrepancy is largely eliminated by the early 1960s; in the United Kingdom, not until the later 1960s.

This difference may well have reflected a phenomenon for the United Kingdom the reverse of that which we noted for the resumption period

25. See *A Monetary History*, p. 352.

for the United States: the replacement of the pound by the dollar as the preferred international currency. The changes in the exchange rate of the pound relative to the dollar, interpreted as due to United Kingdom, not United States, instability, reduced the quantity of pounds demanded. The end of the Bretton Woods system in 1971 presumably had a similar effect on the dollar, but that came too late in our period to show up in our rate of change series.

The wartime deviations offer a fascinating puzzle: they are essentially identical in the two countries in each war, but in both countries the pattern in World War I is the reverse of the pattern in World War II. In World War I, income is more volatile than money (velocity first rises and then declines); in World War II, money is more volatile than income (velocity first declines and then rises). In our *Monetary History*, we explained the World War II decline in velocity in the United States by price controls, the unavailability of consumer durable goods, and the expectation of a postwar contraction accompanied by declining prices. "World War I," we wrote, "differed markedly from World War II with respect to both the availability of goods and expectations about the postwar behavior of prices and incomes. 'Shortages' and 'controls' in World War I were nowhere nearly so sweeping as in World War II, and no major branch of civilian production suspended output entirely. World War I came after nearly two decades of generally rising prices, when the climate of opinion was characterized by belief in unlimited future potentialities rather than by fear of secular stagnation."[26]

Both wars involved much more serious economic dislocations for longer periods in the United Kingdom than in the United States—which is presumably why the return to normal took longer in the United Kingdom after both wars. But the contrast between the two wars in price controls, availability of goods, and public expectations was much the same in the United Kingdom as in the United States.

The financial policy of the two countries is an additional factor, not sufficiently stressed in our *Monetary History*, that was common to the two countries but different between the two wars and that may have contributed to the reversal in the behavior of velocity. In both countries, interest rates rose fairly sharply during World War I but fell during World War II. Partly, this different movement of interest rates reflected the different economic circumstances before the outbreak of war. Mostly it reflected a deliberate government policy of keeping interest rates low during World War II. The effect on velocity was reinforced by the much more extensive and effective official control of prices during World War II in both countries than during World War I. In an interesting dissertation on repressed inflation, Juan Toribio, adducing both theoretical considerations and empirical evidence, argues persuasively that repres-

26. *A Monetary History*, p. 560.

sion of inflation leads to a highly interest-elastic demand curve for money.[27] If this is so, the low controlled interest rates may have induced the public to hold in the form of money an unusually large fraction of the liquid assets they accumulated for the other reasons cited.

These discrepancies do not belie the close similarity between the rate-of-change series in each country for money and income. Indeed, the money and income series show such a remarkable similarity that it seems worth emphasizing that, so far as we are aware, the basic data on money and income from which they are derived are completely independent measurements that have no arithmetically common elements. The money data come primarily from the records of government monetary authorities and of banks; the income data, from a great variety of sources of which monetary authorities and banks contribute at most only that mite that corresponds to their expenditures for factor services. The similarity between the two series in each country does not reflect any spurious correlation arising from reliance on common data. It rather occurs despite independent errors of measurement in the data underlying the two series, and despite the brevity of many phases that limits averaging out of such errors in computing phase averages. The similarity records an economic phenomenon that must be explained in economic terms.

The similarity of movement says nothing in and of itself about direction of influence. It is consistent with changes in money producing corresponding changes in income, or with changes in income producing changes in money, or with changes in both money and income being the common consequence of changes in still other variables.

One quantitative measure of the similarity in the movements of the rates of change in money and income is the correlation coefficient between them, which, for the period as a whole is 0.86 for the United States, 0.84 for the United Kingdom (table 5.6, line 1). This means that at least 74 percent for the United States and at least 71 percent for the United Kingdom of the variation in each series can be accounted for by the systematic element it has in common with the other series. If the nonsys-

27. The essence of his theoretical argument is that, if some goods are rationed at controlled prices, all substitution has to take place among the unrationed goods, which raises the cross-price elasticities among them. Given the extensiveness of rationing at controlled prices in the United Kingdom during World War II, he concludes that, "A British holder of liquid assets had practically closed all possibility of choice except the alternative of buying bonds or keeping his cash balances." He goes on to say that, "In the extreme case, if all goods other than money and securities were rationed, it is conceivable that a liquidity trap might appear in the money market." His empirical evidence consists of relating velocity to interest rates for so-called free market periods and the repressed inflation period 1940–49. He finds small, often statistically insignificant interest elasticities for "free-market" periods, much larger, and statistically significant, elasticities for the repressed inflation period. Juan Toribio, "On the Monetary Effects of Repressed Inflation," Ph.D. diss., University of Chicago, 1970, especially pp. 118–31; quotation from p. 122.

Table 5.6 **Rates of Change of Money, Income, and Velocity: Standard Deviations and Correlations**

Correlation Coefficient	Period and Country									
							Peacetime Years			
							Ex-War		Post–World War I	
	Full Period		Pre–World War I		Post–World War I		United States 1873–1914, 1921–38, 1949–75	United Kingdom 1874–1914, 1921–38 1951–75	United States 1921–38, 1949–75	United Kingdom 1921–38, 1951–75
	United States 1873–1975	United Kingdom 1874–1975	United States 1873–1914	United Kingdom 1874–1914	United States 1914–75	United Kingdom 1914–75				
1. g_M and g_Y	0.8612	0.8408	0.7296	0.9016	0.8960	0.7657	0.8571	0.8502	0.9497	0.8250
2. g_V and g_M	−0.0223	−0.3627	−0.0828	−0.4341	0.0037	−0.4280	0.0455	−0.2170	0.5956	−0.3037
3. g_V and g_Y	0.4889	0.1994	0.6212	−0.0016	0.4474	0.2535	0.5536	0.3294	0.8172	0.2879
Standard deviations										
4. σ_{g_M}	4.4456	3.4968	1.9890	0.8128	5.2772	4.0824	3.6119	2.4382	3.9381	4.0898
5. σ_{g_Y}	5.0949	3.3256	2.5295	0.7322	5.9008	3.8143	4.3327	2.5207	5.4883	4.0689
6. σ_{g_V}	2.5900	1.9316	1.7358	0.3517	2.6207	2.7143	2.2343	1.3594	2.1393	2.4134
Maximum residual variation										
7. $\sigma_{g_M \cdot g_Y}$	2.2595	1.8930	1.3602	0.3516	2.3434	2.6258	1.8607	1.2836	1.2333	2.3113
8. $\sigma_{g_Y \cdot g_M}$	2.5896	1.8003	1.7299	0.3167	2.6203	2.4533	2.2320	1.3270	1.7187	2.2995
Standard deviation of nonsystematic component										
9. g_M	1.6562	1.3952	1.0343	0.2550	1.7018	1.9761	1.3654	0.9437	0.8832	1.7109
10. g_Y	1.8982	1.3269	1.3153	0.2297	1.9029	1.8463	1.6378	0.9756	1.2309	1.7021

tematic element were equally important for money and for income, the correlation coefficients themselves would measure the fraction of variability that money and income have in common—or 86 percent for the United States, 84 percent for the United Kingdom.[28]

28. The usual way of describing the squared coefficient of correlation (r^2) between two series, say M (for the rate of change in money) and Y (for rate of change of income) is to describe it as giving "the fraction of the variation in Y accounted for by M," or, alternatively, "the fraction of the variation in M accounted for by Y." But this description is highly special, really a limiting description. Only one of these two statements can be correct—they are alternatives, not simultaneously valid statements. In the usual statistical jargon: the first assumes M to be fixed or exogenous or measured without error; the second assumes Y to be.

A more meaningful description is the one given in the text—that r^2 is the *minimum* fraction of the variation in Y and in M accounted for by the systematic element they have in common. To see that this is a valid description, we may use the permanent-transitory approach of Milton Friedman, *A Theory of the Consumption Function*. Let us assume that we can regard both M and Y as the sum of a systematic element which is common to the two and a nonsystematic element— these being the counterpart here to the "permanent" and "transitory" components of income and consumption. For simplicity we may assume that all variables are measured as deviations from their means so all average zero. Let

(a) $$M = M_p + M_t$$

(b) $$Y = Y_p + Y_t$$

define the division of each into a systematic component, designated by subscript p, and nonsystematic component, designated by t. As in the consumption counterpart, assume that M_t and M_p, and also Y_p and Y_t, and M_t and Y_t are uncorrelated, and that

(c) $$Y_p = kM_p$$

expressing the idea that these are the systematic elements that the two variables have in common except for a scale factor. We then have that

(d) $$\sigma_M^2 = \sigma_{M_p}^2 + \sigma_{M_t}^2$$

(e) $$\sigma_Y^2 = \sigma_{Y_p}^2 + \sigma_{Y_t}^2,$$

and

(f) $$r_{MY}^2 = \frac{\sigma_{M_p}^2}{\sigma_M^2} \frac{\sigma_{Y_p}^2}{\sigma_Y^2},$$

or $$r_{MY}^2 = P_M P_Y,$$

where P_M is the fraction of the variance of M, and P_Y, the fraction of the variance of Y, contributed by the systematic or permanent component. (This is the notation of *A Theory of the Consumption Function*, which is why we use it here despite possible confusion with our use of P to refer to price.)

In the usual description in which, for example, M is the fixed variable or measured without error, P_M is taken to be unity, and so r^2 is described as the fraction of the variance of Y accounted for by M, and conversely if Y is taken as the fixed variable. It is now clear why these cannot both simultaneously be valid. However, they are lower limits, since P_Y and P_M must both be less than unity, and hence each separately must be between unity and r^2.

If $P_M = P_Y$, then the correlation coefficient itself can be described as the "fraction of their variability the two variables have in common," but this too is a highly special case, since there is no reason in general why the unsystematic element should be the same fraction of the total variability for the two variables. Note that the unsystematic element includes pure

The slightly higher correlation for the United States than for the United Kingdom is somewhat misleading. The correlation is higher only because there is more variation in both money and income in the United States than in the United Kingdom, not because there is a closer relation between money and income. It has long been noted that economic fluctuations in the United States have both a greater frequency and a greater amplitude than in the United Kingdom. This is reflected in the consistently and substantially higher standard deviations of the rates of change for both money and income for the United States than for the United Kingdom (table 5.6, lines 4 and 5; the only exception is for post–World War I peacetime years for money). Hence there is more variation to be accounted for in the United States.

The comparative closeness of the relation between money and income in the two countries can be judged better by comparing standard errors of estimate: the variation in the rate of change in income when allowance is made for the concomitant systematic variation in the rate of change of money, and, conversely, the variation in the rate of change of money when allowance is made for the concomitant systematic variation of income. Lines 7 and 8 of table 5.6 give upper limits to the size of this residual variability. Lines 9 and 10 give an estimate of the residual variability on the assumption that the nonsystematic element is equally important for money and for income.[29] Despite the lower correlation for the United Kingdom, these estimates of the nonsystematic variability, like the initial variability, are smaller in the United Kingdom than in the United States for the period as a whole, though of course the difference is less for the nonsystematic than for the initial variability. The lower

error of measurement. For the United States, for example, our judgment is that such errors of measurement account for a larger fraction of the variance of Y than of M.

The statement that M and Y have a systematic component in common says nothing about direction of influence. It might be that the influence runs either way or both ways or that both systematic components are the common consequences of still other variables.

29. To continue with the preceding note, the standard error of estimate of Y given M, which is usually described as the variation in Y not accounted for by M, is obtained by assuming that $P_M = 1$; and similarly $\sigma_{M \cdot Y}$ by assuming that $P_Y = 1$. Both these assumptions cannot be simultaneously valid, hence both of these "residual" standard errors cannot be simultaneously valid. A better interpretation is that each is the maximum unsystematic error, obtained by assuming that all unsystematic variation is in the particular variable in question.

If $P_M = P_Y$, then the variance of the nonsystematic component is given by $(1 - r)$ rather than $(1 - r^2)$ times the variance of the measured variable. This assumption has been used in computing the entries in lines 9 and 10 of table 5.6.

If $P_M > P_Y$, then the corresponding standard deviation for M would be smaller and for Y larger, and conversely if $P_M < P_Y$.

Despite their unconventionality, we believe that the numbers computed on the assumption that $P_M = P_Y$ give a less biased indication of the size of the nonsystematic component than the maximum estimates in lines 7 and 8.

variability for the United Kingdom for the period as a whole is produced by the pre-1914 period.

The residual or nonsystematic variability consists of two very different elements: pure errors of measurement—these might be called the stochastic statistical element; and variability in income and money attributable to variables that do not affect them alike—this might be called the stochastic economic element. For the United Kingdom, for the period before 1914, the extensive use of interpolation particularly for the income data, probably produces a negative correlation between the statistical and the economic elements, and so biases sharply downward both the initial and the residual variation. Though we suspect, on historical grounds, that the nonsystematic variability was decidedly greater in the United States during this period than in the United Kingdom, we also suspect that the very wide difference recorded in table 5.6 overestimates the difference between the two countries, because of the difference in the statistical characteristics of the United Kingdom and the United States estimates.

For the entire period after 1914, for which the statistical difficulties are less serious, the residual variation is greater for the United Kingdom than for the United States for money but less for income, but both differences are small and not statistically significant. However, this equality too is misleading, reflecting primarily the greater impact of the two wars on the United Kingdom. For post–World War I peacetime years, the nonsystematic variation in the rates of change of money and income are both significantly larger (at the .05 level or a more stringent significance level) for the United Kingdom than for the United States, the reverse of the earlier relation, but again not inconsistent with the historical impression that, in recent decades, the United Kingdom has become the less stable economy.

The velocity series plotted in chart 5.4 is, by definition, the vertical difference between the other two series.[30] The high correlation between the rates of change of money and income implies that the rate of change of velocity has a smaller amplitude of fluctuation than either of them—as it uniformly does (see lines 4, 5, and 6 in table 5.6). Indeed, the reader's first impression may well be, as ours was, that the fluctuations in velocity are surprisingly large in view of the similarity of movements of the money

30. Since $V = Y/M$,

$$\log V = \log Y - \log M,$$

so

$$\frac{\Delta \log V}{\Delta t} = \frac{\Delta \log Y}{\Delta t} - \frac{\Delta \log M}{\Delta t}.$$

Our rates of change assume continuous compounding and hence are equal to these rates of change in the (natural) logarithms.

and income series. The reason is partly that the velocity series fluctuates most at those periods when the other two series are fluctuating most, so the larger differences between the other two series are overshadowed by their common violent movement, and partly that the velocity series reflects the nonsystematic components of both the other series. There is clearly much variation in velocity requiring attention—but clearly also the rigid quantity theory assumption of a strictly constant velocity is not a bad first approximation for movements lasting more than two or three years.

Any measurement error or nonsystematic fluctuation in the rate of change of income enters with the same sign into the rate of change of velocity and hence will tend to produce a positive correlation between the income and velocity series. Conversely, any error or fluctuation in the rate of change of money enters with the opposite sign into the rate of change of velocity and hence will tend to produce a negative correlation between the money and velocity series. These expectations are fulfilled in sixteen of the twenty correlations in table 5.6. Two of the exceptions are trivial (United Kingdom, pre–World War I, and United States, post–World War I). The substantial positive correlation between the rate of change of velocity and of money for United States peacetime years, after World War I, reflects the much larger variation in the income than in the money series, so that its fluctuations dominate the velocity correlations.[31]

31. It is easy to show that

$$r_{VY} = \frac{\sigma_Y - r_{YM}\sigma_M}{\sigma_V},$$

$$r_{VM} = \frac{r_{YM}\sigma_Y - \sigma_M}{\sigma_V}$$

so that

$$r_{VY} \gtreqless 0$$

according as

$$\frac{\sigma_Y}{\sigma_M} \gtreqless r_{YM}$$

and

$$r_{VM} \gtreqless 0$$

according as

$$\frac{\sigma_Y}{\sigma_M} \gtreqless \frac{1}{r_{YM}}.$$

For r_{VY} to be positive and r_{VM} negative, the requisite condition is that both $\frac{\sigma_M}{\sigma_Y}$ and $\frac{\sigma_Y}{\sigma_M}$ be greater than r_{YM}, which generally is the case in table 5.6.

Perhaps the most remarkable feature about the rate of change of velocity, as about its level, is the extraordinary similarity of movement in the two countries. Chart 5.5 superimposes the two separate levels of velocity series from chart 5.2 and the two rates of change of velocity series from chart 5.4. The parallelism for levels and the near identity for rates of change is striking. The rate-of-change series for the two countries are almost duplicates, except for the early period. The loose relation before World War I may reflect statistical defects, particularly the role of interpolation in the United Kingdom figures that produce such a stable rate of change of velocity, or looser links between the two countries than they were destined to become. Thereafter, the only notable discrepancy comes after World War II, when the peak rate of rise of velocity came later in the United Kingdom than in the United States and remained higher until 1970. The obvious explanation is the more severe economic impact of both wars in the United Kingdom than in the United States and hence a sharper and longer reaction.

This striking similarity in the movement of velocity in the two countries is of the greatest importance. It means that no explanation of these movements is acceptable that depends on conditions special to each country separately. The two countries have clearly been part of a single monetary order in which major velocity movements have reflected influences common to the two countries.

Chart 5.6, the counterpart of chart 5.3, shows rates of change for the components of the money and income series of chart 5.4. Population clearly accounts for only a minor part of the fluctuation in the money and income series. For the United States, only World War I, the Great Contraction, and the post–World War II baby boom leave an appreciable impress on the rates of change of population when they are plotted on the same scale as the other series; for the United Kingdom, only World War I, the twenties, and recent years do.

The next two panels for each country, each containing a pair of series, real income per capita, and real money per capita in panel B, and prices and money stock per unit of output in panel C, are derived from the aggregate money and income series by deflating both by the same variables—population and prices, in panel B, and aggregate real income, in panel C. Hence, in each panel the difference between the two series is precisely equal to the difference between the money and income series of chart 5.4, which is to say, equal to the velocity series of that chart.

The elimination of price and population movements leaves much variability in the rates of change in money and income, though for both countries the real magnitudes in chart 5.6, panel B, are much less variable than the original nominal magnitudes in chart 5.4, and also than the nominal series in chart 5.6, panel C, which relate prices to the money stock per unit of output. In addition, for both countries the two series in

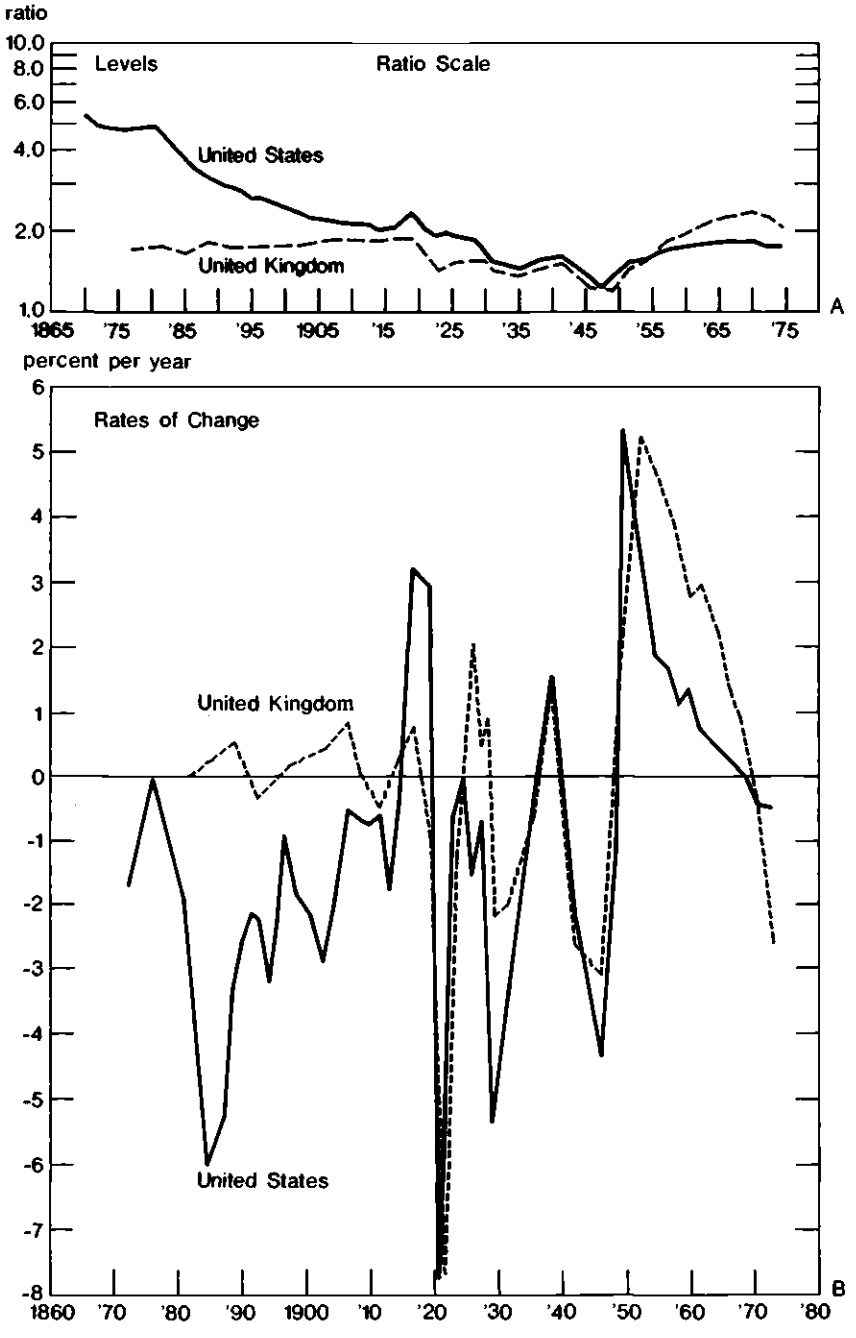


Chart 5.5 United States and United Kingdom velocity: levels and rates of change.

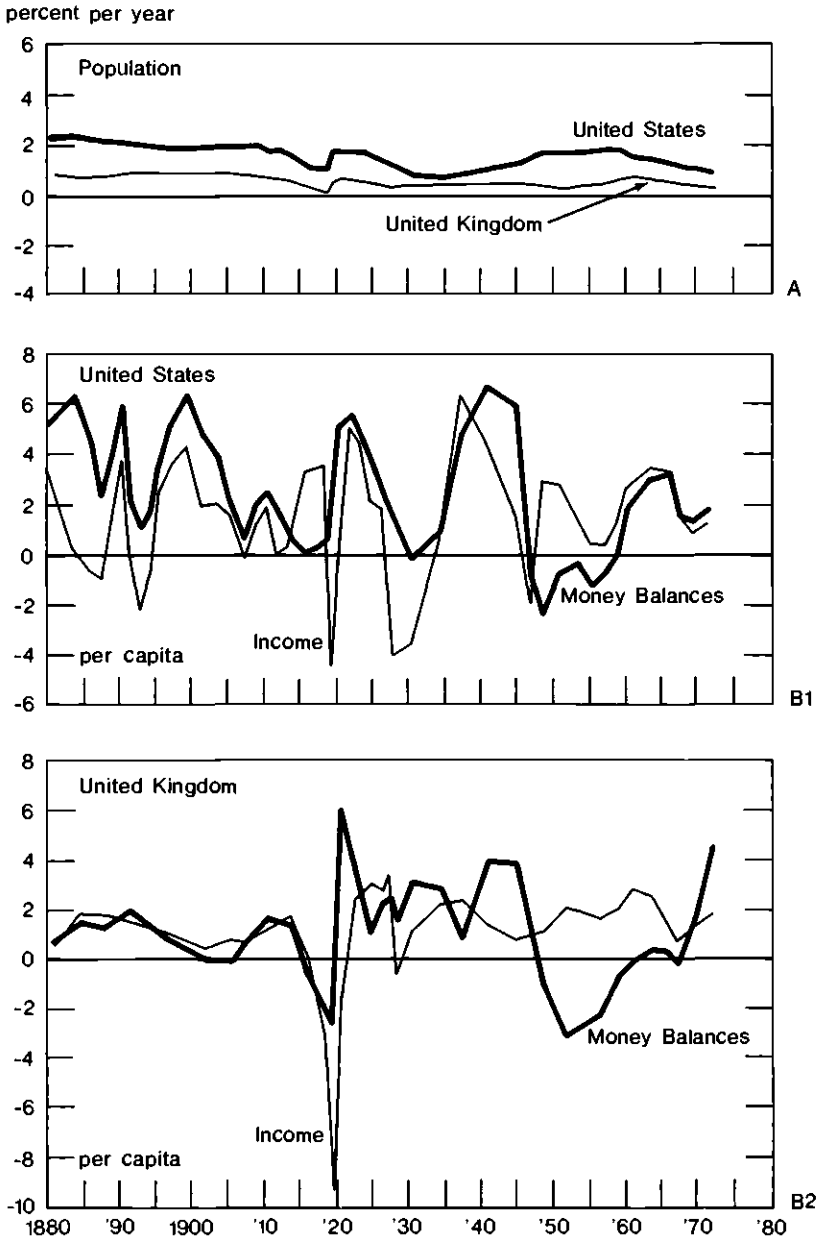
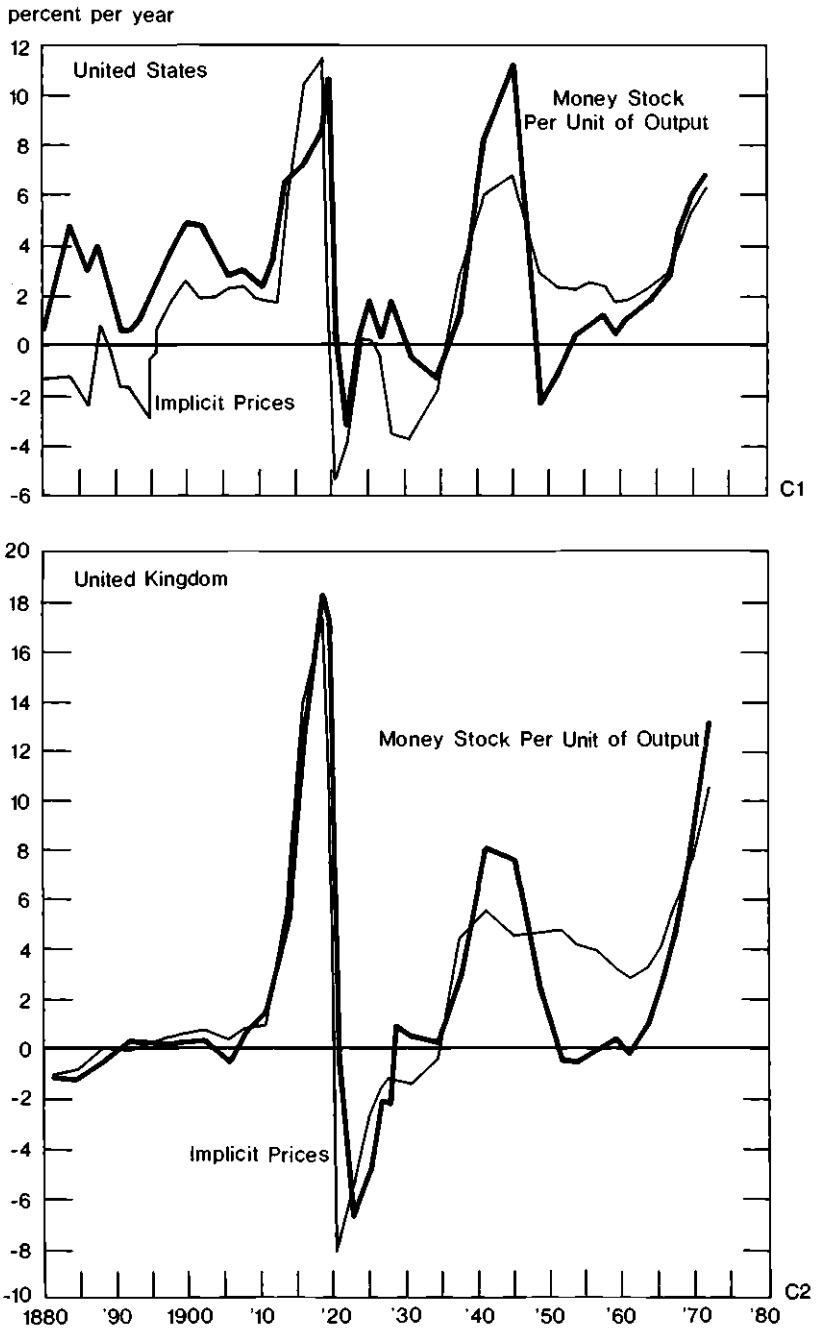


Chart 5.6 Rates of change of United States and United Kingdom population, per capita real income and money, and prices and money stock per unit of output.


percent per year
United States
Money Stock
Per Unit of Output
Implicit Prices
C1
United Kingdom
Money Stock Per Unit of Output
Implicit Prices
C2
1880
'90
1900
'10
'20
'30
'40
'50
'60
'70
'80

panel C are more highly correlated than the two in panel B. The chart thus illustrates our earlier conclusion that the common fluctuations in the rates of change of the stock of money and of nominal income are largely a price phenomenon. However, the chart also underlines the no less interesting fact that the common fluctuations are not solely a price phenomenon. For the United States in particular, the real magnitudes in panel B and not only the nominal magnitudes in panel C move together. For the United Kingdom, there may be some tendency in this direction, but it is much more muted.

This important issue can be examined more clearly in chart 5.7, which plots the rate of change of money (reproduced from chart 5.4) against the rate of change of prices and of real income (reproduced from chart 5.6), the two components of the nominal income series plotted in chart 5.4.

For the United States, it is striking how closely the movements in the stock of money series parallel the movements in real income; indeed, in terms of short-term movements there seems to be, if anything, a closer relation between the movements in money and in real income than between the movements in money and prices. Note, for example, how the bulge in the money series for the triplet of phases centered on 1910–11 (plotted at 1 January 1911) is matched by a corresponding bulge in the output series, but not in the price series,[32] and how much closer the parallelism between money and output is from 1923 to 1939 than between money and prices. The reason the correlation coefficient between money and real income (.620 for the period as a whole) is nonetheless lower than between money and prices (.785) is the failure of the real income series to follow the longer period and larger shifts in the money series as closely as the price series does. For example, when the money series shifts from one level before 1896 to another level thereafter, the price series follows the shift, whereas the real income series does not. Precisely the same difference emerges after World War I when the money series shifts to a lower level. As we noted in *A Monetary History*, longer-period movements in rates of change of money are paralleled mainly by corresponding movements in prices, not in real output.[33] However, chart 5.7 makes it clear that at least for the United States the periods over which rates of change of money and real output move together are of considerably longer duration than individual business cycles.

32. This particular parallelism is so striking that it seemed worth checking to be sure that it did not simply reflect an error in deflation, which recorded what was in fact a variation in prices as variation in output. Accordingly, we computed rates of change, 1869–1914, for two indexes constructed by Edwin Frickey (*Production in the United States, 1860–1914* [Cambridge: Harvard University Press, 1947], pp. 54, 127), both based on physical-quantity data, measuring production for manufacture and industrial and commercial production. The rate of change movements in the two series parallel those in real income after 1890, and show the same distinctive bulge for the triplet of phases centered on 1910–11.

33. Pp. 242–44, 677, 678.

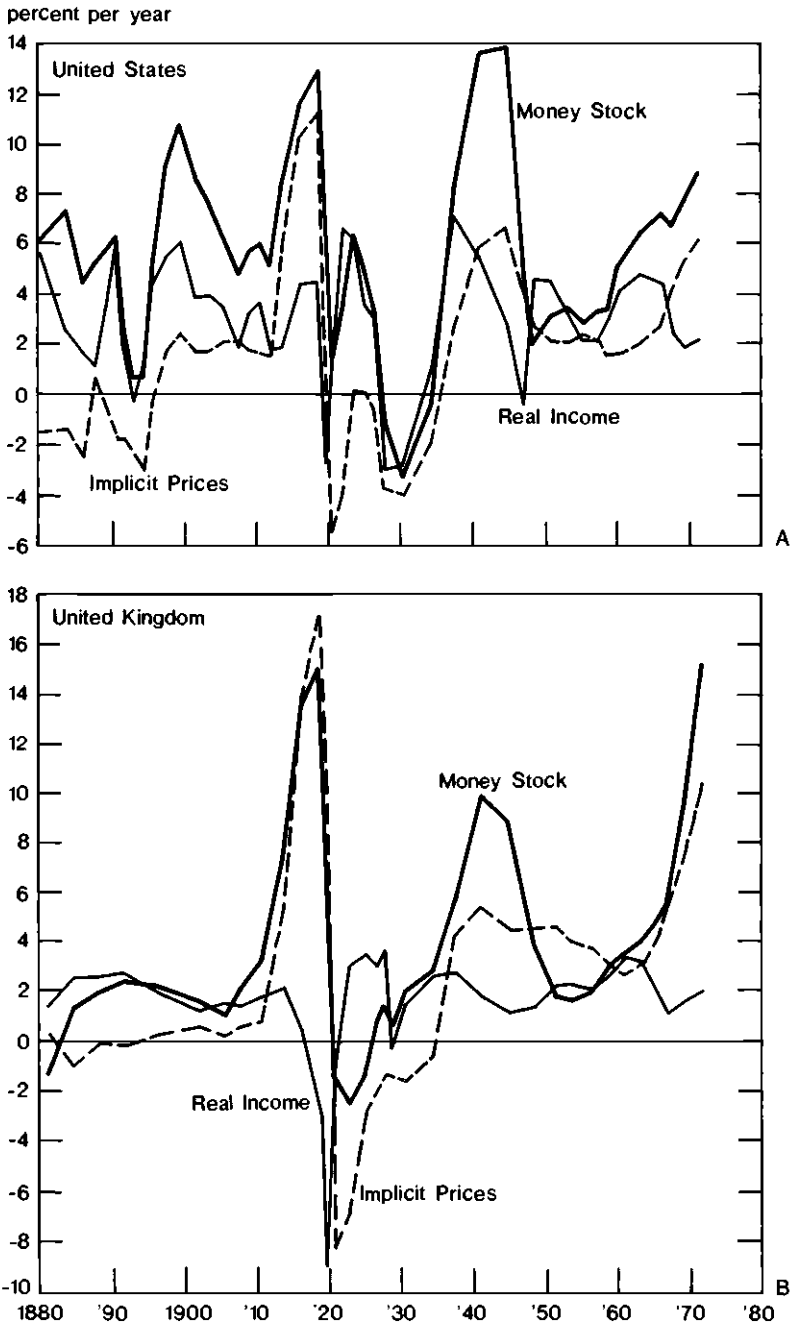


Chart 5.7 Rates of change of United States and United Kingdom money, prices, and real income.

The United Kingdom chart is more difficult to read than the United States chart, but when its story is extracted it turns out to be very much the same. The key difficulty in reading the chart is the greater violence done by two world wars to the United Kingdom than to the United States economy. Consider first the period before World War I. For that period, the money line nearly duplicates the real income series except for the early years. Consider next the period between the two wars. For that period, all three curves are remarkably parallel; but again, as for the United States, if anything, the real income and money series are more closely related, except for the sharp drop from before to after 1928 in the level of the real income curve that makes the computed correlation between the money rates of change and real income rates of change negative (−.308).

Consider next the two world wars. Both countries show very much the same pattern in rates of growth of money and prices: in World War I, sharp and parallel rises of almost the same amount and a subsequent very sharp fall; in World War II, a rise and subsequent fall in money and prices but a much sharper rise and fall in money than in prices, and with the fall in the rate of price change spread over a longer period in the United Kingdom. The behavior of real income differs much more between the countries: in the United States, an initial rise, then decline in both wars; in the United Kingdom, decline throughout the wars. For both countries, the relation between money and real income is much looser for these wartime periods than for the other periods. However, these wartime movements are much larger in amplitude compared with the peacetime movements for the United Kingdom than for the United States. Hence they dominate our first impression of the charts—and also computed correlation coefficients—for the United Kingdom far more than for the United States. For the United States, as noted, the correlation between the rates of change of money and real income is positive for the period as a whole (.620); for the United Kingdom it is negative (−.294). However, if the war periods are excluded, the correlation is positive though negligible for the United Kingdom (.027) and significantly higher for the United States (.802).

The economic relations that prevailed during the war years—and particularly World War II—were no doubt very different than during other times. Price controls, physical rationing and unavailability of goods, the direction of so large a fraction of resources to military use, the widespread expectations of a very different future than present—all no doubt altered the impact of monetary change on real output and prices. However, in addition to such real differences in economic relations, we have great doubts about the accuracy of our series during this period, particularly our price series. Price control meant that price increases took indirect and concealed forms not recorded in the indexes; the large rise in

price indexes when price control was repealed consisted largely of an unveiling of the earlier concealed increases. Hence the price indexes understate the price rise during the war and overstate the price rise after the war. Similarly, price controls in the United States from 1971 to 1973 and in the United Kingdom from 1966 to 1974 distort the reported price indexes.

We have attempted to adjust our price series during World War II and during post–World War II peacetime years for these defects (see secs. 4.1.3 and 4.2.3), but we are far from certain that our adjustments are adequate. We suspect that wartime controls produced errors in the nominal income series and not only in its division into prices and output—this surely was the case insofar as controls stimulated black market and other unrecorded transactions. Hence, in many of the sections that follow we shall present separate results excluding the wartime and immediately postwar years.[34]

The relation between money and real income is considered in much greater detail in chapter 9. We there find that the relation is rather different than might appear given the preceding summary of this chapter. Not only the wars but also the great contractions turn out to produce something of an optical illusion.

5.4 Conclusion

The broad descriptions of the secular movements in money, income, prices, and velocity in the earlier sections of this chapter bring out sharply three phenomena that require further interpretation: first, the common movement of nominal money and nominal income; second, the largely common movement in velocity in the United States and in the United Kingdom; third, the rather different relations in the two countries be-

34. Level observations excluding wars omit the following phases in each war for each country:

World War I				*World War II*			
United States Phase		*United Kingdom Phase*		*United States Phase*		*United Kingdom Phase*	
Number	*Dates*	*Number*	*Dates*	*Number*	*Dates*	*Number*	*Dates*
25	1914–18	12	1914–18	37	1938–44	24	1938–44
26	1918–19	13	1918–19	38	1944–46	25	1944–46
27	1919–20	14	1919–20	39	1946–48	26	1946–51

Rate of exchange observations exclude in addition to those listed above the preceding and following phases:

24	1913–14	11	1913–14	36	1937–38	23	1937–38
28	1920–21	15	1920–21	40	1948–49	27	1951–52

The reason for including the additional phases is that the rate of change triplet centered, for example, on 1914–18 is based on 1913–14, 1914–18, and 1918–19.

tween movements in money, on the one hand, and real income and prices on the other. Succeeding chapters explore these phenomena more fully.

5.5 Appendix: Basic Phase Data

Tables 5.7 and 5.8 give phase average values for our basic data set for the United States and the United Kingdom. Tables 5.9 and 5.10 give the rates of change computed from triplets of the phase average values.

Table 5.7 Average Value of Selected Nominal and Real Magnitudes during Reference Phases: United States, 1867–1975

Phase Number	Mid-phase Dates	Nominal Income Y (Billion $ per Year)	Money Stock M (Billion $ per Year)	Velocity V (Ratio per Year)	Implicit Price Deflator P (1929 = 100)	Real Income y' (Billion $ per Year)	Population N (Millions)	Per Capita Nominal Income Py ($ per Year)	Per Capita Real Income y (1929 $ per Year)	Per Capita Nominal Money Balances Pm ($ per Year)	Per Capita Real Money Balances m (1929$ per Year)
1	1868.5		3.058				38.209			80	
2	1870.0	7.100	3.037	2.337	68.79	10.046	39.476	180	254	77	112
3	1872.0	7.508	3.360	2.235	67.72	11.087	41.443	181	268	81	120
4	1876.0	7.870	3.300	2.384	61.18	12.864	45.564	173	282	72	118
5	1880.5	9.871	3.596	2.745	55.36	17.830	50.357	196	354	71	129
6	1884.0	10.983	4.530	2.424	55.34	19.846	54.726	201	363	83	150
7	1886.5	10.511	4.728	2.223	50.36	20.870	57.931	181	360	82	162
8	1888.0	10.802	4.942	2.185	51.04	21.162	59.853	180	354	83	162
9	1889.5	11.158	5.144	2.169	51.47	21.677	61.769	181	351	83	162
10	1891.0	11.931	5.466	2.183	50.56	23.598	63.705	187	370	86	170
11	1892.0	12.398	5.667	2.188	49.28	25.157	65.010	191	387	87	177

12	1893.5	12.153	5.530	2.197	48.38	25.122	66.964	182	375	83	171
13	1895.0	11.534	5.385	2.142	46.02	25.065	68.924	167	364	78	170
14	1896.0	11.763	5.295	2.221	45.02	26.130	70.229	167	372	75	168
15	1898.0	12.987	5.746	2.260	45.39	28.610	72.831	178	393	79	174
16	1900.0	15.778	6.920	2.280	48.34	32.638	75.444	209	433	92	190
17	1902.0	18.404	8.029	2.292	50.29	36.594	78.356	235	467	103	204
18	1904.0	19.837	8.956	2.215	51.91	38.211	81.395	244	469	110	212
19	1906.0	23.243	10.551	2.203	54.12	42.948	84.605	275	508	125	230
20	1908.0	24.979	11.520	2.168	56.72	44.036	87.855	284	501	131	231
21	1909.5	26.942	12.516	2.153	58.58	45.993	90.514	298	508	138	236
22	1911.0	29.103	13.724	2.121	59.98	48.520	93.132	313	521	147	246
23	1912.5	31.752	15.016	2.115	61.71	51.457	95.432	333	539	157	255
24	1914.0	32.282	16.057	2.011	63.03	51.220	98.163	329	522	164	259
25	1916.5	42.881	20.797	2.062	77.57	55.281	101.724	422	543	204	264
26	1919.0	67.969	28.790	2.361	105.90	64.183	103.859	654	618	277	262
27	1920.0	72.727	32.850	2.214	113.95	63.822	105.483	690	605	311	273
28	1921.0	68.397	33.811	2.023	112.36	60.873	107.494	636	566	315	280
29	1922.5	65.289	34.194	1.909	100.45	64.994	110.139	593	590	311	309
30	1924.0	74.663	37.577	1.987	100.22	74.502	113.023	661	659	332	332
31	1925.5	79.181	41.547	1.906	101.23	78.217	115.786	684	676	359	354
32	1927.0	83.832	44.202	1.897	100.74	83.214	118.213	709	704	374	371
33	1928.5	85.805	46.036	1.864	99.88	85.903	120.451	712	713	382	383
34	1931.0	67.072	43.091	1.557	88.42	75.858	123.469	543	614	349	395

Table 5.7 (Continued)

Phase Number	Mid-phase Dates	Nominal Income Y (Billion $ per Year)	Money Stock M (Billion $ per Year)	Velocity V (Ratio per Year)	Implicit Price Deflator P (1929 = 100)	Real Income y' (Billion $ per Year)	Population N (Millions)	Per Capita Nominal Income Py ($ per Year)	Per Capita Real Income y (1929 $ per Year)	Per Capita Nominal Money Balances Pm ($ per Year)	Per Capita Real Money Balances m (1929 $ per Year)
35	1935.0	54.800	37.716	1.453	77.26	70.932	126.811	432	559	297	385
36	1938.0	71.863	45.595	1.576	80.76	88.978	129.324	556	688	353	436
37	1941.5	104.774	65.060	1.610	92.16	113.686	133.660	784	851	487	528
38	1945.5	169.400	124.158	1.364	124.22	136.366	139.906	1211	975	887	714
39	1947.5	178.728	144.665	1.235	136.13	131.293	144.056	1241	911	1004	738
40	1949.0	197.213	147.784	1.334	144.65	136.340	147.903	1333	922	999	691
41	1951.5	240.973	157.684	1.528	153.04	157.457	154.292	1562	1020	1022	668
42	1954.0	277.301	174.149	1.592	161.50	171.706	160.972	1723	1067	1082	670
43	1956.0	307.592	184.963	1.663	168.77	182.251	166.752	1845	1093	1109	657
44	1958.0	334.556	196.414	1.703	177.80	188.170	172.701	1937	1090	1137	640
45	1959.5	361.743	208.618	1.734	182.88	197.803	177.603	2037	1114	1175	642
46	1961.0	387.224	218.050	1.776	187.35	206.689	182.175	2126	1135	1197	639
47	1964.0	470.701	261.385	1.801	197.55	238.272	190.380	2472	1252	1373	695
48	1967.0	589.771	323.663	1.822	213.03	276.852	197.633	2984	1401	1638	769
49	1968.5	657.625	363.927	1.807	226.03	290.942	200.696	3277	1450	1813	802
50	1970.0	724.400	397.810	1.821	243.16	297.908	203.774	3555	1462	1952	803
51	1972.0	846.520	474.995	1.782	271.95	311.274	207.840	4073	1498	2285	840
52	1974.5	1056.867	594.306	1.778	321.15	329.091	211.935	4987	1553	2804	873

Phase Number	Annual Percentage				High-Powered Money H (Billion $ per Year)	Money Stock per Unit of Output M/y' (Ratio Times 100)	Weight W
	Call Money Rate $R_{S'}$	Commercial Paper Rate R_S	Yield on Corporate Bonds $R_{L'}$	R_L			
1	7.85	7.88	6.46	7.92	.779		2.7
2	8.06	8.46	6.58	8.05	.763	30.23	2.0
3	7.84	8.13	6.40	7.86	.779	30.30	3.6
4	4.60	5.86	5.59	7.05	.771	25.66	5.6
5	5.16	5.18	4.62	6.09	.935	20.17	4.6
6	3.31	5.22	4.27	5.73	1.191	22.83	3.6
7	3.62	4.83	3.89	5.36	1.232	22.65	2.7
8	3.88	5.32	3.84	5.30	1.294	23.36	2.0
9	4.28	5.06	3.73	5.19	1.348	23.73	2.7
10	4.71	5.51	3.87	5.33	1.425	23.16	2.0
11	3.19	4.75	3.89	5.36	1.497	22.53	2.0
12	3.29	5.18	3.85	5.32	1.559	22.01	2.7
13	1.48	3.36	3.66	5.12	1.540	21.49	2.0
14	3.02	4.74	3.61	5.08	1.475	20.26	2.0
15	2.88	4.10	3.42	4.88	1.618	20.09	3.6
16	3.90	4.27	3.27	4.79	1.882	21.20	2.0
17	4.26	4.71	3.31	4.79	2.124	21.94	3.6
18	2.74	4.84	3.53	4.88	2.349	23.44	2.0
19	4.84	5.12	3.58	4.68	2.584	24.57	3.6
20	4.26	5.36	3.88	5.03	2.960	26.16	2.0
21	2.61	4.34	3.82	4.86	3.128	27.21	2.7
22	2.88	4.52	3.85	4.81	3.225	28.29	2.0
23	3.23	4.77	3.93	4.85	3.344	29.18	2.7

Table 5.7 (Continued)

Phase Number	Annual Percentage				High-Powered Money H (Billion $ per Year)	Money Stock per Unit of Output M/y' (Ratio Times 100)	Weight W
	Call Money Rate $R_{S'}$	Commercial Paper Rate R_S	Yield on Corporate Bonds $R_{L'}$	R_L			
24	3.29	5.19	4.05	4.96	3.474	31.35	2.0
25	3.07	4.24	4.17	5.04	4.372	37.62	4.6
26	5.89	5.65	4.75	5.43	6.473	44.86	2.0
27	7.13	6.40	4.93	5.71	7.063	51.47	2.0
28	6.90	6.95	5.14	5.99	7.015	55.54	2.0
29	4.86	5.09	4.80	5.41	6.528	52.61	2.7
30	3.96	4.44	4.64	5.24	6.819	50.44	2.0
31	3.98	4.03	4.52	5.06	7.062	53.12	2.7
32	4.28	4.13	4.35	4.87	7.198	53.12	2.0
33	5.94	4.87	4.21	4.91	7.178	53.59	2.7
34	3.20	3.48	4.35	4.99	7.234	56.80	3.6
35	1.03	1.18	3.75	4.14	9.961	53.17	5.6
36	1.00	0.90	3.04	2.99	13.970	51.24	2.0
37	1.00	0.74	2.70	2.58	23.119	57.23	6.5
38	1.04	0.77	2.53	2.51	40.808	91.05	2.7
39	1.37	1.08	2.56	2.55	45.110	110.18	2.7

40	1.59	1.47	2.77	2.61	45.779	108.39	2.0
41	2.16	1.99	2.80	2.72	46.959	100.14	4.6
42	3.06	2.05	3.08	2.91	49.789	101.42	2.0
43	3.69	2.73	3.16	3.19	49.534	101.49	3.6
44	4.11	3.14	3.65	3.73	49.964	104.38	2.0
45	4.29	3.56	4.09	4.10	50.209	105.47	2.7
46	4.75	3.41	4.39	4.23	49.635	105.50	2.0
47	4.67	3.88	4.35	4.32	54.278	109.70	5.6
48	5.72	5.33	4.85	5.28	63.060	116.91	2.0
49	6.57	6.18	5.84	6.16	69.170	125.09	2.7
50	7.96	7.77	7.07	7.34	75.552	133.54	2.0
51	6.33	5.91	7.18	7.27	85.922	152.60	3.6
52	9.56	8.54	7.79	7.97	102.398	180.59	2.7

Note: Midphase dates ending .5 are as of 30 June; ending .0, as of 1 January. Entries in table are antilogs of reference phase averages for all variables except interest rates, computed from logarithms of original data. Interest rates are in original decimal units.

Source: See table 4.8 for annual data underlying phase averages for nominal income, money stock, implicit price deflator, real income, population, interest rates. High-powered money is the sum of commercial bank reserves and currency outstanding (from the sources used in deriving the money stock). United States money stock has been adjusted for the effect of changing financial sophistication relative to that of the United Kingdom, 1867–1902, as described in section 6.3. Remaining variables in the table were derived from the logs of the phase averages:

Velocity is the antilog of the log of nominal income minus the log of the money stock.

Per capita nominal (real) income is the antilog of the log of nominal (real) income minus the log of population.

Per capita nominal (real) money balances is the antilog of the log of money minus the log of population (and the log of the price deflator).

Money stock per unit of output is 100 times the antilog of the log of money stock minus the log of real income.

For the derivation of the column of weights, see section 3.1.3.

Table 5.8 **Average Value of Selected Nominal and Real Magnitudes during Reference Phases: United Kingdom, 1868–1975**

Phase Number	Mid-phase Dates	Nominal Income Y (Billion £ per Year)	Money Stock M (Billion £ per Year)	Velocity V (Ratio per Year)	Implicit Price Deflator P (1929 = 100)	Real Income y' (Billion £ per Year)	Population N (Millions)	Per Capita Nominal Income Py (£ per Year)	Per Capita Real Income y (1929 £ per Year)	Per Capita Nominal Money Balances Pm (£ per Year)	Per Capita Real Money Balances m (1929 £ per Year)
0	1871.5	.933			59.78	1.561	29.476	32	53		
1	1877.0	1.016	.594	1.709	57.16	1.778	31.172	33	57	19	33
2	1881.5	1.039	.581	1.786	54.29	1.913	32.594	32	59	18	33
3	1885.0	1.044	.618	1.689	51.99	2.008	33.494	31	60	18	36
4	1888.5	1.171	.642	1.823	50.94	2.299	34.442	34	67	19	37
5	1892.0	1.255	.716	1.752	51.92	2.418	35.456	35	68	20	39
6	1897.0	1.434	.815	1.761	50.81	2.823	37.160	39	76	22	43
7	1902.5	1.625	.911	1.784	53.76	3.023	39.111	41	77	23	43
8	1906.0	1.727	.939	1.840	53.99	3.198	40.309	43	79	23	43
9	1908.0	1.823	.977	1.866	55.10	3.309	41.018	44	81	24	43
10	1911.0	1.936	1.047	1.849	56.09	3.452	42.019	46	82	25	44
11	1914.0	2.156	1.188	1.816	58.15	3.708	42.810	50	87	28	48
12	1916.5	2.983	1.587	1.879	76.36	3.906	43.366	69	90	37	48
13	1919.0	4.459	2.359	1.891	117.28	3.802	43.469	103	87	54	46

14	1920.0	4.801	2.688	1.786	140.09	3.427	43.583	110	79	62	44
15	1921.0	4.645	2.799	1.659	145.50	3.192	43.895	106	73	64	44
16	1923.0	3.732	2.626	1.421	113.66	3.284	44.486	84	74	59	52
17	1925.5	3.833	2.507	1.529	105.20	3.644	45.066	85	81	56	53
18	1927.0	3.863	2.527	1.529	102.74	3.760	45.310	85	83	56	54
19	1928.0	3.990	2.573	1.551	100.90	3.954	45.483	88	87	57	56
20	1929.0	4.061	2.608	1.557	100.20	4.053	45.625	89	89	57	57
21	1931.0	3.847	2.628	1.464	97.11	3.961	45.981	84	86	57	59
22	1935.0	3.988	2.912	1.369	91.62	4.352	46.789	85	93	62	68
23	1938.0	4.654	3.236	1.438	96.34	4.831	47.391	98	102	68	71
24	1941.5	6.370	4.213	1.512	121.39	5.247	48.273	132	109	87	72
25	1945.5	8.183	6.702	1.221	146.46	5.587	49.149	166	114	136	93
26	1949.0	9.828	8.158	1.205	170.27	5.772	50.031	196	115	163	96
27	1952.0	12.274	8.520	1.441	198.29	6.190	50.360	244	123	169	85
28	1954.0	13.992	8.981	1.558	215.34	6.498	50.682	276	128	177	82
29	1957.0	16.955	9.339	1.815	243.55	6.962	51.304	330	136	182	75
30	1959.5	19.397	10.102	1.920	265.68	7.301	51.983	373	140	194	73
31	1961.5	22.099	10.715	2.062	279.62	7.903	52.814	418	150	203	73
32	1964.0	25.779	11.744	2.195	300.23	8.586	53.727	480	160	219	73
33	1966.0	29.508	12.958	2.277	323.12	9.132	54.359	543	168	238	74
34	1967.5	31.869	13.887	2.295	346.19	9.206	54.787	582	168	253	73
35	1970.0	38.170	16.180	2.359	399.92	9.544	55.337	690	172	292	73
36	1972.5	50.378	22.317	2.257	502.54	10.025	55.782	903	180	400	80
37	1974.5	67.914	32.515	2.089	646.67	10.502	55.952	1214	188	581	90

Table 5.8 (Continued)

Phase Number	Annual Percentage: Short-Term Rate R_S	Annual Percentage: Long-Term Rate R_L	High-Powered Money H (Billion £ per Year)	Money Stock per Unit of Output M/y' (Ratio Times 100)	Exchange Rate EX £ in U.S. $	Weight W
0	3.56	3.23			5.779	
1	2.89	3.16	.168	33.44	5.242	5.6
2	2.95	3.02	.164	30.39	4.856	4.6
3	2.58	2.99	.161	30.79	4.860	3.6
4	2.78	2.89	.162	27.95	4.874	4.6
5	2.54	2.66	.178	29.64	4.872	3.6
6	2.09	2.38	.196	28.86	4.874	7.5
7	3.18	2.69	.206	30.13	4.874	4.6
8	3.39	2.84	.212	29.35	4.864	3.6
9	3.39	2.94	.218	29.53	4.868	2.0
10	3.06	3.13	.224	30.33	4.870	5.6
11	3.63	3.43	.275	32.02	4.899	2.0
12	4.22	4.16	.430	40.63	4.783	4.6
13	3.74	4.51	.665	62.03	4.592	2.0
14	5.16	4.97	.713	78.42	4.027	2.0
15	5.78	5.27	.697	87.68	3.756	2.0
16	3.22	4.51	.632	79.96	4.372	3.6
17	4.06	4.45	.607	68.81	4.730	2.7
18	4.37	4.56	.593	67.21	4.860	2.0
19	4.21	4.52	.586	65.06	4.864	2.0

20	4.71	4.54	.578	64.35	4.862	2.0
21	3.25	4.39	.566	66.35	4.498	3.6
22	0.78	3.16	.628	66.90	4.647	5.6
23	0.61	3.33	.723	66.99	4.917	2.0
24	1.03	3.27	1.010	80.29	4.129	6.5
25	.86	2.90	1.739	119.95	4.032	2.7
26	.63	3.20	1.915	141.34	3.550	5.6
27	1.81	4.01	1.995	137.64	2.796	2.0
28	2.61	4.01	2.184	138.22	2.804	3.6
29	4.76	4.77	2.503	134.15	2.796	3.6
30	4.19	5.01	2.726	138.36	2.809	2.7
31	5.03	5.95	2.938	135.58	2.805	2.7
32	4.66	5.94	3.163	136.78	2.798	3.6
33	6.36	6.61	3.525	141.90	2.794	2.0
34	6.50	6.89	3.752	150.85	2.667	2.7
35	7.89	8.75	4.193	169.52	2.402	3.6
36	7.27	9.53	5.180	222.62	2.474	2.7
37	11.79	13.85	7.197	309.61	2.337	2.7

Note: Midphase dates ending .5 are as of 30 June; ending .0, as of 1 January. Entries in table are antilogs of reference phase averages for all variables except interest rates, computed from logarithms of original data. Interest rates are in original decimal units.

Source: See table 4.9 for annual data underlying phase averages for nominal income, money stock, implicit price deflator, real income, population, interest rates, and the United Kingdom exchange rate in dollars. High-powered money is the sum of commercial bank reserves and currency outstanding (from the sources used in deriving the money stock). Remaining variables in the table were derived from the logs of the phase averages:

Velocity is the antilog of the log of nominal income minus the log of the money stock.

Per capita nominal (real) income is the antilog of the log of nominal (real) income minus the log of population.

Per capita nominal (real) money balances is the antilog of the log of money minus the log of population (and the log of the price deflator).

Money stock per unit of output is 100 times the antilog of the log of money stock minus the log of real income.

For the derivation of the column of weights, see section 3.1.3.

Table 5.9 **Rates of Change Computed from Triplets of Reference Phase Averages (Annual Percentage): United States, 1869–1975.**

Central Phase of Triplet		Nominal Income	Money Stock	Velocity	Implicit Price Deflator	Real Income	Population	Per Capita Nominal Income	Per Capita Real Income	Per Capita Nominal Money Balances
Number	Midpoint	g_Y	g_M	g_V	g_P	$g_{y'}$	g_N	g_{Py}	g_y	g_{Pm}
2	1870.0		2.873				2.331			0.542
3	1872.0	1.528	0.743	0.785	−2.452	3.980	2.383	−0.855	1.597	−1.640
4	1876.0	3.358	0.884	2.474	−2.359	5.717	2.287	1.071	3.430	−1.403
5	1880.5	4.278	3.697	0.581	−1.376	5.654	2.282	1.996	3.372	1.415
6	1884.0	1.383	4.905	−3.522	−1.314	2.697	2.343	−0.960	0.354	2.562
7	1886.5	−0.701	2.080	−2.781	−2.394	1.693	2.249	−2.950	−0.556	−0.169
8	1888.0	2.000	2.816	−0.816	0.735	1.265	2.142	−0.142	−0.877	0.674
9	1889.5	3.323	3.364	−0.041	−0.312	3.635	2.086	1.237	1.549	1.278
10	1891.0	4.259	3.896	0.363	−1.673	5.932	2.062	2.197	3.870	1.834
11	1892.0	0.495	0.224	0.271	−1.699	2.194	2.006	−1.511	0.188	−1.782
12	1893.5	−2.395	−1.687	−0.708	−2.278	−0.117	1.956	−4.351	−2.073	−3.643
13	1895.0	−1.553	−1.726	0.173	−2.928	1.375	1.914	−3.467	−0.539	−3.640
14	1896.0	4.170	2.579	1.591	−0.272	4.442	1.836	2.334	2.606	0.743
15	1898.0	7.347	6.696	0.651	1.779	5.568	1.796	5.551	3.772	4.900
16	1900.0	8.717	8.365	0.352	2.559	6.158	1.829	6.888	4.329	6.536
17	1902.0	5.731	6.456	−0.725	1.785	3.946	1.903	3.828	2.043	4.553
18	1904.0	5.842	6.835	−0.993	1.834	4.008	1.921	3.921	2.087	4.914
19	1906.0	5.775	6.300	−0.525	2.211	3.564	1.915	3.860	1.649	4.385
20	1908.0	4.177	4.848	−0.671	2.269	1.908	1.929	2.248	−0.021	2.919
21	1909.5	5.108	5.844	−0.736	1.862	3.246	1.952	3.156	1.294	3.892
22	1911.0	5.486	6.075	−0.589	1.729	3.757	1.767	3.719	1.990	4.308

23	1912.5	3.464	5.240	−1.776	1.640	1.824	1.768	1.696	0.056	3.472
24	1914.0	8.055	8.454	−0.399	6.075	1.980	1.575	6.480	0.405	6.879
25	1916.5	14.884	11.678	3.206	10.370	4.514	1.134	13.750	3.380	10.544
26	1919.0	15.981	13.038	2.943	11.363	4.618	0.989	14.992	3.629	12.049
27	1920.0	0.348	8.075	−7.727	2.973	−2.256	1.733	−1.385	−4.358	6.342
28	1921.0	−4.106	1.533	−5.639	−5.329	1.223	1.727	−5.833	−0.504	−0.194
29	1922.5	2.963	3.541	−0.578	−3.798	6.761	1.680	1.283	5.081	1.861
30	1924.0	6.465	6.506	−0.041	0.260	6.205	1.677	4.788	4.528	4.829
31	1925.5	3.896	5.418	−1.522	0.173	3.723	1.509	2.387	2.214	3.909
32	1927.0	2.723	3.416	−0.693	−0.421	3.144	1.330	1.393	1.814	2.086
33	1928.5	−6.437	−1.069	−5.368	−3.597	−2.840	1.069	−7.506	−3.909	−2.138
34	1931.0	−6.476	−3.121	−3.355	−3.814	−2.662	0.766	−7.242	−3.428	−3.887
35	1935.0	−0.473	−0.192	−0.281	−1.797	1.324	0.665	−1.138	0.659	−0.857
36	1938.0	9.990	8.432	1.558	2.741	7.249	0.815	9.175	6.434	7.617
37	1941.5	11.516	13.726	−2.210	5.974	5.542	1.059	10.457	4.483	12.667
38	1945.5	9.640	13.986	−4.346	6.731	2.909	1.228	8.412	1.681	12.758
39	1947.5	4.163	5.306	−1.143	4.379	−0.216	1.582	2.581	−1.798	3.724
40	1949.0	7.574	2.237	5.337	2.839	4.735	1.716	5.858	3.019	0.521
41	1951.5	6.825	3.279	3.546	2.233	4.592	1.703	5.122	2.889	1.576
42	1954.0	5.436	3.575	1.861	2.178	3.258	1.736	3.700	1.522	1.839
43	1956.0	4.705	2.999	1.706	2.413	2.292	1.769	2.936	0.523	1.230
44	1958.0	4.586	3.461	1.125	2.273	2.313	1.817	2.769	0.496	1.644
45	1959.5	4.846	3.502	1.344	1.687	3.159	1.802	3.044	1.357	1.700
46	1961.0	5.969	5.205	0.764	1.722	4.247	1.529	4.440	2.718	3.676
47	1964.0	7.010	6.576	0.434	2.127	4.883	1.367	5.643	3.516	5.209
48	1967.0	7.442	7.306	0.136	2.897	4.545	1.192	6.250	3.353	6.114
49	1968.5	6.858	6.901	−0.043	4.384	2.474	1.047	5.811	1.427	5.854
50	1970.0	7.268	7.716	−0.448	5.293	1.975	1.018	6.250	0.957	6.698
51	1972.0	8.448	8.940	−0.492	6.217	2.231	0.869	7.579	1.362	8.017

Table 5.9 (Continued)

Number	Per Capita Real Money Balances g_m	Call Money Rate $DR_{S'}$	Commercial Paper Rate DR_S	Yield on Corporate Bonds		High-Powered Money g_H	Money Stock per Unit of Output $g_{My'}$	Weight g_w
				$DR_{L'}$	DR_L			
2		−0.012	0.053	−0.023	−0.023	0.085		19.2
3	0.812	−0.659	−0.48	−0.178	−0.178	0.022	−3.237	67.1
4	0.956	−0.281	−0.332	−0.209	−0.209	2.306	−4.833	147.4
5	2.791	−0.125	−0.088	−0.171	−0.171	5.295	−1.957	145.4
6	3.876	−0.302	−0.046	−0.118	−0.118	4.998	2.208	64.6
7	2.225	0.139	−0.014	−0.117	−0.117	1.909	0.387	22.6
8	−0.061	0.218	0.075	−0.056	−0.056	2.993	1.551	12.0
9	1.590	0.277	0.062	0.010	0.010	3.212	−0.271	9.0
10	3.507	−0.348	−0.072	0.069	0.070	4.137	−2.036	7.4
11	−0.083	−0.491	−0.078	−0.007	0.006	3.501	−1.970	7.4
12	−1.365	−0.570	−0.465	−0.078	−0.080	0.960	−1.570	9.0
13	−0.712	−0.241	−0.304	−0.101	−0.103	−2.039	−3.101	7.4
14	1.015	0.352	0.127	−0.082	−0.082	2.298	−1.863	12.8
15	3.121	0.220	−0.119	−0.085	−0.072	6.094	1.128	16.0
16	3.977	0.346	0.152	−0.027	−0.024	6.804	2.207	28.8
17	2.768	−0.290	0.142	0.064	0.023	5.555	2.510	16.0

18	3.080	0.144	0.102	0.069	−0.027	4.903	2.827	28.8
19	2.174	0.380	0.130	0.088	0.038	5.780	2.736	16.0
20	0.650	−0.609	−0.196	0.075	0.060	5.568	2.940	19.2
21	2.030	−0.458	−0.278	−0.008	−0.073	2.869	2.598	9.0
22	2.579	0.208	0.146	0.034	−0.002	2.239	2.318	12.0
23	1.832	0.135	0.221	0.067	0.052	2.498	3.416	9.0
24	0.804	−0.047	−0.169	0.059	0.044	7.052	6.474	28.6
25	0.174	0.520	0.092	0.140	0.093	12.448	7.164	25.0
26	0.686	1.151	0.602	0.220	0.182	14.249	8.420	20.2
27	3.369	0.505	0.653	0.193	0.280	4.053	10.700	4.0
28	5.135	−0.958	−0.611	−0.071	−0.150	−3.323	0.310	7.4
29	5.659	−0.977	−0.837	−0.166	−0.250	−0.932	−3.22	9.0
30	4.569	−0.293	−0.351	−0.094	−0.117	2.631	0.301	12.0
31	3.736	0.108	−0.103	−0.095	−0.121	1.810	1.695	9.0
32	2.507	0.650	0.279	−0.103	−0.051	0.553	0.272	12.0
33	1.459	−0.446	−0.246	0.013	0.031	0.172	1.771	22.7
34	−0.073	−0.707	−0.570	−0.089	−0.139	5.706	−0.459	85.1
35	0.940	−0.369	−0.418	−0.179	−0.268	9.066	−1.516	69.3
36	4.876	−0.005	−0.066	−0.159	−0.237	12.987	1.183	127.4
37	6.693	0.006	−0.015	−0.064	−0.059	14.288	8.184	66.0
38	6.027	0.049	0.044	−0.028	−0.009	11.856	11.077	78.9
39	−0.655	0.158	0.195	0.061	0.029	3.492	5.522	14.4
40	−2.318	0.201	0.224	0.053	0.043	1.037	−2.498	28.6

Table 5.9 (Continued)

Number	Per Capita Real Money Balances g_m	Call Money Rate $DR_{S'}$	Commercial Paper Rate DR_S	Yield on Corporate Bonds		High-Powered Money g_H	Money Stock per Unit of Output $g_{M/y'}$	Weight g_w
				$DR_{L'}$	DR_L			
41	−0.657	0.293	0.117	0.061	0.060	1.686	−1.313	25.0
42	−0.339	0.341	0.158	0.081	0.104	1.242	0.317	41.2
43	−1.183	0.264	0.271	0.142	0.204	0.098	0.707	16.0
44	−0.629	0.174	0.235	0.264	0.260	0.428	1.148	19.2
45	−0.013	0.212	0.091	0.247	0.168	−0.173	0.343	9.0
46	1.954	0.064	0.087	0.045	0.045	1.974	0.958	40.4
47	3.082	0.162	0.319	0.077	0.175	4.004	1.693	36.0
48	3.217	0.409	0.505	0.300	0.392	5.320	2.761	40.3
49	1.470	0.745	0.815	0.740	0.686	5.990	4.427	9.0
50	1.405	−0.128	−0.146	0.346	0.289	6.209	5.741	19.2
51	1.854	0.470	0.278	0.170	0.157	6.791	6.709	23.8

Notes: Interest rates in percent per year.

Source: Table 5.7. Rates of change are slopes of least-squares line of successive triplets of logarithmic phase averages, weighted inversely to their variances. For derivation of rate-of-change weights shown in the final column of this table, see section 3.2.1.

To derive rates of change of unadjusted United States money stock and velocity, for phases 2–16, add 2.5 percent to each entry for money, and subtract 2.5 percent from each entry for velocity. For phase 17, add (or subtract) 2.185 percent, phase 18, 0.936 percent. The effect of the adjustment for financial sophistication disappears by phase 19. See the discussion in section 6.3.

Table 5.10 **Rates of Change Computed from Triplets of Reference Phase Averages (Annual Percentage): United Kingdom, 1870–1975**

Central Phase of Triplet		Nominal Income	Money Stock	Velocity	Implicit Price Deflator	Real Income	Population	Per Capita Nominal Income	Per Capita Real Income	Per Capita Nominal Money Balances
Number	Midpoint	g_Y	g_M	g_V	g_P	$g_{Y'}$	g_N	g_{Py}	g_y	g_{Pm}
1	1877.0	1.118			−0.948	2.066	1.007	0.111	1.059	
2	1881.5	0.358	0.366	−0.008	−1.179	1.537	0.910	−0.552	0.627	−0.544
3	1885.0	1.715	1.427	0.288	−0.911	2.626	0.788	0.927	1.838	0.639
4	1888.5	2.631	2.107	0.524	−0.019	2.650	0.813	1.818	1.837	1.294
5	1892.0	2.421	2.770	−0.349	−0.076	2.497	0.900	1.521	1.597	1.870
6	1897.0	2.443	2.264	0.179	0.388	2.055	0.937	1.506	1.118	1.327
7	1902.5	2.104	1.669	0.435	0.748	1.356	0.911	1.193	0.445	0.758
8	1906.0	1.989	1.158	0.831	0.352	1.637	0.867	1.122	0.770	0.291
9	1908.0	2.269	2.206	0.063	0.746	1.523	0.825	1.444	0.698	1.381
10	1911.0	2.803	3.254	−0.451	0.899	1.904	0.716	2.087	1.188	2.538
11	1914.0	7.711	7.444	0.267	5.458	2.253	0.583	7.128	1.670	6.861
12	1916.5	14.526	13.723	0.803	14.013	0.513	0.328	14.198	0.185	13.395
13	1919.0	14.272	15.270	−0.998	17.267	−2.995	0.135	14.137	−3.130	15.135
14	1920.0	2.039	8.588	−6.549	10.765	−8.726	0.531	1.508	−9.257	8.057
15	1921.0	−8.936	−1.292	−7.644	−8.114	−0.822	0.681	−9.617	−1.503	−1.973
16	1923.0	−3.614	−2.371	−1.243	−6.705	3.091	0.577	−4.191	2.514	−2.948
17	1925.5	0.908	−1.147	2.055	−2.647	3.555	0.472	0.436	3.083	−1.619
18	1927.0	1.465	0.967	0.498	−1.657	3.122	0.369	1.096	2.753	0.598
19	1928.0	2.502	1.575	0.927	−1.252	3.754	0.350	2.152	3.404	1.225
20	1929.0	−1.530	0.646	−2.176	−1.337	−0.193	0.369	−1.899	−0.562	0.277
21	1931.0	0.119	2.092	−1.973	−1.479	1.598	0.425	−0.306	1.173	1.667
22	1935.0	2.282	2.875	−0.593	−0.438	2.720	0.433	1.849	2.287	2.442

Table 5.10 (Continued)

Central Phase of Triplet		Nominal Income	Money Stock	Velocity	Implicit Price Deflator	Real Income	Population	Per Capita Nominal Income	Per Capita Real Income	Per Capita Nominal Money Balances
Number	Midpoint	g_Y	g_M	g_V	g_P	$g_{y'}$	g_N	g_{Py}	g_y	g_{Pm}
23	1938.0	7.250	5.729	1.521	4.384	2.866	0.482	6.768	2.384	5.247
24	1941.5	7.362	9.955	−2.593	5.469	1.893	0.482	6.880	1.411	9.473
25	1945.5	5.797	8.891	−3.094	4.517	1.280	0.477	5.320	0.803	8.414
26	1949.0	6.112	3.941	2.171	4.615	1.497	0.393	5.719	1.104	3.548
27	1952.0	7.097	1.881	5.216	4.730	2.367	0.256	6.841	2.111	1.625
28	1954.0	6.449	1.718	4.731	4.108	2.341	0.382	6.067	1.959	1.336
29	1957.0	5.986	2.061	3.925	3.845	2.141	0.458	5.528	1.683	1.603
30	1959.5	5.848	3.065	2.783	3.103	2.745	0.636	5.212	2.109	2.429
31	1961.5	6.311	3.382	2.929	2.727	3.584	0.731	5.580	2.853	2.651
32	1964.0	6.399	4.165	2.234	3.164	3.235	0.649	5.750	2.586	3.516
33	1966.0	6.129	4.815	1.314	4.034	2.095	0.571	5.558	1.524	4.244
34	1967.5	6.617	5.677	0.940	5.422	1.195	0.445	6.172	0.750	5.232
35	1970.0	9.163	9.491	−0.328	7.447	1.716	0.368	8.795	1.348	9.123
36	1972.5	12.665	15.279	−2.614	10.538	2.127	0.256	12.409	1.871	15.023

Number	Per Capita Real Money Balances g_m	Short-Term Interest Rate DR_S	Long-Term Interest Rate DR_L	High-Powered Money g_H	Money Stock per Unit of Output $g_{M/y}$	Weight g_W
1		−0.066	−0.021			276.3
2	0.635	−0.032	−0.023	−0.562	−1.171	145.4
3	1.550	−0.024	−0.018	−0.243	−1.199	112.0
4	1.313	−0.005	−0.046	1.471	−0.543	88.2
5	1.946	−0.083	−0.060	2.256	0.273	214.5
6	0.939	0.072	0.007	1.367	0.209	225.1
7	0.010	0.156	0.052	0.857	0.313	219.1
8	−0.061	0.045	0.043	0.924	−0.479	49.9
9	0.635	−0.071	0.059	1.064	0.683	56.4
10	1.639	0.040	0.082	3.918	1.350	36.0
11	1.403	0.210	0.185	11.709	5.191	76.3
12	−0.618	0.022	0.217	17.635	13.210	25.0
13	−2.132	0.144	0.206	15.286	18.265	20.2
14	−2.708	1.020	0.378	2.380	17.314	4.0
15	6.141	−0.780	−0.200	−4.192	−0.470	12.8
16	3.757	−0.296	−0.162	−2.925	−5.462	23.8
17	1.028	0.296	0.003	−1.617	−4.702	22.6
19	2.255	0.080	0.031	−1.372	−2.155	7.4
20	2.477	0.170	−0.010	−1.294	−2.179	4.0
21	3.146	−0.641	−0.256	1.817	0.494	67.1
22	2.880	−0.434	−0.189	3.293	0.155	69.3

Table 5.10 (Continued)

Number	Per Capita Real Money Balances g_m	Short-Term Interest Rate DR_S	Long-Term Interest Rate DR_L	High-Powered Money g_H	Money Stock per Unit of Output $g_{M/y'}$	Weight g_W
23	0.863	0.040	0.016	7.362	2.863	127.4
24	4.004	0.023	−0.063	11.943	8.062	66.0
25	3.897	−0.054	−0.012	8.678	7.611	169.7
26	−1.067	0.120	0.161	2.195	2.444	49.6
27	−3.105	0.397	0.172	2.521	−0.486	56.4
28	−2.772	0.618	0.173	4.544	−0.623	35.4
29	−2.242	0.328	0.188	4.083	−0.080	47.3
30	−0.674	0.035	0.248	3.549	0.320	31.7
31	−0.076	0.082	0.187	3.278	−0.202	31.7
32	0.352	0.243	0.128	3.921	0.930	23.8
33	0.210	0.552	0.278	4.93	2.720	19.2
34	−0.190	0.417	0.579	4.363	4.482	22.7
35	1.676	0.153	0.528	6.453	7.775	33.4
36	4.485	0.77	1.059	11.703	13.152	31.7

Note: Interest rates in percent per year per year.
Source: Table 5.8. Rates of change are slopes of least-squares line of successive triplets of logarithmic phase averages, weighted inversely to their variances. For derivation of rate-of-change weights shown in the final column of this table, see section 3.2.1.