Volume Title: A Retrospective on the Classical Gold Standard, 1821-1931

Volume Author/Editor: Michael D. Bordo and Anna J. Schwartz, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-06590-1

Volume URL: http://www.nber.org/books/bord84-1

Publication Date: 1984

Chapter Title: Real Output and the Gold Standard Years, 1830-1913

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Chapter URL: http://www.nber.org/chapters/c11136

Chapter pages in book: (p. 513 - 546)

11 Real Output and the Gold Standard Years, 1830–1913

Stephen T. Easton

The topic "real output and the gold standard" describes in some sense the ultimate objective of our quest to balance the costs and benefits of the gold standard. Per capita real income, the aggregate embodiment of the national standard of living, is a touchstone of any broad macroeconomic policy. If we can show, for example, that real income is higher or grows faster under a set of rules termed a gold standard than under alternative monetary arrangements, then we are well on the way toward new policy prescriptions and a truly new economic order. This paper makes no such claims. Instead I focus on a much narrower and less dramatic set of issues that may ultimately, but not immediately, shed light on the grander question. My task, here, is to characterize the behavior of real output in several nations that were linked in several ways during the most sustained period of a worldwide operating gold standard.

The paper consists of two sections. Section 11.1 deals with eight nations in Europe and North America during the nineteenth and early twentieth centuries to determine whether there was an Atlantic economy in the sense that changes in real output in one country were either correlated with or caused changes in real output in other nations. In addition, I try to discover whether the general move to the gold standard made an appreciable difference to the links among national incomes. Section 11.2 asks whether there is any evidence to support the natural-rate hypothesis during the gold standard years in much the same way as Lucas (1973) examined the output-inflation tradeoff of the post–World

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The author is indebted to John Chant, Peter Coyte, and Anna Schwartz for helpful comments, and to Kelly Busche, Reg Cameron, and Jim Irwin for able research assistance. The author of course bears responsibility for remaining errors.

War II period; then the model is extended to test whether the price level is more appropriately characterized as endogenous or exogenous to most countries during the period. To state the conclusions most succinctly: There is little evidence of an Atlantic economy as far as real-income movements are concerned, there is some evidence in favor of the natural-rate hypothesis, and in some countries the elasticity of aggregate demand is very large.

11.1 The Behavior of Real Output before and after 1879

11.1.1 Dating the Gold Standard[1]

The years between 1879 and 1914 are usually referred to as the gold standard period. In this era the United States joined the United Kingdom and most of the rest of the economic world in adopting the gold standard. Britain eliminated restrictions on gold exports and required the Bank of England to redeem its notes in gold (or coin) in 1821. By 1850 both the United States and France had effectively moved to the gold standard.[2] During the 1860s, the United States joined Germany, Italy (1866), Russia, and Austria-Hungary with inconvertible currencies. In July 1873 Germany moved to the gold standard, and by 1879 most nations had more or less adopted policies consistent with gold. The exceptions were Japan, India, Russia, and Austria-Hungary. These, too, joined the rest of the world in 1895 or so, and the regime persisted until the start of World War I, although Italy formally adhered to the gold standard only during the decade 1884–94.[3]

11.1.2 Models of Real Output during the Gold Standard Years

Most discussions of the gold standard tend to focus on how institutions or economic variables worked under that regime—the behavior of banks and banking systems, relative prices and price levels, interest rates, foreign trade, the balance of payments and gold flows.[4] In most macroeconomic models these variables are associated with changes in real income. National macroeconomic models typically have several windows to the rest of the world. In the case of Keynesian income-expenditure models, these windows include terms-of-trade effects, the direct effect of foreign demand on domestic goods, and a relationship between foreign and domestic interest rates that affects capital flows. Recent monetarist models tend to stress a natural-rate hypothesis coupled with assumptions about the way in which expectations are formed, making a sharp distinction between anticipated and unanticipated magnitudes of exogenous variables.[5] Since these models typically focus on quarterly or yearly fluctuations over relatively short periods, it is not surprising that they ignore other channels by which real output may be altered. Most notably

in the nineteenth century, the movement of labor internationally and the opening of new land for settlement had some effects on the behavior of real income.[6]

The usual model of the nineteenth-century gold standard has tended to examine the interrelationships among exogenous variables in one country and the way in which, say, the balance of payments, trade, and capital account behaved in the other. The question posed here is a different one. It is not whether exports, for example, increase when there is an exogenous rise in income abroad, but rather whether the total effect of the increase in income abroad is enough to raise income significantly in another country. By implicitly aggregating across all the channels by which international excess demands are transmitted, this study seeks to discover whether national incomes, nominal or real, are linked.

Two works that stand as major efforts to explain the behavior of real output during the gold standard are those by Oskar Morgenstern (1959) and Brinley Thomas (1973). Morgenstern studies the behavior of four countries—the United States, the United Kingdom, France, and Germany—by looking at NBER-reference-cycle peaks and troughs. His analysis suggests that during the gold standard period (prior to World War I), the association of the business cycle of the three European nations was relatively close, and that between Europe and the United States was less close. To reach these conclusions, Morgenstern forms a contingency table of months in which various countries were in similar phases of their business cycles—up phases or down phases—and finds a low probability that the observed number of concurrent up and down phases would be observed by chance (pp. 51–73). This methodology is flawed in several ways. First, the reference-cycle data do not abstract from the underlying growth rate observed in all countries. The approach yields a closer association of business cycles, measured as months of shared up or down phases, than would be true if the cycles, net of the underlying growth rates, were measured. And second, with only six to ten business cycles observed in the four countries, any relationship that relies on the cycle itself as a fundamental unit of observation has very few degrees of freedom. Since only up and down movements of the cycle are examined, amplitude of movements is ignored. In addition, the average duration of the cycles among the four countries—between forty-three and seventy months—makes it difficult to accept inferences about the intercountry relationships among the cycles.[7]

Brinley Thomas's *Migration and Economic Growth* (1973) is probably the most detailed analysis of the period. Thomas's model organizes the data about a more or less informal open Keynesian multiplier-accelerator view of the world in which the United Kingdom is the hub. Exports and capital formation depend upon the level of population and migration which in turn depend upon both the natural growth of population and

relative income levels among countries. The gestation period for investment and the natural cycle of population provide for the complex lags observed in a myriad of time series that Thomas correlates. The gold standard provides the international regime, but interest rates set in the United Kingdom mark the tempo to which the nominal monetary aggregates dance. He rejects the monetary approach to the balance of payments out of hand. Thomas finds interrelationships between a variety of time series among nations. He builds a coherent explanation primarily from observations that particular series peaked and troughed together, or that one followed another at a reasonable lag. The various peaks and troughs are often strikingly apparent, but little is done to relate the series to one another in a statistical sense. Thomas is usually concerned with long cycles—of ten or twenty years in duration—but he does not estimate systematic behavior explicitly, and the series he studies have wide variations in periodicity.

My task is considerably less ambitious. I focus on a single aggregate measure, real GNP, and ask whether there is any evidence of the Atlantic economy in the behavior of that measure among countries. By breaking the time period in two—pre-1879 and post-1878—I try to assess possible differences introduced by the United States' move to gold. The strategy is first to look at simple correlations among country real outputs, much as Thomas does, to determine whether the relationships that he finds can be observed, and then to apply Granger-Sims tests to determine whether movements in income of one country cause income to change in another.

11.1.3 Simple Correlations

Tables 11.1 and 11.2 provide the simple correlations among the outputs of a number of nations. The unit of real output is the annual deviation of the log of actual GNP from the log of (exponential) trend GNP. Using this smoothing device is customary, although more sophisticated filters to achieve mean and covariance stationary processes might prove fruitful. The data limitations are rather severe. The gold standard period lasted at most a mere thirty-five years, and some have argued that it lasted only fifteen. Since real-output series for several countries are available only since 1870, the data are limited in the other direction as well.

Tables 11.1 and 11.2 give a bird's-eye view of what a simple year-by-year comparison among real outputs reveals. In the tables, a blank means that the correlation was not statistically significant at the 0.10 level. Although I corrected for autocorrelation in the residuals of the correlations, I show the uncorrected simple correlations in table 11.1. Eyeball comparisons of peaks and troughs would not correct for such autocorrelations and the correction might suggest a misleadingly sanguine view of the simple relationships. In table 11.2, I note shifts from significant to insig-

Table 11.1 Simple Correlations of Real-Output Deviations from Trend, 1830–79

No. of Observations	US (37)	CN (12)	UK (50)	GER (30)	ITL (19)	DEN (10)	NOR (15)	SWD (10)
US	X	−.6**						
CN		X						
UK			X	.3*	−.5*	.65**	.5*	
GER				X			.6**	.7**
ITL					X	.6*		
DEN						X		.6*
NOR							X	.6*
SWD								X

Sources: US = United States values using Gallman (1968) data from 1830; no observations from 1860 to 1869. CN = Canadian values from 1869 (Dick 1978). UK = United Kingdom based on Mitchell (1975) from 1830 and Feinstein (1972) from 1855. GER, ITL, DEN, NOR, SWD = Germany, Italy, Denmark, Norway, and Sweden based on Mitchell 1975.

Notes: The table shows correlation coefficients between country pairs of log deviations from the log of the trend of real GNP (or NNP). No entry = no significant correlation at the 0.10 level; * = significant at the 0.10 level; ** = significant at 0.05 or better.

Table 11.2 Simple Correlations of Real-Output Deviations from Trend, 1879–1913

	US	CN	UK	GER	ITL	DEN	NOR	SWD
US	X	.5**	.4**	−.7**			.3′	
CN		X		−.4′	.3*	−.02*′		
UK			X	−.4**	−.5**		−.3*	
GER				X				.3′
ITL					X	.3*	.5′	.6**
DEN						X	.4**	.5**
NOR							X	.6**
SWD								X

Sources: Same as for table 11.1.

Notes: There are 35 observations for each correlation. No entry = no significant correlation at the 0.10 level; * = significant at the 0.10 level; ** = significant at the 0.05 level; ′ = not significant at the 0.10 level when autocorrelations accounted for although apparently significant before the correction; *′ = significant at 0.10 level after correction for autocorrelation.

nificant coefficients depending on whether correction is made for autocorrelation in the residuals.

1830–79

During the years prior to the United States' return to the gold standard excluding the Civil War decade, there is no evidence of a simple associa-

tion of real output in the United States and the United Kingdom. The U.S. measure is negatively associated with Canadian output and with no other country measure although, with the exception of the United Kingdom, there are few observations for correlations with other countries. Canadian output, like that of the United States, appears to be independent of the measure for the United Kingdom and the rest of Europe. Fluctuations in output in the United Kingdom are associated more or less strongly with output changes in Norway, Denmark, and Germany, and are negatively related to those changes in Italy. Changes in real output in Germany also appear to be related to those in the Scandinavian countries and, to a leser extent, to those in the United Kingdom. A degree of positive association exists among real outputs of the Scandinavian countries. Thus in this early period some association of outputs is evident within Europe, with the United Kingdom displaying the most significant number of associations in the group of countries I examine. Little association of output is evident between Europe and North America.

1879–1913

During the gold standard era, U.S. output appears to be positively associated with that in the United Kingdom, Canada, and Norway, and negatively associated with that in Germany. Canadian output, however, as in the earlier period, remains unrelated to output in the United Kingdom, but is positively associated with output in the United States. Output in the United Kingdom now is negatively correlated with output in Germany, Italy, and Norway, whereas the association in the earlier period had tended to be positive. That negative relationship is the one that Thomas finds and upon which several of his hub-periphery interpretations of the time series depend.

Real output in Germany is negatively associated with that in both Canada and the United States and in the United Kingdom and unrelated to other European outputs. Real output in the Scandinavian countries and Italy appears positively associated more strongly than before 1879, and the negative relationship between Italy's and the United Kingdom's real output persists as in the earlier period. Real output in Italy also displays a slight positive correlation with that in Canada. Note that the output links among Denmark, Norway, and Sweden become much stronger in the later period. In 1885 central-bank reserves of any one country could be located in central banks of the other two and still serve as a basis for domestic currency issue.

Significant simple correlations among real-output changes in many countries provide no evidence of causal impetus. They do not by themselves support the notion that the United Kingdom was the hub around which at least some nations revolved. Common cyclical movements

among the European nations are not sufficient evidence that they were in a state of causal dependency upon one another.[8]

Although the associations in tables 11.1 and 11.2 provide a method for analyzing the behavior of real-output movements—one that underlies the casual comparison of time series by many authors—there is an alternative methodology—the Granger and Sims tests for causality.

11.1.4 The Granger Test

One method of defining causality has been to say that X causes Y if past values of X significantly affect Y, once past values of Y have been considered. In a regression framework, if the b_i's of equation (1) are significant, then X is said to cause Y (Granger 1969).

$$(1) \qquad Y_t = a_o + \sum_{i=1}^{\infty} a_i Y_{t-i} + \sum_{i=1}^{\infty} b_i X_{t-1} + u_t,$$

where u_t is white noise. By placing X on the left-hand side one can also test to see whether Y causes X.

The Sims test (1972), an alternative that amounts to the same thing asymptotically, is to regress Y on both past and future values of X. If the coefficients on the future values of X prove significant, i.e., the a_i's in equation (2), the conclusion is that Y causes X.

$$(2) \qquad Y_t = a_o + \sum_{i=1}^{\infty} a_i X_{t+1} + \sum_{i+0}^{\infty} b_i X_{t-1} + u_t.$$

Sargent (1979, pp. 277–92) provides a helpful discussion of the theory underlying the test and some examples.

Table 11.3 reports the results of a Granger test, equation (1) with four lags, on the bivariate relationships among changes in national outputs.[9] Table 11.3 should be read as follows. Row-head country output causes

Table 11.3 **Granger Causal Links between National Real Outputs, 1881–1913**

	US	CN	UK	GER	ITL	DEN	NOR	SWD
US	X		.25			.10	.25	.25
CN		X	.25	.25	.25	.25	.05	
UK	.25	.10	X		.25		.01	.25
GER	.05			X				.10
ITL			.25	.10	X			
DEN			.25		.05	X	.25	
NOR	.25					.25	X	.25
SWD					.05	.05	.25	X

Notes: Read across the rows for causal direction. Row-head country causes column-head country at the significance level in the table. Each column-head country is caused by the row-related elements in the column. A blank indicates a significance level greater than 0.25.

column-head country output at the significance level reported in the table. In the first row there is no causal connection between output changes in the United States and Canada at the 0.25 significance level or better. There is, however, a causal relationship flowing from the United States to the United Kingdom at the 0.25 significance level. According to the United States column, output in the United States is caused by output in the United Kingdom and in Norway, each at the 0.25 significance level, and in Germany at the 0.05 confidence level. These unusually lax significance levels have been chosen so as to give as much latitude as possible for the display of bivariate relationships.

The key feature of table 11.3 is that of the 56 possible bivariate causal relationships, 27 are significant at the 0.25 confidence level, of which 10 are significant at the 0.10 level, 6 at the 0.05 confidence level, and 1 at the 0.01 confidence level. This pattern casts considerable doubt on any systematic causal relationships among the outputs.[10] At the usual 0.05-or-better significance level, Canada and the United Kingdom cause Norway, Germany causes the United States, Denmark and Sweden cause Italy, and Sweden causes Denmark. These relationships are not very attractive since the output of small countries appears to be determining that of large countries more often than the other way round. Certainly there is almost no evidence of a systematic hub-periphery relationship between the United Kingdom and other countries and little evidence to suggest a large number of bivariate causal relationships during the gold standard period. The simple correlations of tables 11.1 and 11.2 may arise either from a common external force or from concurrent domestic conditions, but they do not indicate significant bivariate causation between national outputs.

To see what patterns might emerge if the period is not limited to the classical gold standard years, 1881–1913, table 11.4 examines the same patterns of bivariate causal links for different dates. In table 11.4—as in table 11.3, row-head nation causes column-head nation—there is little evidence of systematic relationships, although the United Kingdom does seem to display more causal links at more exacting significance levels than any other nation, and its links with Germany and Canada are not unreasonable.

The reasons for such poor causal links among nations may be due to measurement errors in the data that raise the noise-to-signal ratio beyond acceptable bounds. Relatively few observations are available at best. To supplement the Granger causal relationships, table 11.5 uses a Sims test to examine the full range of data available for each country.[11] Once again the pattern of causations reflected in table 11.5, like that of tables 11.3 and 11.4, shows little evidence of systematic causal relationships. It may be reasonable that U.S. and U.K. real outputs caused Canadian real output, but it seems odd that Denmark's real output should have a significant effect on that of Italy.

Table 11.4 **Granger Causal Links between National Real Outputs, Various Periods**

	US(1830)	CN(1869)	UK(1830)	GER(1850)	ITL(1860)	DEN(1870)	NOR(1865)	SWD(1873)
US	X	1873–1913:	1838–59: .10 1873–1913:	—	1871–1913:	1873–1913: .10	—	1877–1913: .25
CN	—	X	—	1872–1913:	1872–1913: .25	1874–1913:	1873–1913: .25	1877–1913:
UK	—	1872–1913: .05	X	1854–79: .10	1865–1913: .25	1874–1913	1869–1913: .10	1877–1913: .10
GER	1873–1913: .05	—	—	X	—	1874–1913:	1869–1913: .25	1877–1913: .25
ITL	—	—	—	1865–79: .25 1865–1913: .25	X	—	1869–1913: .25	—
DEN	—	—	—	—	1874–1913: .25	X	1874–1913: .05	1877–1913: .25
NOR	1873–1913: .25	—	—	—	—	—	X	1877–1913: .25
SWD	—	—	—	—	1877–1913: .25	—	1877–1913: .05	X

Notes: Read across the rows for causal direction. The figure beside the country header is the year data become available. If the significance level was not at least 0.25, only the years covered by the test appear. In each case the test covered dates common to both sets of country data.

Table 11.5 **Sims Causal Links between National Real Outputs, 1830–1913**

	US	CN	UK	GER	ITL	DEN	NOR	SWD
US	X	.05				.06		
CN	.22	X	.12					
UK		.05	X		.10	.16	.17	.06
GER				X				.05
ITL			.10	.10	X		.15	
DEN	.15				.05	X		
NOR							X	
SWD				.10				X

Notes: Read across the rows for causal direction. Row-head country causes column-head country at the significance level in the table. Each column-head country is caused by the row-related elements in the column. A blank indicates that the significance level was not at least 0.22.

A natural objection to the above approach is that it imposes too rigid a relationship between the outputs of the countries in our sample. In particular the Granger-Sims tests yield a causal association between outputs only if the same causal pattern is observed throughout the series. For this to be the case in the context of national-output movements, a disturbance in the United Kingdom, say, must be transmitted to the United States in every episode in the same fashion. This relationship may be reasonable if the United Kingdom is thought to be the leading nation, and all shocks have the same effect upon the participants. For example, an increase in U.K. output always raises or lowers output in the other country.

But consider the possibility—suggested by Geoffrey Wood in commenting on an earlier version of this paper—that in one episode a domestic shock to demand tends to stimulate output abroad, and in another episode the shock to domestic supply tends to reduce output abroad. That possibility is the one most likely to obscure the international causal links between real outputs—though one can easily imagine a model in which a positive supply shock stimulates the foreign economy as well. When there is no simple positive or negative association between national incomes, the Granger-Sims tests show no relationship. Yet one country has caused the output in another to change.

One way to check whether positive *or* negative changes in one country's output are transmitted to those of another country is to examine the links among the absolute values of output deviations. The question is whether a shock, in either demand or supply, say, that affects domestic output, measured by the absolute value of the change in domestic output, is associated with a change in the absolute value of output abroad. Thus the same methodology as before serves, only now the units of observation are the absolute values of the deviations from trend levels of national outputs.

The results for both the gold standard years and the entire sample period are consistent with the earlier finding that there is no systematic evidence that changes in one country's output are related in a Granger-Sims fashion to outputs in other countries (tables 11.A.1 and 11.A.2 of the Appendix).

Another possible reason that no evidence emerges of significant bivariate relationships is that the true underlying relationship may be between groups of countries. The technique used here does not reject the possibility that blocs of nations, the Scandinavian countries, for example, are more relevant for causal connections than each nation in the bloc individually.[12]

The lack of causal dependency of national outputs upon one another is an important issue in several contexts. The notion that one country was an engine of economic expansion or contraction for an Atlantic economy is dubious at the aggregate level. This is not to say that particular components of national output were not strongly related to one another. Investment in the United States, for example, might have been affected by investment in the United Kingdom. But at the level of aggregate outputs, the relationships do not appear to have been particularly strong. Money-demand studies such as those that underlie the monetary approach to the balance of payments typically assume the independence of real national incomes. At least on a pairwise basis, the assumption appears to be justified. Finally, whatever the many channels by which disturbances were transmitted from economy to economy, the sum of those disturbances (bilaterally) from one national output to another appears to have been weak during the gold standard period. Changes in a nation's output were determined by domestic and possibly international variables, but not in a simple leader-follower fashion.[13]

The results of this section are largely negative, showing little indication of bilateral relationships among the real outputs of various nations. Another approach is to ask whether real-output changes during the gold standard years correspond to current experience and theory. Section 11.2 explores the output-inflation tradeoff in the past and asks whether there is any evidence for the historical period of a "natural rate" of real-output growth.

11.2 Output, Inflation, and the Domestic Determination of Prices

In section 11.1 little evidence emerged of bivariate relationships among national outputs during the gold standard period. Section 11.2 examines the interconnectedness of real output from a different perspective. The perspective is a model of each economy based on a maintained hypothesis that both the price level and the level of output are endogenously determined by domestic conditions. The closed-economy model, developed

originally by Lucas (1973), assumes that the elasticity of the aggregate demand schedule is unity. The model is then recast (Arak 1977) to allow for the possibility of a nonunitary aggregate-demand elasticity. The presumption of the analysis is that very high estimated price elasticities of demand are consistent with the view that countries were small. The relevant price level in that case is an international price level exogenous to the home country. In the event, the evidence is mixed. Although high elasticities of demand are present—some are infinite—the estimates are not sufficiently precise to rule out a unitary elasticity in most cases.

Since the Lucas model has been of great interest as a device for exposing and testing a rational-expectations approach to the Phillips curve,[14] section 11.2.1 reports results of tests similar to those used by Lucas. Lucas's data were drawn from the post–World War II era, and it is at least of passing interest to see how the same tests fare with data from the gold standard era. Section 11.2.3 estimates the elasticity of the aggregate demand schedule and describes a model that allows the price level to become, in effect, an exogenous variable.[15] Estimates of the elasticity of demand give some information on the degree to which countries were able to determine their own price levels. Although the evidence is mixed, as was apparent in the conference papers and the discussion from the floor, the speed with which nations adjusted to international prices is still an unsettled issue (McCloskey and Zecher 1976, and their paper in this volume).

11.2.1 Lucas's Model

The cyclical behavior of aggregate supply, y_{ct}, is assumed to depend upon the discrepancy between the actual and expected price level, plus a lagged value of cyclical real output (where all variables are measured in natural logarithms) so that[16]

$$y_{ct} = \gamma[P_t - E_t(P_t | I_t)] + \lambda y_{c,t-1}. \tag{3}$$

Using information about the average price level and the observed price in the local market, the aggregate-supply function can be written as:

$$y_t = y_{nt} + \theta\gamma(P_t - \bar{P}_t) + \lambda[y_{t-1} - y_{n,t-1}], \tag{4}$$

where y_{nt} refers to the secular level of real output common to all markets, $\bar{P}_t$, the known mean level of prices, and

$$\theta = \frac{\tau^2}{\sigma^2 + \tau^2},$$

where τ^2 is the variance of deviations of local prices from $\bar{P}_t$ and σ^2 is the variance of the overall price level.

Assume that the demand for goods can be represented in a simple form:

$$y_t + P_t = x_t, \tag{5}$$

where x_t refers to the (log of) nominal income. Assume that changes in x_t are normally distributed and are independent with mean δ and variance σ_x^2. The reduced forms for y_{ct} and ΔP_t are:

$$y_{ct} = -\pi\delta + \pi\Delta x_t + \lambda y_{c,t-1}, \tag{6}$$

$$\Delta P_t = -\beta + (1-\pi)\Delta x_t + \pi\Delta x_{t-1} - \lambda\Delta y_{c,t-1}, \tag{7}$$

where β = the (exponential) trend growth rate of real output,

$$\pi = \frac{\theta\gamma}{1+\theta\gamma} \text{ or, substituting for } \theta,$$

$$\pi = \frac{\tau^2\gamma}{(1-\pi)^2\sigma_x^2 + \tau^2(1+\gamma)}.$$

From equations (6), (7), and the definition of π, it follows that when σ_x^2 becomes large, π approaches zero, and demand shocks have little effect on real output, being increasingly absorbed as price-level changes. Thus, a prediction of the theory is that values of π should decline as the sample variance of nominal income changes (Δx_t) increases.

11.2.2 The Evidence

Table 11.6 reports a summary of the country-by-country regression results. In the table the first two columns display values of π and λ which are drawn from the regression results of equation (6), the reduced form for cyclical income. The R^2 associated with regression equation (6) is in column 3, and the R^2 associated with equation (7) is in column 4. Column 5 contains the variance of nominal-income changes for each of the countries and relevant time periods. The time periods have been constructed so that they cover interesting periods of a reasonable length. In each case the three decades 1881–1913 are distinguished from the preceding years. For most countries at least a few observations are available for years before the world gold standard era. The table gives the estimates for the full run of data and for subperiods.

Two basic tests of the model are presented. The first test, whether the country-by-country regressions fit well, gives generally favorable evidence. The R^2's of the different equations range from .33 to .94 with most of the values falling around .75—the same order of magnitude as those Lucas (1973) obtained for more recent data. A second encouraging finding is that the values of π and λ with two exceptions fall within the interval zero-to-unity which is consistent with theoretical expectations.[17] Although certainly not conclusive, these features of the model are generally supportive of the approach.

A less encouraging picture is presented in figure 11.1 where π is plotted

Table 11.6 **Summary Statistics**

	Coefficient on Nominal-Income Change π (s.e.) (1)	Coefficient on Lagged Real Cyclical Output λ (s.e.) (2)	$R^2_{y_{ct}}$ (3)	$R^2_{\Delta P}$ (4)	Variance of Nominal-Income Percentage Changes (5)
Canada					
1870–1913	.69	.91	.82	.33	.00864
	(.07)	(.07)			
1881–1913	.73	.98	.84	.33	.00758
	(.09)	(.08)			
Germany					
1854–1913	.32	.76	.61	.74	.00498
	(.05)	(.06)			
1854–1879	.36	.83	.49	.74	.00749
	(.10)	(.18)			
1879–1913	.31	.64	.70	.74	.00328
	(.06)	(.09)			
Italy					
1866–1883	.22	.59	.56	.83	.00603
	(.07)	(.16)			
1884–1894	.32	.71	.55	.68	.00356
	(.15)	(.26)			
1895–1913	.52	.97	.95	.79	.00541
	(.07)	(.06)			
1881–1913	.46	.94	.92	.78	.00569
	(.05)	(.05)			
Norway					
1893–1913	.15	1.01	.75	.92	.00293
	(.06)	(.14)			
Sweden					
1863–1913	.51	.82	.79	.66	.00511
	(.06)	(.07)			
1863–1879	.51	.84	.79	.70	.00811
	(.09)	(.13)			
1881–1913	.54	.74	.79	.63	.00378
	(.07)	(.10)			
United Kingdom					
1832–1913	.19	.82	.73	.87	.00410
	(.03)	(.06)			
1832–1859	.16	.70	.70	.94	.00832
	(.04)	(.11)			
1881–1913	.23	.86	.71	.77	.00209
	(.08)	(.10)			
United States					
1834–1859	.48	.65	.76	.54	.00400
	(.08)	(.10)			
1881–1913	.76	.96	.92	.56	.00318
	(.06)	(.06)			

Sources: Real output as in table 11.1. Prices: Canada (Dick 1981); Germany, Italy, Norway, Sweden, United Kingdom before 1855 (Mitchell 1975, table 11); United Kingdom after 1855 (Feinstein 1972, table 61); United States (U.S. Bureau of Census 1960).

against the variance of nominal income σ_x^2 for the years of the gold standard, 1881 to 1913. If the model adequately characterizes the economy's response to nominal-income shocks, a negative relationship should be displayed. No such relationship emerges.[18] One possible explanation is relatively little variabililty in the nominal-income variances across the countries in the sample (table 11.6, col. 5), in comparison, say, to Lucas's study. There are no outliers like Argentina or Paraguay with an order-of-magnitude difference in nominal-income variance from the rest of the sample. If one excludes these two observations from Lucas's sample, then the negative relationship between π and σ_x^2 for his results is obscure as well.[19]

Another way to view the data is to break the sample for each country into subperiods and examine the pattern of π and income variances. The advantage of this procedure is that the value of γ, the elasticity of supply, is more likely to be stable within a country than across countries. The disadvantage is the unavailability of many periods so that the result of the comparison must be informal rather than statistically rigorous.

Figure 11.2 plots the results of the exercise. In each case the first observation plots π against the variance of nominal income in a period prior to the years 1881–1913. The second observation, the point to which the arrow is drawn, represents the combination of π and the nominal-income variance in the period 1881–1913. Splitting the data in this fashion means assuming some systematic difference between a world on the gold

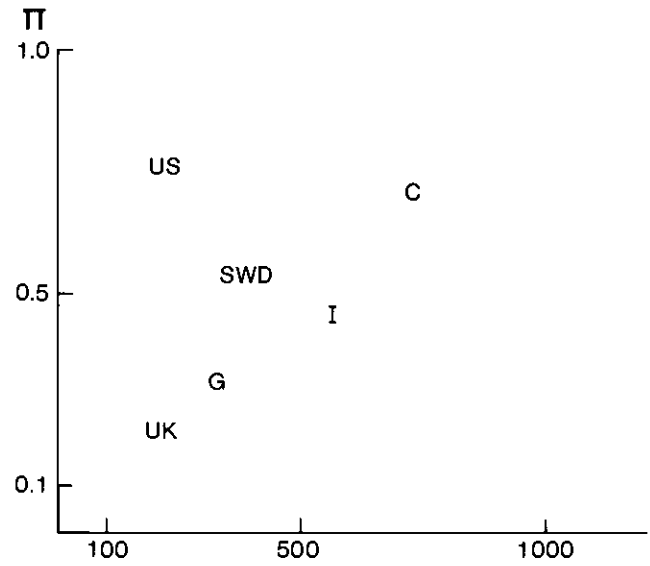

Fig. 11.1 The relationship between π and σ_x^2, 1953–67, and during the gold standard years, 1881–1913. σ_x^2 = variance of nominal income $\times 10^{-5}$. *Source*: Table 11.6.

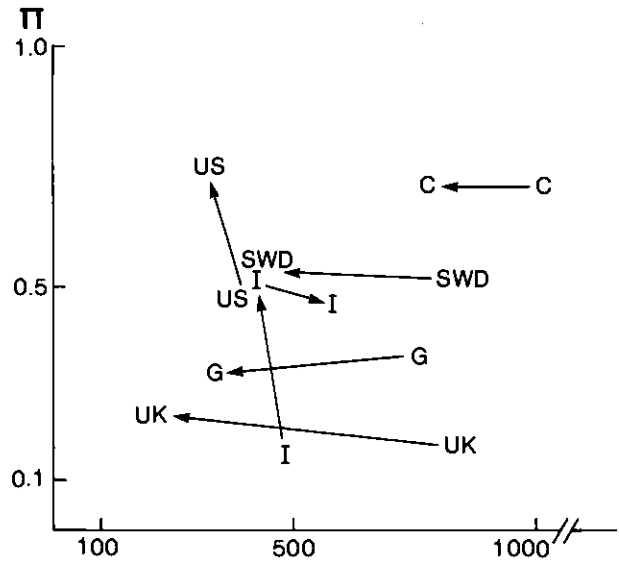

Fig. 11.2 Values of π and σ_x^2 before and after the gold standard years. σ_x^2 = variance of nominal income $\times 10^{-5}$. *Source*: Table 11.6.

standard and a world on various alternative monetary arrangements; some countries are formally on a bimetallic standard, some are floating, and some are on a gold standard. For countries on a gold standard throughout the period, as the United Kingdom was, splitting the data before and after 1881 should reveal no change.

Figure 11.2 shows that in most cases the fall in the variance of nominal income during the gold standard period gave rise to an increase in π. The exceptions, Canada and Germany, are also the countries in table 11.6 for which the fits of the equations are the weakest. Italy is treated slightly differently than the other countries in figure 11.2 since the exchange rate was fixed only from 1884 to 1894. The first arrow indicates the change from pre-gold standard years, 1863 to 1883, to the fixed-rate period, and the second arrow points to the whole 1881–1913 era. Although there are only a few observations, the behavior of π and σ_x^2 in Italy is consistent with the changes in nominal-income variance observed during the subperiods. Unlike the general decline in nominal-income variance during the 1881–1913 decades, nominal-income variance in Italy increases before and after the period of the Italian gold standard decade. The two countries for which π and σ_x^2 move in the "wrong" direction are Germany and Canada, but in both countries the change in π is rather small. Thus even this informal test yields mixed results. For most of the countries in

the sample, behavior is consistent with the predictions of the theory, but the pattern is not overwhelming.

In sum, there is some evidence to support this form of the model, and some reasons why the evidence might be expected to be weak, but the major predictions are disappointing. However, at least one more element of the model deserves investigation—the assumption of a unitary elasticity of aggregate demand, embodied in the notion that nominal income or, more precisely, the change in nominal income, is the relevant exogenous variable.

11.2.3 International Interconnectedness

The major limitation of the Lucas model from an international perspective is that it ignores the possibility that countries are linked by international arbitrage (McCloskey and Zecher 1976). In a gold standard environment—one in which the exchange rate is rigid—domestic prices depend upon foreign prices, and if the country is small and open, the domestic price level is exogenous. In terms of the Lucas model, in equation (3)—the aggregate-supply equation—the domestic price level should be replaced by the foreign price level. Deviations of actual from expected foreign prices would drive the model, making it necessary to develop a price index for each country that reflected the relevant foreign prices. An alternative would be to recast the theory, using world nominal-income shocks as the relevant exogenous demand variable, and then predict world-price-level changes and world-cyclical-output responses.

To avoid such constructions based on tenuous data, I pursued the closed-economy version of the theory which assumes that there is exogeneity in domestic nominal-income shocks and that domestic prices are at least in some measure determined by domestic demand and supply. Since in section 11.1 no systematic causal relationship between nominal or real incomes in our several countries was evident, that finding—granted that only bilateral relationships were examined—serves as some justification for eschewing the "world-scope" approach. If domestic prices are rigidly linked to world prices, then equations (6) and (7) are irrelevant, since world prices are determined by world conditions and not simply by domestic nominal income. Let demand be characterized by $y_t = -\xi P_t + x_t$ where ξ becomes very large. In that case neither equation (6) nor equation (7) is relevant, since $\pi = \theta\gamma/(\xi + \theta\gamma)$, which means equation (3) must include some index of foreign prices.

This concern leads to a test of the model. Does the specification in equations (6) and (7) fit the data? In particular, is there evidence that changes in measured price levels for each country are set in international markets so that the demand schedule facing each country is highly elastic? If we enforce the restriction that $\xi = 1$, then the R^2's in table 11.6

provide a general test of goodness of fit. If we estimate ξ, assuming an exact fit (i.e., the errors are exactly zero) for equations (6) and (7), we can test the restriction that $\xi = 1$ (Arak 1977) and also test whether the exact form of the model is appropriate (Lucas 1977).

If $\xi \neq 1$, then ΔP_t and y_{ct} may be written as:

$$\Delta P_t = \beta_o + \frac{(1-\lambda)}{\xi} y_{ct-1} + \frac{U_t}{\theta\gamma + \xi}, \tag{8}$$

$$y_{ct} = \lambda y_{ct-1} + \frac{\theta\gamma}{\theta\gamma + \xi} U_t, \tag{9}$$

where U_t is the error associated with nominal disturbances.[20]

The coefficients of y_{ct-1} in the two equations allow us to construct an estimate of ξ, the price elasticity of demand for real output; regressing the residuals of equation (8) on the residuals of equation (9) gives an estimate of $\theta\gamma$, the supply response to an unexpected change in prices; and the R^2 of the regression which regresses the residuals of equation (8) on the residuals of equation (9) allows us to test the assumption that the exact version of the model is appropriate since the errors should be proportional and the R^2 high.

Table 11.7 presents the values of λ and ξ and the approximate standard errors. The final column reports the R^2 of the residuals regression. The R^2's of both equation (8) and (9) are uniformly low, as expected, and are *not* reported. The R^2 of regressing the residuals of equation (8) and on the residuals of equation (9), reported in the final column, are also uniformly low and sometimes negative. Recall that it is a homogenous regression.

Table 11.7 **Estimates of Price Elasticity of Demand for Real Output (ξ)**

	λ (s.e)	$(1-\lambda)/\xi$ (s.e)	ξ (s.e.)[a]	R^2 of residuals of eq. (8) on residuals of eq. (9)
Canada				
1869–1913	.63	−.04	−9.25	.0
	(.12)	(.08)	(18.26)	
1869–1881	.52	.18	2.7	.04
	(.29)	(.19)	(2.38)	
1881–1913	.70	−.10	−3.0	.0
	(.13)	(.09)	(2.37)	
Germany				
1853–1913	.58	.00	****	.01
	(.10)	(.16)	****	
1853–1879	.44	−.40	−1.65	−.02
	(.17)	(.27)	(1.03)	
1879–1913	.71	.43	.67	.02
	(.11)	(.20)	(.62)	

Table 11.7 (continued)

	λ (s.e)	$(1-\lambda)/\xi$ (s.e)	ξ (s.e.)[a]	R^2 of residuals of eq. (8) on residuals of eq. (9)
Italy				
1862–1913	.87	−.01	−13.0	.09
	(.08)	(.11)	(142.78)	
1866–1883	.51	.10	5.0	.01
	(.19)	(.43)	(26.20)	
1884–1894	.61	.06	6.4	.10
	(.31)	(.46)	(48.0)	
1895–1913	.89	−.32	−.47	.20
	(.11)	(.11)	(−)	
Norway				
1892–1913	.96	.30	.13	.01
	(.14)	(.43)	(.47)	
Sweden				
1862–1913	.68	.05	6.4	.07
	(.11)	(.11)	(13.91)	
1862–1879	.65	−.04	−8.75	.09
	(.18)	(.20)	(43.52)	
1881–1913	.71	.22	1.3	.06
	(.15)	(.15)	(.56)	
United Kingdom				
1832–1913	.79	.06	3.5	.04
	(.07)	(.17)	(9.85)	
1832–1859	.73	.31	.87	.20
	(.13)	(.49)	(1.31)	
1832–1879	.79	.18	1.2	.07
	(.24)	(.09)		
1881–1913	.78	−.16	−1.3	.0
	(.19)	(.10)		
United States				
1831–1859	.61	.12	3.25	.02
	(.15)	(.14)	(3.58)	
1870–1913	.67	.07	4.7	.16
	(.11)	(.07)	(4.42)	
1881–1913	.68	−.05	−6.4	.05
	(.12)	(.06)	(7.3)	

Sources: Same as for table 11.6.

[a] $SE(\bar{\xi}) \cong \left(\frac{\xi^2}{1-\lambda}\right)\left[\text{VAR}\left(\frac{1-\lambda}{\xi}\right) - \frac{1}{\xi^2}\text{VAR}(1-\lambda)\right]^{1/2}$.

The exact specification of the model is thus rejected by the data. I have not reported estimated values of the coefficient $\theta\gamma$ that were statistically significant at the usual confidence level in only two of the twenty-five or so regressions.

In general, the values of ξ are quite erratic, and although they do not reject $\xi = 1$, they tend to be uncomfortably large, especially for the smaller countries, Canada and Sweden.

11.3 Conclusion

What is the upshot of this study? The Lucas model, a model that does not explicitly take account of international links among countries, is only broadly conformable to the evidence. The most powerful implication—the relationship between the coefficient on nominal-income change (π) and the variance of nominal-income percentage changes (σ_x^2)—is not supported by simple cross-sectional evidence. Higher and lower nominal-income-variance episodes, however, in individual countries do lend some support to that relationship. Our test of the restrictions that demand elasticity was unitary is not very powerful. Although the result is consistent with the restriction, it is also usually consistent with high-elasticity estimates. A high elasticity would be expected if prices in different countries were closely linked to one another—if the world were filled with small open economies. Price behavior may conform to the rule of international arbitrage, since a measure of that behavior discussed above responds in a predictable fashion to shocks in nominal income.

In section 11.1 little evidence emerged that either real or nominal output was causally related in a bivariate fashion among countries. The evidence suggests that nominal (and real) shocks may be generated in part domestically (or the evidence suggests no single international source). The attempt to capture international links in section 11.2 was only partly successful. There are two possible routes to follow in future work to explain real- or nominal-income behavior. One route is to construct a set of world prices and aggregate shocks that may impinge on individual countries, each of which would be small. The other route is to gather additional data—perhaps quarterly or semiannual observations—and use vector autoregressions to discover whether blocs of countries provide the links among nations. Finally, one general conclusion to be drawn from this study is that during the gold standard years the bilateral links among national incomes were not particularly strong in a causal sense and that at least some observed domestic-price and real-output behavior is explicable on the assumption that the price elasticity of aggregate demand is not infinite. Economies appear to have been less small than might have been anticipated, but the issue is still open.

Appendix

Figure 11.A.1 contains a plot of values of π and σ_x^2 from both Lucas 1973 and table 11.6.

Tables 11.A.1 and 11.A.2 illustrate the results for some of the countries in the sample when the absolute value of output deviations of one country are assumed to Granger-cause the output deviations of another country. Table 11.A.1 reports the *F*-value of the effects of the restric-

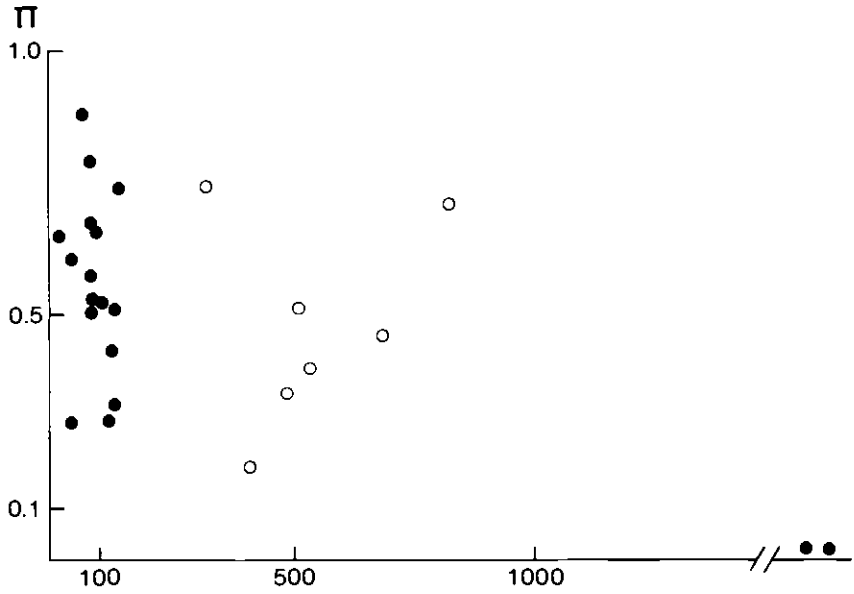

Fig. 11.A.1 Values of π and σ_x^2, 1953–67, and during the gold standard years, 1881–1913. σ_x^2 = variance of nominal income $\times 10^{-5}$. The black circles are drawn from Lucas 1973, tables 1 and 2; the white ones are drawn from fig. 11.1. *Source*: Lucas 1973, table 6.

Table 11.A.1 **Granger Causal Links between National Absolute Values of Output Deviations, 1881–1913: Values of the *F*-test**

	U.S.	U.K.	Germany	Canada
U.S.	X	2.74	—	0.56
U.K.	0.85	X	1.14	1.24
Germany	—	0.83	X	—
Canada	0.75	6.69	—	X

Source: Same as table 11.3.

Table 11.A.2 **Granger Causal Links between National Absolute Values of Output Deviations, Full Sample Years: Values of the *F*-test**

	U.S.	U.K.	Germany	Canada	Italy
U.S.	X	0.19	0.62	0.78	—
U.K.	1.68	X	1.10	1.95	1.66
Germany	0.89	—	X	—	0.24
Canada	0.16	4.69	—	X	—
Italy	—	1.43	1.07	—	X

Source: Same as table 11.4.

tions. A high F means that the row country Granger-causes the column country. In tables 11.A.1 and 11.A.2, the only significant F, at the 95 percent confidence level, is for Canada Granger-causing the United Kingdom. Thus, as is the case when causation is based on the algebraic value of output deviations from trend, the absolute values of the deviations also reveal little binational linkage among countries. Although potentially a weaker restriction of Granger-causation between national outputs, the test based on the latter set nonetheless reveals no significant pattern.

Notes

1. For a summary of the gold standard years see Yeager 1966, pp. 251–65. A more detailed discussion may be found in Hawtrey 1935 and, for the United States and the United Kingdom, in Bordo 1981.

2. Both France and the United States were officially on a bimetallic standard—gold and silver—but large changes in available quantities made official ratios, approximately 15:1 in the United States and 15.5:1 in France, too great to be sustained; thus the United States was effectively on a gold standard for much of the period 1834–59. Since we were unable to unearth real output data for France, no more will be said about this interesting interaction of France with the rest of the world.

3. Countries joined the gold standard at different times and some dropped out for various periods. Russia and Japan both joined in 1897. Italy was a member of the gold standard "club" only between 1884 and 1894 (Fratianni and Spinelli, this volume), although Bloomfield (1959, p. 13) has dated the period as 1883–91. Austria-Hungary was never legally on gold, although Bloomfield suggests that its exchange rate was stable relative to gold from 1900 to 1914. Argentina left gold in 1885 and returned in 1900. Bulgaria left in 1899 only to return in 1906. Other countries dropped out at various times: Portugal (1890), Chile (1898), and Mexico (1910). Spain was not associated with the gold standard, and China, El Salvador, and Honduras remained on a silver standard.

4. See McCloskey and Zecher 1976, pp. 357–85 in which they cite much of the standard literature associated with these questions.

5. Choudhri and Kochin 1980 have a good discussion of the different models available.

6. There is an extensive literature on "staple" models of growth and development. See, for example, North 1966, Chambers and Gordon 1966, Dales 1966, and Williamson 1980.

7. For a more detailed discussion of efforts to identify business cycles, see McCulloch 1975 and Neftci 1979.

8. The United Kingdom may still have been a hub for some countries. We have no evidence on the association of output between the United Kingdom, Australia, Argentina, and India, to name a few. It is important to stress that Thomas, in particular, is concerned with long swings whereas I examine year-to-year fluctuations.

9. One of the key problems of this methodology is to determine the appropriate length of the lags. In principle they may be infinite. In tables 11.3–11.5 reported here, lags up to six periods, and, when relevant, leads of six periods are reported. An *F*-test on additional lags (and leads) indicated no significant effects beyond those reported in the tables.

10. To assess the degree to which the nations shown in table 11.3 are causally independent, assume that each causal interaction—each of the 56 elements of table 11.3—is independent, then at the 0.05 confidence level, 0.05×56 of the elements would be statistically significant by chance. We use the binomial distribution—approximated from the central-limit theorem by a normal distribution—to calculate the probability that the 6 significant elements actually found are due to chance. The null hypothesis is that the number of significant elements is $2.8 (= 0.05 \times 56)$; the alternative is that the observed number is greater than 2.8. Calculate the standard value ϕ:

$$\phi = \frac{6/56 - 2.8/56}{\sqrt{\frac{(.05)(.95)}{56}}} = 1.96.$$

The hypothesis that the observed pattern is random at the 0.05 confidence level is rejected when 1.96 is compared to a normal distribution.

But there are two obvious problems with each procedure: only integer values of the number of significant relationships is possible, and the trials may not be independent. Allow 3 to be the "expected" number of random significant relationships, then $\phi = 1.84$. Choose the confidence level consistent with 3 significant relationships, .054, then $\phi = 1.78$. These calculations still give some evidence supporting the hypothesis that the pattern of observed causal links is nonrandom. There is a sort of "catch-22" quality to the experiment, however, since the calculations assume that the trials were independent. That assumption is surely at risk if income in country A causes income in country B and country C, and income in country B appears to cause income in country C as well. Consider in table 11.3 that Sweden causes both Italy and Denmark. But Denmark causes Italy too. The observed causation is very possibly spurious and surely reflects an interdependence. Eliminating the potentially spurious relationship and computing ϕ, which is equal to 1.35, means that the observed distribution of significant elements does not differ from that expected from a random sample at the 0.05 confidence level. (At the 0.10 confidence level there are 8 untainted interactions and again ϕ falls below the critical level.) A vector autoregression to see whether Denmark explained any additional variation once Sweden was accounted for was negative, but there were relatively few degrees of freedom. The fact that loss of a single observation drives the observed pattern well into the range consistent with random behavior at the 0.05 level provides additional support for the claim that the pattern of table 11.3 is not significant. Carrying out the same procedure at the higher confidence levels 0.10 and 0.25 yields similar conclusions. Because it is so dependent on the independence of the trials, this form of "test" really gives only an upper bound on the number of causal links. The conclusion is that with any sort of simple correction for interdependence, table 11.3 does not support the hypothesis that real outputs of countries were firmly linked during the gold standard period.

11. The results of the Sims test are usually similar to those found by the Granger methods. I find no reason to prefer one test over another with these data although Feige and

Pearce 1979 report the Sims test to be very sensitive to the prefilter used, and Geweke, Meese, and Dent 1979 report other drawbacks.

12. Neftci 1979 reports experiments along these lines using contemporary data. With the small amount of historical data available, however, vector autoregressions quickly use up the limited number of degrees of freedom.

13. Table 11.3 was recast using *nominal income* instead of real income, consistent with the approach in section 11.2 that considers nominal income the exogenous impulse to which output and prices respond. Unfortunately, the patterns of causation (not reported here) were every bit as faint and erratic as those in table 11.3.

14. The natural-rate debate still burns hotly. See Phelps 1971, Barro and Fischer 1976, and Azariadis 1981 for recent discussions.

15. For some criticisms of Lucas's (1973) model, see Arak 1977 and Lucas 1977.

16. The notation corresponds to Lucas 1973 for easy reference, but for simplicity omits the market index Z.

17. Norway is an exception with a 1.01 value of λ. But there are observations for Norway only from 1892 to 1913, and the standard error of the estimate is .14.

18. This is true even if we ignore Canada, for which the output data are notoriously poor, and Norway, for which the data, based on fewer observations than the rest, fit least well.

19. The Appendix shows a plot of π and λ from Lucas's (1973) post–World War II estimates and from table 11.6 for 1881–1913.

20. If demand is $y_t = -\xi P_t + x_t$ then nominal income is $y_t + P_t$ so that $y_t + P_t = (1 - \xi)P_t + x_t$. Only if $\xi = 1$ is the exogenous shock Δx_t exactly equal to changes in nominal income. In the context of equations (8) and (9), $\Delta x_t = \delta + \mu_t$, where δ is a constant, the rate of growth of nominal output.

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Comment Geoffrey E. Wood

Professor Easton's paper begins by telling us that the choice between alternative monetary standards should depend on which standard leads to the highest available level, or rate of growth, of output per head. That notion (apart from any minor qualifications that might be made to regarding output per head as the only measure of welfare) is surely correct. What can money, neutral and therefore affecting only the price level in the long run, contribute to the level or rate of growth of real output? In view of its neutrality, money's only contribution can be to increase the predictability of the future price level. The crucial test that should guide us in choosing between the gold standard and all other monetary standards is therefore a comparison of price-level predictability under different monetary systems. This test is not among the large number of tests whose results are reported in Professor Easton's paper. Its absence suggests an uncertainty of aim which led to failure to link economic analysis with an examination of the data. This failure, it will be argued, is the crucial one which produced the defects in Professor Easton's paper.

The comments that follow are divided into four sections. First, the questions Professor Easton addresses are summarized. The answers he produces are then discussed. Third, some details in the paper are examined. The comments then conclude with a summary of the lessons of this paper.

The Questions

Professor Easton uses data drawn from a wide range of countries, over a long run of years, to address the following questions.

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He is indebted for discussion of these comments to Charles Goodhart and Forrest Capie.

1. Is there any evidence of correlation, or causal influences, or both, between real-income movements in these countries?
2. Does whatever relationship existed between real-income movements in different countries before 1879 change after that year, in which the United States formally adopted the gold standard?
3. Is the output-inflation relationship hypothesized by Robert E. Lucas, and tested in his 1973 paper, found in the data of this period?
4. Is the price level "more appropriately characterized as endogenous or exogenous to most countries during the period" (p. 514)?

Briefly, Easton's answers to the first two questions are "no," to the third a tentative "yes," and to the fourth, "in some countries the elasticity of aggregate demand is very large" (p. 514).

The Answers in Detail

Output Fluctuations

Easton's examination of the relationship among output fluctuations is best considered in two separate sections. First he looks at correlations among various countries of annual deviations of the log of actual GNP from the log of trend GNP. He finds that by this measure there is, during 1830–79, a good degree of association of output fluctuations within Europe, but no association of any significance between Europe and North America. After 1879 (when the United States resumed the gold standard), the United States becomes involved in this pattern of correlation, as to a lesser extent does Canada.

Sometimes the correlations are negative and sometimes positive. This result was noted earlier by Brinley Thomas (1954), and is indeed what one would expect in a world where fluctuations in output about trend are produced by a mixture of demand shocks and supply shocks. The reason for this can be summarized very briefly.

Consider first a demand expansion. An expansion in demand in one country resulting from, for example, a drop in the savings rate, would under fixed rates "spill over" into the balance of payments as imports rose and exports fell, thus increasing demand overseas.[1] So long as the *short-run* aggregate supply curve were not vertical, there would be a positive output change in both countries, and hence a positive correlation between output movements.

We should not, however, expect a similar response to a supply fluctuation. Consider the example of an unexpected, favorable, supply shock in one country. The shock would raise output and thereby increase the demand for money. With a fixed exchange rate, funds are drawn in from overseas, thus producing a monetary contraction overseas (unanticipated because the supply shock was unanticipated). This squeeze will in turn,

because of its being unanticipated, produce a recession overseas. Hence if the income fluctuation originates in a supply shock, there will be a negative correlation between income movements in different countries under a fixed-exchange-rate regime. Therefore Easton's results, because they essentially replicate Brinley Thomas's earlier work, and on analytical grounds, should so far be no surprise. So much for correlation.

Easton next proceeds to look for "causal" relationships, using Granger-Sims methods to identify timing patterns. He looks first at relationships among fluctuations in national income and then at relationships among the absolute values of these national-income fluctuations. He carries out these tests because

> significant simple correlations among real output changes in many countries provided no evidence of causal impetus. They do not by themselves support the notion that the United Kingdom was the hub around which at least some nations revolved. (P. 518)

His tests reveal some bilateral relationships, but no strong, overwhelming connections. What do these negative findings indicate? A first and basic point is that his tests have absolutely nothing to do with the "engine-of-growth" hypothesis. That hypothesis is concerned with national-income trends; Easton's tests examine deviations from trend. If the engine-of-growth hypothesis were the focus of these tests (as is implied in the above quotation), then it can only be said that the tests were not well chosen.

Do the tests reveal anything? The answer is that they do provide a little information. The first half of this section, which mixes together positive- and negative-income correlations and looks for timing relationships between them, is totally pointless. Since we knew before carrying out the tests that the sample period contained a mixture of positive and negative correlations between income fluctuations, we could have anticipated that these would roughly offset each other, thus concealing whatever relationship might have existed. Looking at absolute values, as is done in the second half of this "causality" section, avoids this problem. By finding no clear lead-lag relationship among these fluctuations, Easton shows that *cycles* in one country did not, by and large, have much of a systematic timing relationship with *cycles* in another. That information is useful.

It must be stressed, however, that these tests have revealed nothing about causality in the sense that A causes B, meaning that the occurrence of A is necessary and sufficient for the occurrence of B. There are very few occasions in economics when the isolation of a timing relationship, or failure to isolate such a relationship, can confirm or refute a hypothesis. The occasion on which Easton has used these tests is not one of them.[2]

The Lucas Hypothesis

It is useful first to quote from Lucas (1973).

> The positive association of price changes and output arises because suppliers misinterpret general price movements for relative price changes. It follows from this view, first, that changes in average inflation rates will not increase average output, and secondly, that the higher the variance in average prices, the less "favorable" will be that observed trade off.

Before this idea can be tested by cross-country comparisons as Lucas did (and Easton does),[3] there must be a good amount of inflation variability between countries. Is that likely to be found under the gold standard?

Here the arguments of McCloskey and Zecher, advanced both at this conference (chap. 2) and in an earlier paper (1976), might become important. They argue that commodity arbitrage was an important link between countries under the gold standard. If that argument is correct, it is clearly impossible for countries in that period to differ significantly in either their inflation rates or in their inflation-rate variability.

It is not, however, necessary *for the purposes of examining Professor Easton's paper* to decide whether McCloskey and Zecher are correct. The price indexes used by Easton are dominated by internationally traded goods in which there was, certainly after the telegraph revolution of the early 1870s, quite indisputably very close arbitrage. The behavior of these price indexes could not diverge substantially across countries.

Hence whether it would be possible to test the Lucas hypothesis on this period's data by use of some other price indexes remains an open question. What is clear, though, is that given the indexes used by Easton, it is impossible for the gold standard years after 1870 to give confirmation of the Lucas hypothesis. Even if that hypothesis described the world perfectly, the world could by its nature not generate data on which the hypothesis could be tested.

In view of this, what do Professor Easton's findings tell us? He found some modest confirmation of the Lucas hypothesis before 1879, but essentially none after. This is encouraging for the hypothesis. Before 1879 prices were tied together less closely than they were afterwards; before 1879 not all the countries in his sample were on the gold standard, and because of poorer communications, arbitrage in traded goods occurred more slowly than it did after that date. His findings can therefore be described as being consistent with the Lucas hypothesis, although it cannot be claimed as confirmation of it.[4] Easton's informal work, in which he uses graphical methods and (very sensibly) breaks the period into before and after the gold standard, provides some support for this view.

His tests for the price elasticity of demand for each country's output

are, as he admits, so inconclusive as to be consistent with almost any prior expectation.

Points of Detail

Three details of Professor Easton's paper require comment. First, the choice of countries can best be described as eclectic. It is curious to include the Scandinavian countries and exclude Belgium, the Netherlands, France, Argentina, India, and Australia. These were important countries in the system—a fact surely outweighed by the relatively poor data available. In particular, Australia was a most important member of the periphery. It is just not good enough to write (footnote 8), "We have no evidence on the association of output between the United Kingdom, Australia, Argentina, and India, to name a few." The data to seek that evidence do exist; the omission of, certainly, Australia and Argentina is of sufficient importance that it should have been either rectified or justified.

Second, his rather harsh strictures on Morgenstern (1959) and Thomas (1954) are totally unjustified. Morgenstern, he writes, did not "abstract from the underlying growth rate"—but that is surely sensible if one is interested in relations among economies over a long period of years. With regard to Thomas, the assertion that it is difficult to accept inferences about the relationships among cycles because Thomas looks at cycles of varying amplitude and duration is certainly not self-evidently true—but it is presented as if it were.

Third, some of the results he obtained are (as in some cases he notes himself) distinctly odd. For example, from 1879 Canada's income fluctuations appear associated with those of the United States, and those of the United States are associated with those of the United Kingdom. But no association is found between Canadian and United Kingdom income fluctuations. Turning to patterns of causality, there are some most curious findings. Germany "causes" U.K. fluctuations, Denmark and Sweden "cause" Italian fluctuations, but Norwegian fluctuations, although *correlated* with those in Denmark and Sweden, do not appear to join fluctuations in those two countries in "causing" Italian fluctuations. These findings may result from the omission of some third variable from the bivariate causality tests. But it is much more likely that they are the chance result of extensive manipulation of poor-quality data.

The Lessons of the Paper

What does this paper tell us? The author himself does not seem sure; if we read the concluding section, we find proposals for future work, but no clear statement of what has been achieved. In fact, four lessons emerge very clearly from the paper. First, it confirms that a fairly predictable monetary system imposes no particular systematic behavior pattern on

the real economy. That confirmation is useful. Second, it demonstrates that in the gold standard period looking at individual episodes is helpful, while examining the period as a whole on balance conceals information. Third, the paper is a useful reminder of the dangers of taking at face value the results of the extensive and elaborate statistical manipulation of not particularly reliable data. Fourth, and perhaps most important, it shows very clearly just how necessary it is to consider analytically the question being addressed before rushing at the data with a battery of statistical techniques.

Notes

1. This alleviation of demand pressure was known in the United Kingdom during the Bretton Woods era as the "problem" of the balance of payments. For discussion of the cyclical behavior of the United Kingdom's balance of payments in this period, see Williamson and Wood 1976.

2. Two further points should be noted on the use of Granger-Sims tests in this paper. First, although two references are cited that suggest Granger's methods are superior, a Sims test is used in one instance without an indication of why it was chosen. Second, "To supplement the Granger causal relationships, table 11.5 uses a Sims test to examine the full range of data available for each country" (p. 520). Now one thing Granger-Sims methods have revealed quite unambiguously is the importance of the exchange-rate regime for relationships between countries. See e.g., Mills and Wood 1978. Thus simply flinging together data from different exchange-rate regimes could certainly not help reveal any "causal" relationships; indeed, it is more likely to conceal them.

3. It should be pointed out that Easton takes no account of the comments of Neil Wallace on Lucas (1973), which Lucas acknowledged in a note (1976) to be of some importance to the interpretation of his paper. As Easton's paper is affected by a different and prior flaw, however, this issue is not pursued here.

4. Easton points to the lack of cross-country inflation variability as the reason for the failure of the test, but does not seem to grasp why it occurred or what it implies.

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Discussion of Huffman-Lothian and Easton Papers

MELTZER commented on the view that seemed to prevail in the preceding sessions to the effect that institutions didn't matter: Sweden's growth didn't matter; it didn't matter if Sweden was on the gold standard or not; Italy not being on the gold standard didn't matter; nothing seemed to matter. This session's papers and the comments on them raise an important issue because they ask the question whether in fact and in which way did institutions matter.

Suppose the fluctuations are entirely random, random mixtures of supply and demand shocks. What is random and what is not random with respect to prices is not independent of the perceptions that people have, what they expect prices are going to do, and how long these movements are going to persist; surely that set of beliefs depends very much on the nature of the monetary system. The proposition may be a difficult one to test, but it certainly is not impossible to test—that the monetary rule, the fiscal rule, and the agreements that people have made among themselves and between countries have something to do with the way in which cycles, price movements, exchange-rate movements, monetary movements occur. The fact that we don't find in patterns of shocks exactly what might be expected from a rigid interpretation of these arrangements should not immediately lead to the view that the arrangements don't matter at all—that what the rule is or what kind of monetary system we have doesn't matter.

It would seem a little early to dismiss the importance of rules, one reason being that the nature of what is considered a permanent deviation and what is considered simply transitory white noise might be very different. For example, compare the Irish potato famine and its effect on prices in England, where the price of wheat apparently doubled or trebled during the course of a very short period of time and then fell by 50 percent, to the uncertainty generated in the modern economy by a similar rise in the price of oil. In the earlier episode, under the prevailing institutions of Britain, no one expected price controls to be put on wheat, no one expected any of the kinds of policies that would be very likely to be high on the list of what one might expect when similar shocks take place today. So I hope that the monetary and fiscal rule will be considered to

have more importance than was being assigned to it earlier in the conference.

BARRO, commenting on Easton's paper, pointed out an error in the version of the Lucas model that was utilized. In point of fact, the output and inflation equations in the model are not independent. The inflation equation is just the first difference of the output equation. Thus, there is no point to estimating separately the output equation and the inflation equation.

DORNBUSCH indicated that in reading the Lothian-Huffman paper, he was unable to link the theoretical and empirical sections of the essay.

MCCLOSKEY started with a general comment. There comes a point, he suggested, when the results of fitting hyperplanes to time-series data are so strange that one must question the advisability of the exercise. In the Huffman-Lothian paper, for example, there is a one-year lag in the adjustment of interest rates to external shocks. One can imagine certain circumstances in which such an adjustment lag might exist, but the foregone profit opportunities seem tremendous. Thus, this result must be treated skeptically.

McCloskey went on to quarrel with the way the word "significance" was used in these papers as a basis for making inferences. In fact, all the "significance" level indicates is the probability of type-one error.

LOTHIAN accepted McCloskey's first point. Their paper was not an attempt to present an explicit test of interest arbitrage. The authors merely wanted to have interest rates in the model.

THOMAS commented on Easton's paper. In his introduction, Easton states that there is little evidence of an Atlantic economy as far as real income movements are concerned. That statement is based on an analysis of the United States, Canada, the United Kingdom, Germany, Italy, Denmark, Norway, and Sweden. Yet the term "Atlantic economy" was chosen to represent the United Kingdom and a periphery of developing countries, namely, countries of recent settlement overseas—not all of them in or around the Atlantic ocean. It is quite clear in the literature that the Atlantic economy includes countries such as Canada, the United States, Argentina, Australia, and New Zealand. The rather eccentric set of countries considered in Easton's paper could not possibly warrant a conclusion about the existence of an Atlantic economy.

ABRAMOVITZ elaborated upon Thomas's point. There is another sense in which the selection of countries and the uniform treatment of the whole period is unrepresentative of the notion of the Atlantic economy. Consider the question of migration from European countries to the United States. The links between the United States and the various European countries were changing over time. Immigration occurred as European nations entered their periods of industrialization and the movement from their farms began. For example, before the U.S. Civil

War German immigration began, followed after the war by immigration from Scandinavia, then Italy, and so on. Changes in the linkages among countries must be taken into account.

EASTON commented on his usage of the phrase "Atlantic economy." He argued that all the countries he dealt with were closely related to one another. His footnote 8 carefully distinguishes his hypothesis from the hypothesis with which Brinley Thomas was concerned. Thomas is concerned with the long swing, whereas Easton is looking at year-to-year fluctuations. While the United Kingdom may still have been an economic hub for some countries, there is no evidence of any association of output between the United Kingdom, Australia, Argentina, and India.

LOTHIAN acknowledge the problematic nature of the real-income estimates used in the Huffman-Lothian paper. Regarding the use of vector autoregressions, he acknowledged that the authors had reported some peculiar correlations. However, they had been careful not to make strong assertions on the basis of such results. Lothian also addressed one of Dornbusch's comments regarding the paper's emphasis on monetary variables. The authors had begun their inquiry with the presumption that monetary shocks were important but that real shocks might have mattered also. Dornbusch and Frenkel may be right that a harvest failure was the cause of a particular decrease in the gold stock. Yet the question remains: Is there then feedback from the endogenous changes in money to the real side of the economy? Are major monetary fluctuations associated with subsequent real-income fluctuations? Granger's and Sims's methodology provides a technique for distinguishing the influence of real and monetary variables.

HUFFMAN commented that note 11 of the paper describes at some length the problems of interpreting Granger tests. It is well known that coefficients on successive lag values of a given variable will oscillate in sign. Huffman and Lothian report the results of a wide range of tests with the aim of providing different pictures of the relationships among variables. Not all of the pictures necessarily lead to the same conclusions. Huffman suggested that one's priors make a difference in how one interprets the results. However, in Huffman's view, there are plausible interpretations for most of the results the authors present.