**FINANCIAL INTEGRATION IN ANTEBELLUM AMERICA:
STRENGTHENING BODENHORN'S RESULTS**

by

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ABSTRACT

Howard Bodenhorn has argued that U.S. financial markets prior to the Civil War were integrated. This finding challenges some of the conventional wisdom about the history of U.S. capital markets. A re-examination of Bodenhorn's work reveals flaws in his methodology that casts doubt on his results. Yet after addressing these weaknesses and offering an alternative analysis of his data, we find that Bodenhorn's essential result is confirmed: capital markets do appear integrated in the antebellum period.

In a recent article in this Journal, Howard Bodenhorn made a remarkable suggestion: "Antebellum financial markets may have outperformed those of the post-Civil War period."¹ According to Bodenhorn, antebellum capital markets displayed notable integration, as indicated by movements in short-term (60 day) interest rate data for important commercial centers east of the Mississippi. When considered in light of Lance Davis's work, suggesting poor integration of credit markets immediately after the Civil War and only gradual integration thereafter, we believe economic historians will find Bodenhorn's hypothesis provocative--even startling.² We found the hypothesis so suggestive that we attempted to replicate Bodenhorn's analysis--a process that generated both "bad news" and "good news." The "bad news" is that we believe the evidence Bodenhorn provided for his hypothesis is weak or irrelevant. The "good news" is that the data Bodenhorn generated support the integration hypothesis more strongly than even Bodenhorn suggested.

Bodenhorn combined existing data on short-term interest rates with several new series collected or derived from local periodicals spanning the period 1836 to 1859. The rates for Boston came from Frederick R. Macaulay, whereas the rates for New York and Philadelphia were monthly averages of weekly rates as published in the New York Tribune and Bicknell's Counterfeit Detector, respectively.³ Rates for Charleston and New Orleans derived from the Charleston Mercury, (New Orleans) Daily Picayune, and New Orleans Price Current, though for these cities

the newspapers published only prices of discounted bills of exchange. Following Eric S. Schubert, Bodenhorn converted these prices to interest rates using price quotations for bills of exchange due on sight (short bills) and bills of exchange due in 60 days (long bills).⁴

Using the results of a variety of tests, Bodenhorn argued that credit markets were well integrated before the Civil War. First, he noted the positive and "large" correlations in movements of interest-rate differentials between cities.⁵ Table 2 reproduces these correlation coefficients. Second, after accounting for the transactions costs of moving funds between cities, he concluded that interest-rate differentials fell between arbitrage points for most of the period.⁶ Third, his stationarity test strongly rejected the null hypothesis that interest-rate differentials between city-pairs contained unit roots, a result that implied the cointegration of regional interest-rate series, (that is, the series followed common trends).⁷ All of these results suggested to Bodenhorn that, allowing for the costs of transferring funds between commercial centers, antebellum credit markets east of the Mississippi were integrated.

Bodenhorn made our attempts to replicate his analysis relatively easy by wisely publishing his data in an appendix. A glance at the data's descriptive statistics (not reported by Bodenhorn) proves interesting. Column 2 of Table 1 reports the means and standard deviations of the series. With the exception

of New York, the average interest-rate levels across the period appear quite close. We find it intriguing that New York apparently enjoyed a discount on the order of 190 to 250 basis points relative to other cities. New York's advantage is not entirely an artifact of sample choice.⁸ We calculated the interest-rate differentials for each city-pair and report the results in columns 3 through 6. Although smaller, New York's advantage remains. Interest rates in other cities may reflect risk premia relative to New York, but we leave the exploration of that hypothesis to others.

Although we generally replicated Bodenhorn's correlations of interest-rate movements, we question the power of that analysis to reveal or reject market integration. The last column of Table 2 reports our correlation coefficients for the first differences in monthly interest rates. With the exception of one city-pair, we reproduced Bodenhorn's results precisely.⁹ As the z-scores indicate, however, many of the correlations are statistically insignificant.¹⁰ In any case, we believe that correlations of interest-rate movements (first differences) provide weak tests of integration. Correlations of first differences essentially focus on the second time derivative of a series. Even if two series shared identical, constant, second time derivatives, they could diverge, contrary to the integration hypothesis.

Secondly, Bodenhorn's stationarity results are irrelevant to the integration hypothesis. Bodenhorn apparently reported in his Table 2 the results of estimating the following regression:

$$d_{jt} = \beta_0 + \beta_1 d_{jt-1} + \sum_{i=1}^N \alpha_i \Delta d_{jt-i} + \epsilon_t \quad (1)$$

where d_{jt} is the difference in interest rates between two cities.¹¹ He argued that evidence of stationarity in the difference in rates between cities suggested that arbitrage transactions eliminated large differences, which would imply efficiency, as well as integration, of the respective capital markets. Stationarity of the differences provides strong evidence of integration if the individual interest-rate series are nonstationary. However, if the individual series are stationary, then linear combinations of the series are also stationary.¹² In the latter case, then, one cannot infer capital market integration from a finding that the differences are stationary.

We report the results of our stationarity tests for the interest-rate series in Table 3. We found that all the series are stationary. We tested each series for stationarity by estimating the following regression:

$$\Delta r_{it} = \beta_0 + \beta_1 r_{it-1} + \sum_{j=1}^N \alpha_j \Delta r_{it-j} + \epsilon_t$$

where r_{it} is the interest rate in city i at time t .¹³ The null hypothesis for nonstationarity of the series (a unit root) is $\beta_1=0$. Rejection of the null implies stationarity. A glance down column 2 of Table 3 suggests rejection of the null for each series at the 1 per cent level, that is, the interest-rate series

for each city displays stationarity. As we have already noted, this means, in turn, that the difference between any two of these series will be stationary simply as a statistical fact, implying nothing about the integration of markets.

We believe that evaluating the correlations between interest-rate levels (rather than first differences) provides a stronger test of market integration than the tests carried out by Bodenhorn. Bodenhorn apparently considered but rejected this test and followed instead George Stigler and Robert A. Sherwin by correlating first differences of interest rates.¹⁴ Stigler and Sherwin used first differences because their price level data often displayed evidence of random walks or common time trends.¹⁵ But since the interest-rate series in the present case are stationary, we need not rely on first differences.¹⁶ If two regions with stationary interest rates are integrated into a single market, this union should be reflected in correlations of levels. Because integrated markets may or may not exhibit correlations in first differences, correlating levels is a stronger test of Bodenhorn's hypothesis.

Combined with evidence presented in Table 1, the correlations of interest-rate levels reported in Table 4 strongly support Bodenhorn's hypothesis of antebellum capital-market integration. The 95 per cent confidence intervals for the mean differentials of interest rates between cities, reported in columns 3 through 6 of Table 1, all lie within the 2.5 percentage point band that Bodenhorn implicitly used as arbitrage points for

capital movements.¹⁷ This result suggests that, for the most part, interest rates between cities were closely linked at every point in time.¹⁸ The correlations between interest-rate levels in Table 4 are all positive and statistically significant at the 1 per cent level, except for the correlation of the Boston/Charleston rates, which is positive and statistically significant at the 10 per cent level. These results strongly support Bodenhorn's hypothesis of antebellum market integration.

We believe Bodenhorn's article makes a significant contribution to the literature in terms of developing new data on interest rates and in challenging existing presumptions about the nature of the nineteenth century American economy. We found the evidence for integration presented by Bodenhorn weaker than he suggested, but our reevaluation of the data he generated supports the hypothesis that the antebellum capital market was indeed integrated. We expect Bodenhorn's contribution to inspire more work on the nature of nineteenth century U.S. (particularly antebellum) credit markets and to revive debate on the economic disruptions of the Civil War. We look forward to seeing the development of this new literature.

Notes

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1. Howard Bodenhorn, "Capital Mobility and Financial Integration in Antebellum America," this Journal, 52 (Sept. 1992), p. 586.
2. Lance Davis, "The Investment Market, 1870-1914: The Evolution of a National Market," this Journal, 20 (Mar. 1960), pp. 1-30.
3. Frederick R. Macaulay, The Movements of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856 (New York, 1938). See notes to Appendix Table 1 of Bodenhorn, "Capital Mobility," p. 609 for detailed sources of data.
4. Eric S. Schubert, "Arbitrage in the Foreign Exchange Markets of London and Amsterdam during the 18th Century," Explorations in Economic History, 26 (Jan. 1989), pp. 2-3.
5. Bodenhorn, "Capital Mobility," p. 590, Table 1.
6. Ibid., pp. 591-92, Figures 2 and 3.
7. Ibid., pp. 593-94.
8. To some extent it is, however. Because of substantial missing observations in some of the series, the means and standard deviations reported in Table 1, column 2, are not

strictly comparable, but they are suggestive.

9. We could not verify Bodenhorn's coefficient for Boston/Philadelphia. Communication with Bodenhorn indicated that his reported coefficient reflected a transposition error and that our estimate is correct.

10. Bodenhorn did not report tests for statistical significance in the correlation coefficients.

11. We believe this expression is inappropriate as a test for stationarity and that the correct test requires estimating the following:

$$\Delta d_{jt} = \beta_0 + \beta_1 d_{jt-1} + \sum_{i=1}^N \alpha_i \Delta d_{jt-i} + \epsilon_t \quad (2)$$

both with and without a time trend. In fact, we think Bodenhorn estimated this specification. We failed to replicate his results by estimating equation (1), but we came quite close when we estimated equation (2).

12. R.F. Engle and C.W.J. Granger, eds., Long-Run Economic Relationships, Readings in Cointegration (New York, 1991), p. 6.

13. As Bodenhorn noted in footnote 21, the number of lags must be determined empirically in order to reduce the error term to white noise. Rather than using Bodenhorn's method, however, we chose to follow the simpler procedure advocated by John Y. Campbell and Pierre Perron, "Pitfalls and Opportunities: What Macroeconomists should Know about Unit Roots," in Olivier Jean Blanchard and Stanley Fischer, eds., NBER Macroeconomics Annual 1991 (Cambridge, MA, 1991), p. 155. We also ran the regressions

with time trends, but found the coefficients on time statistically insignificant and the implications for stationarity unaffected by including the trend.

14. Bodenhorn, "Capital Mobility," p. 590; and George Stigler and Robert A. Sherwin, "The Extent of the Market," Journal of Law & Economics, 28 (Oct. 1985), pp. 558, 562.

15. See, for example, their discussion of silver futures prices (Stigler and Sherwin, "Extent," p. 559).

16. Correlations of interest rate levels in fact reflect movements of interest rates relative to their means. Bodenhorn correctly notes that equality of interest rates in two regions (either at a given point in time or on average) is neither necessary nor sufficient for integration. This reasoning may have led him erroneously to reject level correlations as a test of market integration. High correlations of interest-rate levels do not imply, nor are they implied by, equality of interest rates at a point in time or on average.

17. Bodenhorn, "Capital Mobility," Figures 2 and 3, pp. 591-92.

18. We recognize that, as a practical matter, information and capital must have moved with lags, and that measurement error especially afflicts data recorded long after they were generated. Both considerations suggest that a more sophisticated, dynamic specification of the relationships between rates would improve the analysis. Nevertheless, we find these results encouraging, and we hope others will undertake the more detailed, dynamic analysis that they suggest will prove fruitful.

TABLE 1
DESCRIPTIVE STATISTICS AND DIFFERENCES OF INTEREST-RATE LEVELS, 1836-1859

(1)	(2)	(3)	(4)	(5)	(6)
Mean					
City	Standard Deviation	New York	Philadelphia	New Orleans	Charleston
Boston (1)	9.29	1.70	.025	-.71	.31
	4.73	1.46 1.95	-.33 .38	-1.25 -.17	-.33 .96
Boston (2)	9.44				
	5.40				
New York	7.00		-1.76	-1.93	-1.25
	2.85		-2.02 -1.49	-2.29 -1.57	-1.63 -.86
Philadelphia	8.91			-.66	.60
	3.56			-1.14 -.17	.15 1.06
New Orleans	9.54				.61
	4.56				.15 1.06
Charleston	8.96				
	4.09				

Note: Column 2: Means and standard deviations are not strictly comparable because of missing observations for some cities. Columns 3 through 6: Top numbers are the mean differentials between rates; for example, row 1, column 3 (1.70), is the mean differential, subtracting New York's rates from Boston's. Bottom numbers are the lower and upper bounds, respectively, of 95% confidence intervals for the differentials.

Source: Calculated from Bodenhorn, "Capital Mobility," Appendix Table 1.

TABLE 2
CORRELATIONS OF INTEREST-RATE MOVEMENTS

(1)	(2)	(3)	(4)
City Pair	Observations	Bodenhorn Estimate	Replicated Estimate
Boston New York	210	.63	.63** (4.68)
Boston Philadelphia	225	.72	.31* (2.11)
Boston New Orleans	251	.16	.16 (1.13)
Boston Charleston	266	.13	.13 (0.90)
New York Philadelphia	180	.50	.50** (3.21)
New York New Orleans	207	.48	.48** (3.27)
New York Charleston	198	.19	.19 (1.18)
Philadelphia New Orleans	213	.23	.23 (1.49)
Philadelphia Charleston	217	.10	.10 (0.63)
New Orleans Charleston	239	.13	.13 (0.89)

** = significant at the 1 percent level.

* = significant at the 5 percent level.

Notes: Column 1: Boston series is Boston (1). Column 4: z-scores are in parentheses.

Sources: Bodenhorn, "Capital Mobility," Table 1, p. 590; and Appendix Table 1.

TABLE 3
TESTS FOR UNIT ROOTS IN INTEREST-RATES LEVELS

(1)	(2)	(3)
City	β_1	lags
Boston (1)	-.16 (4.91)	2
Boston (2)	-.23 (4.95)	3
New York	-.21 (4.08)	2
Philadelphia	-.18 (4.18)	1
New Orleans	-.27 (4.27)	6
Charleston	-.18 (4.81)	5

Notes: Absolute values of tau statistics are in parentheses.

All coefficients are statistically significant at the 1% level.

Results are reported for regressions without time trends. The number of lags was determined as in Campbell and Perron,

"Pitfalls and Opportunities, p. 155, starting with a maximum of six lags. Critical tau values were determined from James G.

MacKinnon, "Critical Values for Cointegration Tests," in R.F.

Engle and C.W.J. Granger, eds., Long-Run Economic Relationships, Readings in Cointegration (New York, 1991), pp. 274-75.

Source: Calculated from Bodenhorn, "Capital Mobility," Appendix Table 1.

TABLE 4
CORRELATIONS OF INTEREST-RATE LEVELS

(1)	(2)	(3)
City Pair	Correlation Coefficient	Observations
Boston New York	.86** (8.22)	214
Boston Philadelphia	.73** (6.03)	230
Boston New Orleans	.50** (3.77)	258
Boston Charleston	.23* (1.70)	272
New York Philadelphia	.84** (7.10)	184
New York New Orleans	.71** (5.54)	210
New York Charleston	.56** (3.88)	206
Philadelphia New Orleans	.52** (3.67)	216
Philadelphia Charleston	.47** (3.29)	222
New Orleans Charleston	.59** (4.59)	248

** = significant at the 1% level.

* = significant at the 10% level.

Notes: Absolute values of z-scores are in parentheses.

Source: Calculated from Bodenhorn, "Capital Mobility," Appendix Table 1.