BUSINESS CYCLE VOLATILITY IN DEVELOPED MARKET ECONOMIES, 1870-1986: REVISIONS AND CONJECTURES

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INTRODUCTION

The conventional wisdom concerning the volatility of American business cycles has been, until very recently, that the post-World War II period was actually subject to much milder business cycles than the pre-Great Depression period. This view was largely based on the empirical work of Simon Kuznets and was seen to support the belief that Keynesian macroeconomic policies contributed considerably to increasing the stability of business cycles in the United States after World War II.1 Christina Romer [1986a, 1986b, 1989], however, revised Kuznets’s real GNP estimates for the pre-Depression period (most significantly for the 1889-1909 period) and challenged the view that the pre-Depression period (1889-1925) was, in any meaningful way, more volatile than the post-World War II period (1947-1985).2 Romer’s revised estimates speak in favor of the argument that increased government intervention did little, if anything, to affect increased macroeconomic stability in the United States. This point has been reiterated by Sheffrin [1991, 36, 37, 40, 42, Ch. 2] who, using real GNP and GDP estimates for six other countries — the United Kingdom, Norway, Italy, Denmark, Sweden, and Canada — concludes that there is little difference in cyclical volatility between the 1871-1914 and 1951-84 periods with the exception of Canada and Sweden.3 It should be noted here that Sheffrin excludes the 1915-28 period from his analysis, and thus his volatility estimates are not directly comparable to Romer’s. This is also the case with a more recent study by Bockes and Kohoe [1993] that adds Australia, Germany, and Japan to Sheffrin’s list of countries and largely restates some of the empirical results and interpretation of the results found in Sheffrin [1988, 1991].4

Nathan Balke and Robert Gordon [1969] have recently revised Romer’s real U.S. GNP for the 1869-1928 period and thereby Romer’s volatility estimates. Their new estimates support the traditional view that the post-World War II period’s business cycles, in fact, were characterized by much less volatility than were business cycles of the pre-Depression period. It seems that we have now come full circle. The Balke and Gordon estimates are the most comprehensive revisions of U.S. real GNP available to date. Unlike the Kuznets and Romer GNP estimates, both of which only incorporate direct measures for commodity output, Balke and Gordon [1989, 40, 51-58] also use direct measures for non-commodity transportation, communications, and construction outputs.5

On a more general level, Angus Maddison [1984, 66-67; 1991, 87-88, 112-119], using the most recent real GDP estimates available for sixteen developed market economies (including Canada and the U.S.), finds that in all of these economies with few exceptions, there was much more cyclical volatility during the 1870-1913 period as compared to the post-World War II period. Finally, Andrea Bollo [1989, 1714-17] applies four volatility measures to real GDP estimates for fifteen countries which are also examined.
by Maddison and finds that, for the most part, the post-World War II period was much less volatile than the pre-World War I period. However, since Maddison, like Sheffrin and Backus and Kohoe, excludes the 1915-28 period and Boltro excludes the 1914-28 period from their analyses respectively, their volatility estimates are not directly comparable with Romer’s nor Balke’s and Gordon’s. Moreover, Maddison’s measure of cyclical volatility, the maximum peak-trough fall in GDP or lowest rise, is both quite different and less comprehensive than the measure adopted by Romer, Balke and Gordon, Sheffrin, and Backus and Kohoe, the standard deviation of deviations from the trend. Boltro’s volatility measures, on the other hand, although much more comprehensive than Maddison’s, do not appear to replicate the methodology adopted by the former authors.

Clearly, the problem with this literature is that it lacks comparability. Rigorous estimates of cyclical volatility in addition to and comparable with those available for the U.S., therefore, can serve to provide further evidence to test the hypothesis that business cycles were relatively less volatile following the Second World War in the more developed market economies. In this article, a variety of Canadian real GNP estimates are averaged over the period 1915-28 for the 1970-1985 period. Finally, I measure the severity of Canadian business cycles. To make the Canadian results comparable to the American, I use the same time frames and methodology to measure cyclical volatility adopted by Romer and Balke and Gordon. This is the first time such estimates have been constructed for Canada. Also, to supplement the Canadian volatility estimates, the annual real GDP index numbers presented in Maddison [1991, Appendix A] are employed to construct estimates of the severity of business cycles for twelve developed market economies. These include the countries examined in both Sheffrin’s [1991] and Backus’s and Kohoe’s [1992] work. Finally, unlike both Maddison and Sheffrin, I adopt Romer’s time frames and methodology to construct the volatility estimates for these twelve countries so that, in the final analysis, all estimates are comparable.

The volatility estimates for each of the Canadian GNP series reveal that business cycles in the 1870-1928 period were relatively much more volatile than those in the 1947-86 period, even more so than what Balke and Gordon find for the U.S. I also find this to be true for the other twelve countries examined. It is only when one compares the 1870-1908 and 1954-72 periods and excludes World War I and its aftermath from the analysis, that one finds some evidence of a small reduction in cyclical volatility over the pre-Depression to the post-World War II period. This finding, however, holds for only three of the countries examined: West Germany, Denmark, and Norway.

**METHODOLOGY**

An integrative step in measuring the volatility of business cycles is the method chosen to detrend the real GNP estimates. In the American case, Balke and Gordon employ the detrending method and benchmark years suggested by Romer to make their volatility estimates for the American economy compatible with hers. To detrend GNP, Romer estimates log-linear trend lines through logarithms of estimated "actual" real GNP for selected benchmark years. Her choice of benchmark years is of critical importance and is based on an "admittedly arbitrary and imperfect procedure." She chooses years corresponding to "points of maximum expansion in the business cycle," as opposed to selecting benchmark years on the basis of peak or trough GNP years. The latter, less arbitrary, method is rejected since it apparently "accentuates" the size of cyclical fluctuations. Romer, 1990, 141. Once the GNP estimates are detrended, the log of actual real GNP and the log of the trend GNP are used to estimate the standard deviation of deviations from the trend (SDDDT). The SDDDT provides us with what is, in effect, a measure of average cyclical volatility over a particular time frame. The SDDDT is also a suitable measure of the severity of business cycles, particularly when there are variations in trend growth rates (Romer, 1989, 28; Balke and Gordon, 1989, 56-57). One potential problem with the SDDDT, however, is that it is sensitive to the choice of benchmark years. Thus one must take particular care that the benchmark years will not only coincide with "normal years," an admittedly somewhat arbitrary decision, but also not bias the value of the SDDDT in a direction favorable to one’s hypothesis.

I adopt Romer’s preferred methodology to measure the severity of business cycles in Canada as well as for the 12 additional countries examined below. My results, therefore, are comparable to Romer’s and Balke’s and Gordon’s. However, to control for potential inadvertent biases introduced in the selection of benchmark years, I present a complementary set of SDDDT estimates for relevant countries, including Canada and the U.S., using peak years and trough years during the benchmark years. Finally, SDDDT estimates are computed for the 1870-1908, 1870-1928, 1954-72, and 1947-86 periods, the same time frames adopted by both Romer and Balke and Gordon in their respective studies. Also, as in the aforementioned American studies, I estimate the volatility ratios by dividing the SDDDT for 1870-1908 by that for 1954-72 and by dividing the SDDDT for 1870-1928 by that for 1947-86. The first ratio is for the period net of the major shocks to the economy that were experienced at the time: World War I and its aftermath; the immediate repercussions of the Second World War; the Korean War; and the 1973 oil price shock. These shocks are incorporated, on the other hand, in the second ratio presented. This allows one to determine how well or poorly the countries under study were able to adjust to major shocks to their economies, exclusive of the Great Depression.

**CANADIAN REAL GNP ESTIMATES**

Presently, there are three series of real GNP available for Canada. The earliest one is by O.J. Firestone [1958]. However, the background material upon which Firestone based his final estimates are now lost to scholars, and his final estimates for intercensal years are apparently drawn from very meagre interpolators. Any results emanating from Firestone’s estimates, therefore, must be treated with more than the usual abundance of healthy scepticism. More recently, M.C. Urquhart, in association with Alan Green, Marvin McNiss, Thomas Rymes, Alasdair Sinclair, and Marion Steel, has constructed a new and much more rigorous nominal GNP series for the 1870-1936 period from which Urquhart [1986] constructs a new real GNP series. As with Firestone’s GNP estimates and indeed the American GNP estimates, Urquhart’s most reliable estimates are for census years. It appears from the documentation provided by Urquhart [1986, 64-85] that his annual estimates for commodity output are at least as rigorous as those which underlie the various American GNP series. In addition to commodity output estimates, Urquhart constructs annual estimates for non-commodity output. Such annual estimates, it should be remembered, are constructed entirely by assumption as in the traditional Kuznets-based American GNP estimates. Romer’s differs, however, by challenging the
assumptions underlying the construction of non-commodity output. 19 Balke's and Gordon's revision is much more extensive and is constructed much more carefully than their estimates, to a large extent, are based on direct annual estimates for transportation, communications, and construction output. Not only does Urquhart (1986, 11-15) present annual estimates for these three sectors, he also presents additional annual estimates for electric light and power, banking and finance, residential rents, federal government, provincial government, municipal services, and public school and university education. These estimates make Urquhart's nominal GNP estimates, in the very least, as rigorous and reliable as Balke's and Gordon's revised GNP estimates for the U.S. 20

The only component of Urquhart's annual nominal GNP estimates which are constructed entirely by assumption are his estimates for miscellaneous services consisting of the wholesale and retail trade and the community, business, and personal service sectors. These two sectors contributed from 12 percent of nominal GNP in 1870 and 1880 to 22 percent in 1926 [Urquhart, 1986, 11-15]. Estimates for the intercensal years in Urquhart's series are constructed by assuming that the volatility of these sectors' output is the same as that for the rest of the estimated nominal GNP. The extent that the volatility of these sectors' output was less than the average, Urquhart's nominal estimates exaggerate the volatility of the business cycle and thus yield upper-bound estimates of cyclical volatility.

Urquhart's implicit assumption about the volatility of miscellaneous services, however, does not seem to be unreasonable since miscellaneous services consists largely of output which is in no way sheltered from cyclical movements in the rest of the economy, particularly for the pre-World War II period. Moreover, data are available from which to determine the relationship between movements in GNP net of miscellaneous services and movements in miscellaneous services from 1926 to the present [Leacy, 1983, series 66, 67, 70, 71, 75]. In the 1926-46 period, net GNP moves 0.66 for one with miscellaneous services. This relationship changes little in the 1926-33, 1933-39, or 1939-46 periods and becomes 0.92 for one in the 1926-38 period. In contrast, net GNP moves 0.68 for one with miscellaneous services for the 1946-65 period and only 0.57 for one in the 1946-76 period. It is only after World War II that movements in net GNP and in miscellaneous services are no longer a close match. Therefore, if the relationship between these two series in the 1870-1926 period bears any affinity to their relationship in the 1926-46 period, Urquhart's estimates for miscellaneous services are, in all probability, not very far from their true values. And, at present, no evidence exists from which to determine what the true values, in fact, might be. Only if one assumes that the pre-World War II relationship between movements in net GNP and movements in miscellaneous services holds for the 1870-1920 period would Urquhart's miscellaneous service estimates tend to seriously exaggerate the volatility of business cycles in the 1870-1926 period. 21

Urquhart converts his nominal GNP series into a real GNP series by deflating his nominal series, net of estimates for gross domestic capital formation (GDCF), using three different series of price indexes for the 1870-1900, 1900-19, and 1919-26 sub-periods respectively. The principal shortcoming of the Urquhart real GNP series lies in the method he uses to deflate his fairly rigorous nominal GNP estimates. The first price index series used by Urquhart to deflate nominal output is the most limited. It is heavily weighted towards food expenditure and is based on price data for Kingston, Ontario alone [Urquhart, 1986, 85-86; Barnett, 1963]. The 1900-13 series is based largely on

<table>
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<tr>
<th>Periods</th>
<th>Revised Canadian Real GNP</th>
<th>Urquhart Canadian Real GNP</th>
<th>Firestone Real GNP</th>
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<tr>
<td>1870-1908</td>
<td>5.09</td>
<td>3.59</td>
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<td>5.86</td>
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<td>1908-1928</td>
<td>6.75</td>
<td>7.23</td>
<td>7.25</td>
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<tr>
<td>1954-1972</td>
<td>2.11</td>
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<tr>
<td>1947-1966</td>
<td>2.15</td>
<td>1.85</td>
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Volatility Ratios

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<tr>
<td></td>
<td>2.41</td>
<td>2.27</td>
<td>2.43</td>
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Notes and sources: BM and PP refer to the "normal" and peak-to-peak method of selecting benchmark years respectively when deflating GNP. All volatility ratios are statistically significant at least at the 95 percent level. See text for further details.

19 wholesale prices, and data for the years 1901-04 and 1906-08 are interpolated (Urquhart, 1986, 85-86; Bertram and Percy, 1979). The last series, covering the 1913-26 period, is the most reliable of the three. It is constructed from Canada-wide prices of food, clothing, rent, fuel and miscellaneous expenditures. However, these price data are not weighted for their associated output's contribution to GNP (Urquhart and Buckley, 1965, 298). Gross domestic capital formation is deflated using a price index for the cost of capital goods. Since GDCF is estimated from Urquhart's estimates to represent about 15 percent of nominal GNP, with the exception of the 1906-14 period when it composed 25.5 percent of GNP, the price index for the cost of capital goods is given a weight of about 15 percent whereas the "consumer" price index is given a weight of the residual nominal GNP, or of about 85 percent [Urquhart, 1986, 33-34].

20 Nominal GNP, however, is comprised of the outputs of many sectors whose prices may not have moved in the same direction, or may not have been at the same level as the crude composite price index developed by Urquhart. Urquhart's price index does not incorporate the price information of most of the components that make up his nominal GNP estimates. It seems fair to ask, therefore, whether the price index numbers based upon the prices of the actual components of nominal GNP would yield different real GNP estimates and thereby different volatility estimates from those obtained from Urquhart's composite price index numbers.
### BUSINESS CYCLE VOLATILITY 2

After a careful examination of the different real GNP series available for Canada for the 1870-1872 period, three sets of benchmark years coinciding with normal years were finally adopted to define these series. For the Firestone series the benchmark years are: 1871, 1877, 1885, 1889, 1892, 1894, 1896, 1903, 1913, 1923, and 1928. For the Urquhart real GNP series the benchmark years are: 1870, 1880, 1885, 1890, 1897, 1909, 1918, 1924, and 1928. For the revised real GNP series the benchmark years are: 1870, 1877, 1883, 1892, 1896, 1903, 1913, 1923, and 1928. The differences in benchmark years are a product of the differences in the cyclical movements which characterize the various real GNP series. For the 1947-56 period there is, of course, only one set of benchmark years: 1948, 1956, 1961, 1969, 1977, and 1984. These benchmark years yield a set of SDTPI and volatility estimates (Table 1) directly comparable to Romer's and Balke's and Gordon's (the BM estimates of Tables 1 and 2). My other set of SDTPI and volatility estimates are produced using the peak to peak method of selecting benchmark years (the PP estimates of Tables 1 and 2).

The BM volatility ratios for the longer time frame, 1870-1928/1947-86, are 2.41, 2.69, and 2.63 for the Firestone, Urquhart, and the revised GNP estimates respectively. The PP ratios for these periods are 2.63 for the Urquhart GNP estimates and 2.73 for the revised GNP estimates. This compares to the American BM volatility ratios for these periods of 1.80 for the Balke and Gordon GNP estimates and 1.36 for the Romer estimates. The American PP volatility ratios for these periods are 2.48 and 1.53 respectively (Table 2). The BM volatility ratios for the shorter time frame, 1870-1900/1944-72, are 2.68, 2.27, and 2.41 for all of the above Canadian GNP series respectively. The PP volatility ratios are 1.70 for the Urquhart GNP series and 1.74 for the revised series. For the Balke and Gordon GNP series and for the Romer GNP series, the BM volatility ratios are now 1.71 and 1.24 respectively, whereas their PP volatility ratios are 2.29 and 1.83 respectively.

The least reliable of the Canadian GNP estimates, those of Firestone, as well as the more reliable Urquhart estimates and, arguably, the most reliable real GNP series of all, the revised GNP series, all yield both BM and PP volatility ratios which clearly show that the pre-Depression period was much more volatile than the post-World War II period. The largest volatility ratios are generated for the longer time frame, and this is largely because the 1870-1900 period was less volatile than the 1870-1928 period. The differences in cyclical volatility from one period to the next is clearly illustrated in Figure 1. It is, nevertheless, important to note that the BM and PP SDTPIs are different and...
that the PP volatility estimates are less than the BM volatility estimates. Even so, the lowest volatility ratios, for the shorter time frames using the PP SDDTs, reveal that the pre-World War I period was 70 percent more volatile than the post-World War II period.

The BM and PP SDDTs also yield different volatility estimates for the U.S.. In this case, however, the PP volatility ratios exceed the BM volatility ratios for both the Balk and Gordon and the Romer GNP series. This serves to reinforce Balk’s and Gordon’s findings that business cycles in the post-World War II period were, indeed, much less severe than in the pre-Depression era. Also, Romer’s conclusion that there is little difference in cyclical volatility between the pre-Depression and post-World War II periods, based on her BM SDDTs, is in no way affirmed when her real GNP series is detrended using an alternative method of selecting benchmark years. For the longer time frame, the volatility ratio rises to 1.5 and for the shorter time frame the volatility ratio rises to 1.5 from a BM volatility ratio of about 1.25 for both time frames. Even Romer’s GNP series, it is clear, generate volatility ratios suggestive of a rather large reduction in cyclical volatility from the pre-Depression to the post-World War II period.

Finally, I find that the differences in the SDDT between the pre-Depression and post-World War II periods are statistically significant for all the Canadian GNP series used in this article as well as for my PP estimates for the U.S. for both the Balk and Gordon and the Romer real GNP series. I adopt the same test of statistical significance initially used by Romer and later adopted by Balk and Gordon. ²⁹ It is important to note here that Romer’s finding — rejected by Balk and Gordon — that there was little difference in cyclical volatility between the pre-Depression and post-World War II period is based on more than her revised volatility ratio of 1.25 compared to 1.70 for the Kuznets-based GNP series. ³⁰ It further requires the rejection of a 25 percent reduction in cyclical volatility as a fairly substantial fall in the severity of business cycles. Romer [1989, 29] dismisses what she refers to as the “modest” 25 percent reduction in cyclical volatility as inconsequential since she finds that the 1.25 volatility ratio is not statistically significant “even at a 90 percent confidence level.” Statistical significance, however, should not be confused with substantive significance, and it is in no way clear that even if cyclical volatility fell by “only” 25 percent over time, that this decline in volatility is not of economic (substantive) importance. Moreover, tests of statistical significance can only reveal the probability that one’s results are a product of chance or, more precisely, the probability that one’s results can be expected to be replicated over repeated random samples drawn from a well-defined population. Since volatility estimates are derived not from samples but from the entire relevant population of data (GNP series), some experts have argued that the use of significance tests cannot provide us with any useful information. ³¹

CYCLICAL VOLATILITY IN SOME DEVELOPED MARKET ECONOMIES

For every country examined in this study, and it includes all countries included in Shenfield’s as well as in Balk’s and Kehoe’s studies, the severity of business cycles, using either the BM or PP volatility ratios, diminished dramatically from 1876-1928 to 1947-66 (Table 2 and Figure 1). In fact, volatility ratios for most of the 12 countries examined here are even greater than those for Canada or for the United States. Relatively low volatility countries are Denmark (1.93 to 2.52), Norway (2.12 to 3.50), and Sweden (2.61 to 2.62), and even these relatively low ratios clearly reveal a notable decrease in cyclical volatility from one period to the next.
FIGURE 1 (Cont.)
The Volatility of Business Cycles, 1870-1928 and 1947-1986

Source and notes: see text.
Both the BM and PP volatility ratios for the shorter time frame are lower than for the longer time frame for all 12 countries examined here with the exception of Australin. In Australia, the opposite is true due to the relatively much higher volatility experienced during the 1880s (Figure 1). For the remaining 11 countries, lower volatility ratios are largely a product of the greater stability of the 1870-1908 period compared to the 1970-1978 period, and the lack of significant increased stability of the 1954-72 period compared to the 1974-96 period. The lower volatility ratios for the shorter time frame, nevertheless, reveal a significant reduction in cyclical volatility from 1870-1908 to 1945-72 for most countries examined. Austria and Belgium experienced a relatively mild, yet still substantial reduction in cyclical volatility with volatility ratios ranging from 1.2 to 1.4. The volatility ratio for the UK is about 1.4. Finland's ranges between 1.5 and 1.7, while Italy's volatility ratio falls between 1.5 and 4.8. Next in line are Sweden and Japan with volatility ratios which, at a minimum, are about 1.7. Australia has a volatility ratio of between 3.5 and 14.0. For Germany, Denmark, and Norway, however, there is little, if any, indication of a reduction in cyclical volatility. 

These results serve to reinforce Maddison's (1991, 87) finding that, for the most part, business cycles in developed market economies tended to become more stable in the 1870-1913 period compared with the post-World War II period. However, that these trends are little or no reduction in the severity of the business cycle volatility for three countries does bear further investigation. My results also reveal that, with respect to the longer time frame, the severity of business cycles fell dramatically and without exception from the pre-Depression to the post-World War II period, thereby supporting the traditional view that business cycles became much less severe after the Second World War, even if one omits the Great Depression from one's analysis. 

Finally, it is important to note that the large fall in cyclical volatility over time cannot be associated with a fall in per capita GDP growth in the fourteen countries examined in this article. The arithmetic mean of per capita GDP growth for all of these countries increased from 1.37 percent annually in the 1870-1928 period to 3.50 percent in the 1947-96 period while the arithmetic mean for volatility fell from 2.58 to 1.90. The arithmetic mean of per capita GDP growth also increased from the 1870-1908 to the 1954-72 period, rising from 1.42 to 3.68 percent annually while the arithmetic mean for volatility fell from 3.04 to 1.59. Moreover, I find little relationship between per capita GDP growth and cyclical volatility within each of the periods examined. Spearman rank correlation coefficients for per capita rates of GDP growth and cyclical volatility for each of the 1870-1898, 1870-1928, 1954-72, and 1947-85 periods are calculated to be 0.033, 0.690, 0.247, and -0.008, respectively. These results strongly suggest that increased cyclical volatility is not a necessary condition for relatively high rates of per capita GDP growth — a point Sheffrin (1991, 42-43) has raised with respect to the pre-World War I period. 

CONCLUSION

The hypothesis that business cycles were prone to much less stability before the Great Depression than after the Second World War is strongly supported by the volatility estimates for Canada, the U.S. and Angus Maddison's twelve country sample. Only three countries do not fit this pattern and only with respect to the shorter time frame which excludes the era incorporating major economic shocks and their subsequent repercussions for the pre-Depression period. The two sets of cyclical volatility estimates for Canada and for the leading developed market economies presented in this article can in any way serve to prove the validity of the Keynesian claim that increased government macroeconomic intervention since the Second World War contributed towards increased cyclical stability. However, since a marked decrease in cyclical volatility did take place after World War II, these results are consistent with the view that increased government intervention, either through discretionary fiscal or monetary policy or through the development of built-in or automatic stabilizers, might have contributed to this reduction. The extent to which such intervention actually did affect cyclical volatility, as opposed to other factors which might have affected this outcome such as the changing structure of the economy, remains a matter for further empirical research. 

If, on the other hand, no evidence of significant differences in cyclical volatility had been found between the pre-Depression and post-World War II periods, one could have argued, at the very least, that increased macroeconomic government intervention since World War II probably had little effect on cyclical volatility (Romer, 1986, 333). And as Sheffrin points out, evidence for the dampening in the severity of business cycles makes it much harder to argue in favor of real business cycle theory.

Real business cycle theories rely primarily on technological shocks as the source of economic fluctuations. If the business cycle has not dampened dramatically, then it may be possible to construct models that are applicable for long time periods without resorting to unobserved differentials in the variance of technological disturbances. However, if the business cycle has been dampened, the case for real business cycles becomes more difficult to make. [1988, 74]

The evidence presented above, therefore, speaks more in favor of Keynesian theory and also against real business cycle theory.

NOTES

1. For example, James Tobin (1980, 64-68) argues against the new classical economics which holds that the market-economy is characterized by strong self-adjustment mechanisms driving the economy continuously towards a full employment equilibrium. Tobin instead favors the view that the market economy is inherently unstable and requires intelligent and timely government intervention to stabilize the economy. Tobin makes reference to the more traditional evidence on the volatility of business cycles to maintain that the new classical macroeconomics, "does not describe the societies in which we happen to live." See also, the important empirical study by DeLong and Summers (1986), and Taylor (1990).

2. Romer's revision of the Kuznets or standard real GNP estimates for the United States is rooted in her rejection of Kuznets's basic assumption that structured his construction of GNP estimates for the 1869-1908 period from commodity-based output data. Kuznets assumes that there is approximately a one-to-one relationship between movements in GNP and commodity output. Romer, on the other hand, applies regression relationships between movements in GNP and commodity output based on data for the 1909-20 and 1947-85 periods (Romer, 1989, 23-4, 31-36; Beale and Gordon, 1989, 56-51). Romer concludes that the "dramatic stabilization short of the Kuznets series is almost entirely due to Kuznets's assumption that GNP varies nearly one-to-one with commodity output in the period 1890-1908, while GNP varies 0.6 for one with commodity output in the postwar era" (1989, 31).
3. Shaffrin's (1981) real estimates show that in the United Kingdom, Italy, and Denmark movements in GNP during the 1971-1984 period were more volatile than they were during the 1951-1964 period by 20, 25, and 34 percent respectively, compared to only 9 percent in Norway. Shaffrin like Rosen, assumes that a decline in cyclical volatility of about 30 percent over the post-war period is practically discussed below. Shaffrin finds, however, that in Sweden the 1971-1984 period was 144 percent more volatile than the pre-war period. In Canada (outside of the U.S.A.), cyclical volatility is practically discussed below. Shaffrin finds, however, that in Sweden the 1971-1984 period was 144 percent more volatile than the pre-war period. In Canada (outside of the U.S.A.), cyclical volatility is found to be 70 percent more volatile than the post-World War II period. See, Shaffrin (1991, Ch. 2) for a detailed review and discussion of the debates that focus on the volatility of the business cycle. Shaffrin (1991, 47-50) concludes, from his review of the evidence, that there can be little doubt that the post-World War II business cycle has been damped, at least in the United States, Canada, and Sweden, relative to the pre-World War I business cycle. For an earlier, less elaborate version of the same see Shaffrin, (1988).

6. Becker and Reboe (1993) find that for Australia and Germany the business cycle was 20% and 50% respectively more volatile in the pre-World War II period than in the post-World War II period. The Japanese business cycle was 20% less volatile in the pre-World War II period.

7. This section contains more details on the measurement of volatility used by Borla and Gallo and Shaffrin. The countries included in Shaffrin's analysis are: Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Japan, Netherlands, Norway, Sweden, Switzerland, and the U.S. The estimates contained in Maddison's most recent book (1990) are based on the most current available real GDP estimates. One should note that for the United States, Maddison uses the Gallo-Borla real GDP estimates. See Maddison (1993, 195-222) for a detailed discussion and sources of the GDP estimates used in his analysis and for his presentation of the annual real GDP index numbers for the 1970-1989 period for the above countries.

8. Solow (1988) uses the following method to estimate cyclical volatility: the standard deviation of annual percentage changes in GNP, the coefficient of variation of annual percentage changes in GNP, the mean absolute percentage deviation of GNP from its long-run trend, and the mean percentage deviation of GNP from potential, quoted by "Breath of Bank".

9. Investigating the link between Canadian business cycles by Chalmers (1964, 164), however, does not measure volatility as it is defined in this article, nor does he use estimates of real GDP in his own work. He estimates that the volatility of the Canadian business cycle is only 2% times as high as his methodology is comparable to Rosen's and to Ball and Golos's and Rogers's (1991, 84-85) and Boschack and Reboe (1992) also estimate the volatility of the Canadian business cycle by using the GDP estimates of Canada and the U.S. I exclude the Netherlands and Switzerland from my study since annual real GDP index numbers for these countries are only available for the United States and Canada, see Maddison's most recent book (1990). See also Solow (1988), 56-57. Becker's and Reboe's (1993) preferred method of determining time series differs from the ones chosen by Rosen, Gallo and Reboe, and adopted for this study. These studies find that the interwar period business cycle was unexpectedly much more volatile than that of the prewar and postwar years.

10. Frontiers's (1986, 277-294) real GDP estimates for the 1870-1910 period are based on text-based interpolations from his 1910 real GDP estimate. The 1870-1910 series is derived from a weighted series for the

11. BUSINESS CYCLE VOLATILITY

12. volume of wheat, fish, potatoes, coal, oil, sulfur, raw wool, and tobacco produced, net of exports minus imports, plus the number of passengers carried by steam railways. Also used are estimates of government expenditures, exports and imports, and estimates of the apparent consumption of construction materials. Household estimates for the later period are based on adjusted estimates taken from other sources.

13. U.S. Department of Agriculture, Forest Service, Survey (1986, 44-53, 69-82) offers only estimates in the manner in which the annual estimates are derived. The use of trade data is to trade to interpolate estimates for other years. (1986, 44-53, 69-82). However it appears that trade data no way dominate the estimates of the annual commodity output estimates.

14. See notes 2 and 4 above.

15. Green (1986) presents a detailed discussion on the construction of the annual transportation estimates. However, as with the commodity component of annual GNP, U.S. Department of Commerce (1986, 66-71) only outlines the manner in which the major annual commodity estimates are constructed.

16. U.S. Department of Commerce, Survey (1986, 66-71) only outlines the manner in which the majority of the annual transportation estimates are constructed.

17. U.S. Department of Commerce, Survey (1986, 66-71) only outlines the manner in which the majority of the annual transportation estimates are constructed.
274 EASTERN ECONOMIC JOURNAL

26. The per capita GDP growth rates calculated from the real GDP index numbers and population estimates found in Maddison (1991, Appendix A and B).

27. In the 1870-1879 period I found, for example, that Australia and Italy, the slowest and third slowest growing countries, ranked among the most volatile countries. In this period, the United States and the United Kingdom, on the other hand, were the second fastest growing countries, with annual fluctuations at the lower end of the scale.

28. In 1870-1879, the United States had the lowest rate of per capita GDP growth while experiencing the most volatility of all countries examined. In 1870-1879, the United States had the highest rate of per capita GDP growth while experiencing the most volatility of all countries examined. The most volatile growth countries of the 1941-1946 period, Germany, was one of the least volatile countries.

29. With respect to the importance of structural changes to changes in cyclical volatility over time, Boltho (1990, 171-211) finds that, for the most part, it is highly imprecise to conclude that the diminishing importance of agriculture to GDP from 1870-1913 to 1950-79 contributed to the dampening of the business cycle.

REFERENCES


