An Empirical Addendum to Robust Rank Tests of the Unit Root Hypothesis

R. W. Koenker

February 13, 1996

Nelson and Plosser (1982), applying the approach of Dickey and Fuller, tested 14 familiar U.S. macroeconomic time-series and found that all but one –unemployment– exhibited evidence for the unit-root hypothesis. Perron (1988) obtained very similar results using the tests described in Phillips (1987) and Phillips and Perron (1988). Subsequent literature employing change-point models has raised questions about these conclusions, see, for example, Perron (1989), and Zivot and Andrews (1992). In this section we offer yet another reprise on the Nelson and Plosser series. We employ the trend model (4.1) but adopt an agnostic attitude on the choice of the lag truncation and the order-of-the-Dickey-Fuller-autoregression parameters l and p. There has been some controversy about the choice of these parameters in the literature. Nelson and Plosser chose $p = 2$ for most of the series and $p \leq 4$ for all of the series except industrial production for which they selected $p = 6$. Perron (1989) using different order selection procedures tended to select higher-order models. We report results for $(l, p) \in \{2, 4, 6, 8\} \times \{1, 2, 4, 8\}$ for each of the series in the figures below.

Results for each series is represented in a separate figure. Each figure is divided into 16 separate subpanels corresponding to a (l, p) pair. In each panel we plot critical values for the rank test of the unit-root hypothesis at the .01, .05 and .10 levels. Observed values of the test statistics are plotted in each panel as small circles representing the test based on the Wilcoxon, normal, and sign scores in descending order. Rejection of the unit root hypothesis occurs when these circles fall *to the left* of the indicated critical value bars. Thus in Figure 1, illustrating the results for real GNP, the rank tests reject quite strongly for $l = 6$ and 8 and small values of p like 1 or 2. However, in the upper left corner of the figure where p is large and l is small the tests support the unit-root hypothesis.

As expected the Wilcoxon and normal scores versions of the test agree quite closely, while the sign-score based test is occasionally discordant. This is consistent

with the asymptotic theory which suggests that the sign score test has somewhat lower asymptotic efficiency than the other tests unless the innovation density is extremely peaked at the median. For unemployment, we again find that the rank tests tend to reject strongly in the lower right corner of the figure for p small and l large. But the evidence is more mixed when the lag truncation parameter is small.

Briefly, reviewing the results for the other series, we see that for the nominal variables the rank tests tend to support the unit-root hypothesis while per-capita real GNP, real wages, industrial production and even velocity exhibit some evidence against it.

REFERENCES

Nelson, C.R. and Plosser, C.I. (1982) Trends and random walks in macroeconomic time series, *Journal of Monetary Economics*, **10**, 139-162.

Perron, P. (1989) The great crash, the oil price shock and the unit root hypothesis. *Econometrica*, **57**, 1361-1401.

Zivot, E., and Andrews, D.W.K. (1988) Further evidence on the great crash, the oil price shock, and the unit-root hypothesis, *Journal of Business and Economic Statistics*, **10**, 251-270.

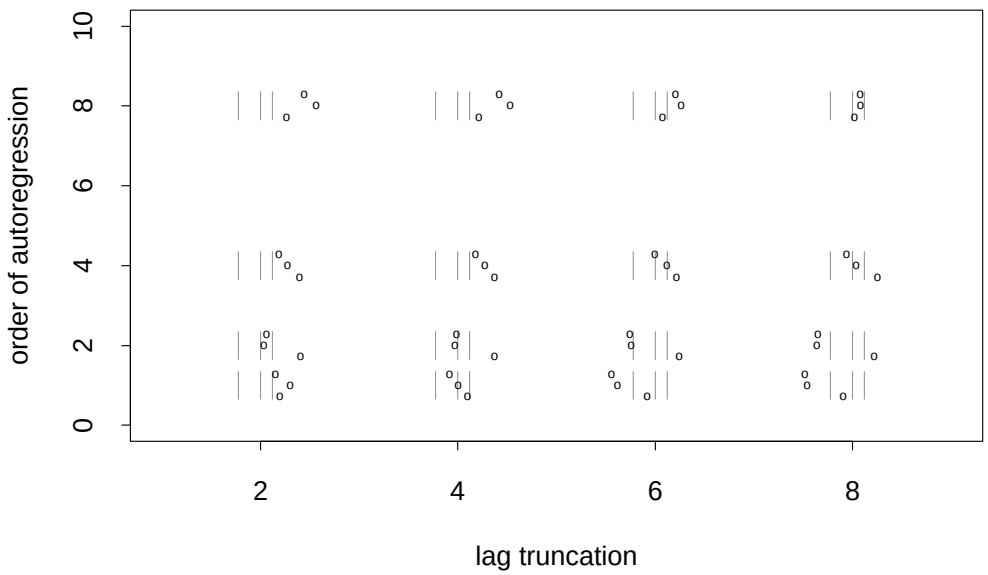


Figure 1: Test Statistics for Unit Root Hypothesis for US Real GNP. The figure consists of 16 subpanels corresponding to 4 different levels of the lag truncation parameter, l, and 4 levels of the order the of autoregression, p, in the Dickey-Fuller model. In each subpanel the 3 vertical bars indicate critical values for the test statistics at .01, .05, and .10 levels. The circles indicate the observed test statistics in each panel: in descending order they are based on the the Wilcoxon, normal and Sign score function. Rejection of the unit-root hypothesis occurs when these points fall *to the left* of the indicated critical value bars.

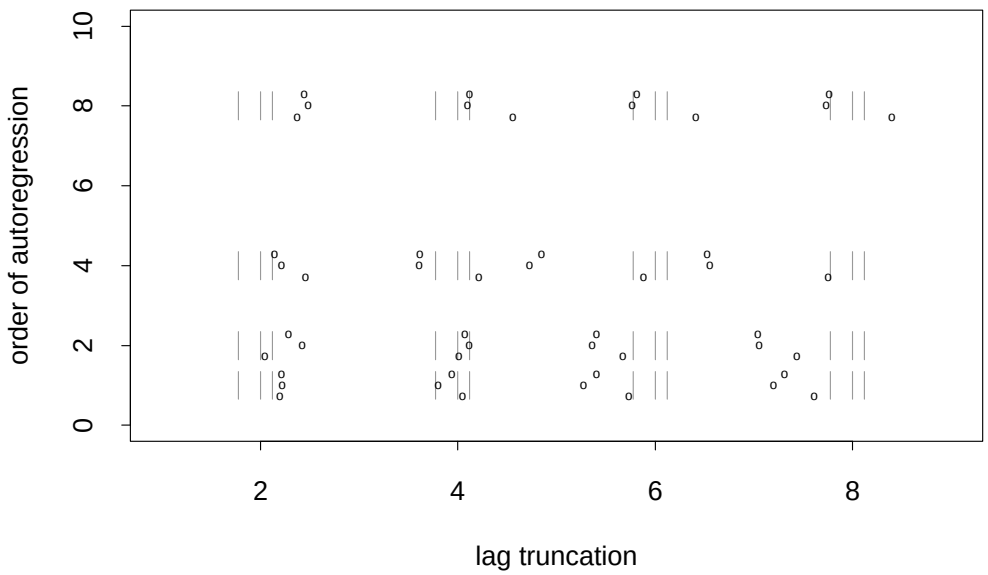
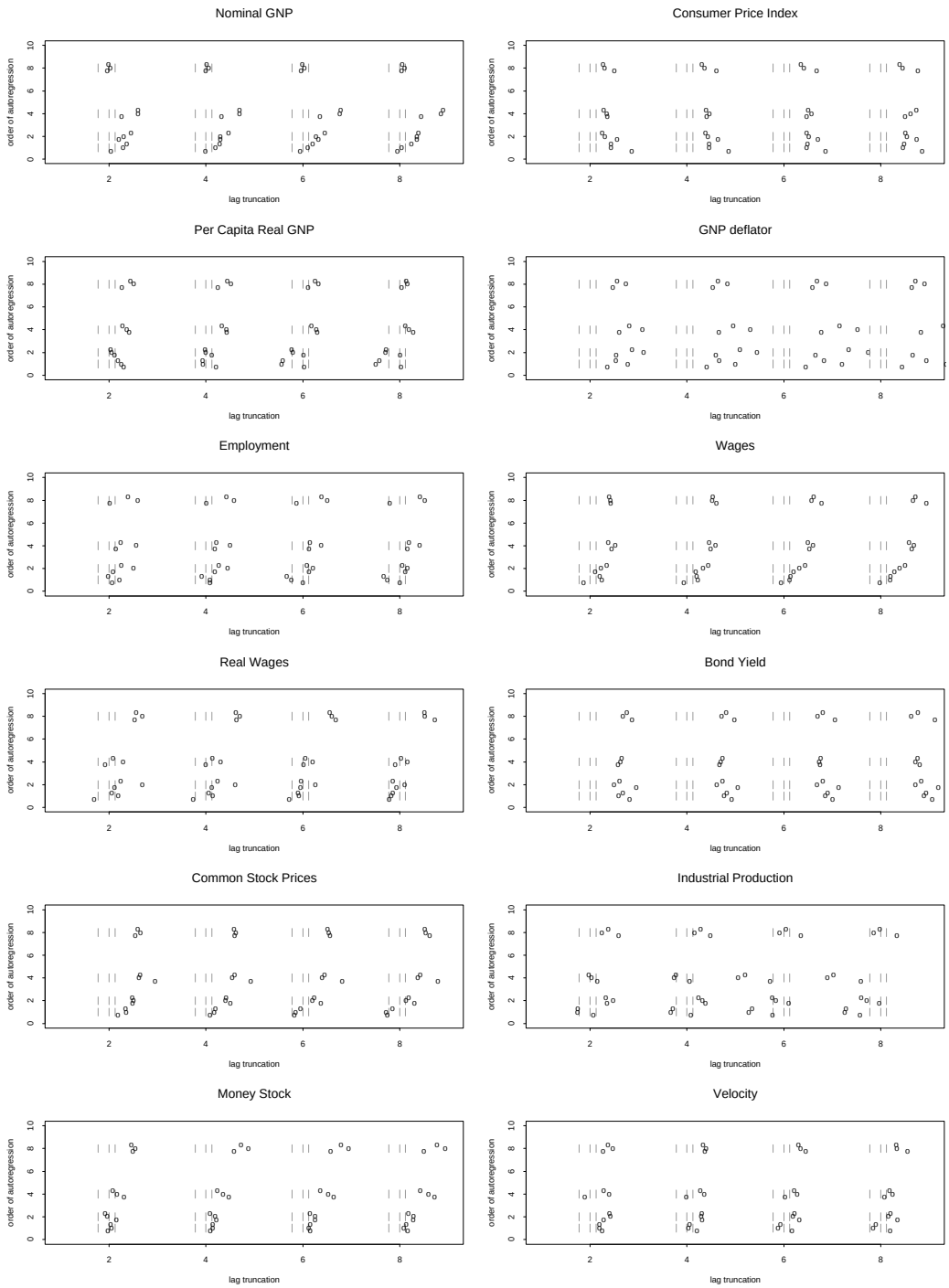


Figure 2: Test Statistics for Unit Root Hypothesis for US Unemployment. The figure consists of 16 subpanels corresponding to 4 different levels of the lag truncation parameter, l, and 4 levels of the order the of autoregression, p, in the Dickey-Fuller model. In each subpanel the 3 vertical bars indicate critical values for the test statistics at .01, .05, and .10 levels. The circles indicate the observed test statistics in each panel: in descending order they are based on the the Wilcoxon, normal and Sign score function. Rejection of the unit-root hypothesis occurs when these points fall *to the left* of the indicated critical value bars.


Nominal GNP
Consumer Price Index
Per Capita Real GNP
GNP deflator
Employment
Wages
Real Wages
Bond Yield
Common Stock Prices
Industrial Production
Money Stock
Velocity
order of autoregression
lag truncation