

Accepted Manuscript

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PII: S0304-4076(17)30014-3

DOI: <http://dx.doi.org/10.1016/j.jeconom.2016.12.004>

Reference: ECONOM 4342

To appear in: *Journal of Econometrics*

Received date: 14 May 2015

Revised date: 28 April 2016

Accepted date: 2 December 2016



Please cite this article as: Su, L., Wang, X., On time-varying factor models: Estimation and testing. *Journal of Econometrics* (2017), <http://dx.doi.org/10.1016/j.jeconom.2016.12.004>

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On Time-Varying Factor Models: Estimation and Testing*

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February 7, 2017

Abstract

Conventional factor models assume that factor loadings are fixed over a long horizon of time, which appears overly restrictive and unrealistic in applications. In this paper, we introduce a time-varying factor model where factor loadings are allowed to change smoothly over time. We propose a local version of the principal component method to estimate the latent factors and time-varying factor loadings simultaneously. We establish the limiting distributions and uniform convergence of the estimated factors and factor loadings in the standard large N and large T framework. We also propose a BIC-type information criterion to determine the number of factors, which can be used in models with either time-varying or time-invariant factor models. Based on the comparison between the estimates of the common components under the null hypothesis of no structural changes and those under the alternative, we propose a consistent test for structural changes in factor loadings. We establish the null distribution, the asymptotic local power property, and the consistency of our test. Simulations are conducted to evaluate both our nonparametric estimates and test statistic. We also apply our test to investigate Stock and Watson's (2009) U.S. macroeconomic data set and find strong evidence of structural changes in the factor loadings.

*The authors thank the co-editor Oliver Linton, an associate editor, and three anonymous referees for their constructive comments and suggestions. They also express their sincere appreciation to Serena Ng for discussions on the subject matter. They thank the conference and seminar participants at the Princeton-QUT-SJTU-SMU Frontiers in Econometrics Conference, the SNU Workshop on Advances in Microeconometrics, the International Symposium on Recent Developments in Econometric Theory with Applications in Xiamen University, UC San Diego, University of Washington in Seattle, and National University of Singapore for their valuable comments. Su gratefully acknowledges the Singapore Ministry of Education for Tier-2 Academic Research Fund (AcRF) under grant number MOE2012-T2-2-021 and the funding support provided by the Lee Kong Chian Fund for Excellence. Wang acknowledges financial supports from the National Science Foundation of China (No. 71401160) and the Ministry of Education of Humanities and Social Sciences Project of China (No. 14YJC790120). Address Correspondence to: Liangjun Su, School of Economics, Singapore Management University, 90 Stamford Road, Singapore 178903; E-mail: ljsu@smu.edu.sg, Phone: +65 6828 0386.

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