ELSEVIER

Economics Letters 73 (2001) 375–378

economics letters

www.elsevier.com/locate/econbase

Present value model, heteroscedasticity and parameter stability tests

Jack Strauss, Taner Yigit*

Department of Economics, St. Louis University, 3674 Lindell Blvd., St. Louis, MO 63108-3397, USA

Received 26 January 2001; accepted 29 May 2001

Abstract

This work demonstrates that parameter stability tests of the present value model depend critically on adjusting for heteroscedasticity and breaks in the regressors. A bootstrap procedure by Hansen addresses these concerns and fails to reject a stable long run relationship between stock prices, earnings and dividends. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Present value; Parameter stability; Heteroscedasticity

JEL classification: G12; C22

1. Introduction

Although the presence of heteroscedastic errors in the stock market is well established (Poterba and Summers, 1986; Schwert, 1989) cointegration testing of the present value model has not accommodated for the large and persistent volatility in the data. This paper examines the long run stability of the cointegrating relation between stock prices, dividends and earning, correcting for both heterogeneity in the marginal distributions of the variables and an arbitrary break in the regressors. Previous works (e.g. Campbell and Shiller (1987)) apply either Engel Granger or Johansen techniques, which assume i.i.d. error structure and stability in the parameters. Our work paper demonstrates these assumptions lead to false inference in analyzing long run relationships in the stock market.

Using quarterly data from 1926.1 to 1999.4, data support the presence of persistent and large volatility as well as structural breaks for real stock prices, earnings and dividends. Consequently, Johansen tests of the present value framework suffer from parameter instability and heteroscedastic errors. A method by Seo (1998) addresses parameter stability using the Johansen cointegration

*Corresponding author. Tel.: +1-314-977-3604; fax: +1-314-977-3897.
E-mail address: yigitmt@slu.edu (T. Yigit).

0165-1765/01/$ – see front matter
PII: S0165-1765(01)00506-7

framework, but assumes homoscedastic error structures along with no break in the regressors. Our work applies a recent method by Hansen (2000) that corrects for both breaks in the regressors using a homoscedastic bootstrap method and incorporates persistent volatility in errors with a heteroscedastic bootstrap technique. Results indicate that tests of the present value model depend substantially on the assumptions of the error structure. Heteroscedastic bootstrap *P*-values fail to reject parameter stability between real stock prices, earnings and dividends; whereas, the homoscedastic and Seo methods both reject stable long-run relationships. A sub-sample of 1950.1–1999.4 shows these results are robust to a post Depression/World War time period.

2. Methodology

Previous tests for structural change (e.g. Andrews, 1993; Andrews and Ploberger, 1994) are derived under the assumption that the regressors are stationary and exclude structural change in their marginal distribution. Hansen's (2000) method ameliorates this problem by using a fixed regressor bootstrap to adjust for heteroscedastic error processes and arbitrary changes in the regressors including structural shifts and exogenous stochastic trends. Hansen shows that in the following equation

$$Y_t = X_t\beta + \varepsilon_t \tag{1}$$

the test for stability of parameter (β) relies crucially on whether the distributions of the regressors X_t experience a structural change. He applies the Sup-LM, Ave-LM, and Exp-LM statistics to test for the parameter stability in the cointegrating vector and designs bootstrap methods to incorporate changes in the mean, variance and/or serial correlation of the regressors. The heteroscedastic bootstrap not only achieves the correct asymptotic distribution under general forms of conditional heteroscedasticity but also has 'reasonable size properties in small samples'. Rejection of the null hypothesis of parameter stability implies no long run or cointegrating equilibrium.

An alternative approach by Seo (1998) uses the Johansen VEC framework to test for parameter stability in the cointegrating vector. This procedure provides an alternative test of cointegration, since the lack of parameter stability indicates no cointegration (Hansen, 1992). Although the Seo method uses the same LM statistics as Hansen, it has a strong assumption of homoscedastic error structure. To isolate the effect of heteroscedasticity on Johansen cointegration and Seo parameter stability results, we contrast them to Hansen's more generalized bootstrap techniques.

The paper applies these techniques to test the present value model in the long run. Rejection of the null hypothesis indicates parameter instability between stock prices, dividends, and earnings and lack of support for the present value framework. Our paper investigates whether the assumptions of stable coefficients, homoscedastic error structures and no breaks in the regressors are responsible for the weak support for the present value model (see Campbell and Shiller (1987, 1988), Diba and Grossman (1988) and West (1987)). Additionally, we examine the link between dividends and earnings since the dividend-smoothing model predicts a stable long run relationship between these two variables.

3. Results

We use real quarterly data provided by Shiller (www.econ.yale.edu/~shiller) and adopt 1926.1–1999.4 as the sample period since earlier quarterly data are interpolated from annual series. Table 1

Table 1
Parameter stability and cointegration results for stock market variables

	Johansen cointegration	Seo test (statistics)		Hansen test (homoscedastic) (*P*-values)		Hansen test (heteroscedastic) (*P*-values)	
	LR statistics	Exp-LM	Sup-LM	Exp-LM	Sup-LM	Exp-LM	Sup-LM
1926.1–1999.4							
Price–div.	23.94*	16.4*	39.0*	0.00	0.00	0.14	0.14
Price–earnings	13.02	8.23*	24.2*	0.00	0.00	0.07	0.07
Earnings–div.	19.83	8.12*	22.9*	0.00	0.00	0.05	0.06
1950.1–1999.4							
Price–div.	16.48	18.0*	45.5*	0.71	0.77	0.54	0.60
Price–earnings	20.35*	2.61	9.56	0.27	0.34	0.25	0.31
Earnings–div.	16.35	13.5*	35.4*	0.00	0.00	0.02	0.02

** (*) indicates significance at 1% (5%).

gives Johansen cointegration statistics for logged pairs of real stock prices, earnings and dividends. Results support cointegration between price/dividends, but not between price/earnings and earnings/dividends. Seo parameter stability tests however reject stability at the 5% confidence level for all three relationships and question the Johansen cointegration conclusions. Hansen moreover argues that when regressors have structural breaks, parameter instability tests such as Seo's also may have false inference. To investigate the existence of structural breaks in the individual regressors, we apply the Andrews (1993) test for unknown breakpoints. The Andrews tests reveal breaks in stock price (1955.1), dividends (1954.4), and earnings (1948.3); LM statistics are 34.9**, 37.8** and 36.8**, respectively, where ** indicates significance at 1%. Hence, the conclusions of the Seo tests are unreliable due to the difficulty in determining the source of the instability, caused by a break in the regressor or cointegrating relationship.

To accommodate for these breaks in the regressors, we apply the Hansen procedure. The homoscedastic bootstrap results strongly reject parameter stability; whereas, the heteroscedastic bootstrap procedure yields higher *P*-values due to fatter tails in the distribution. This causes size problems (over-rejections of the null) and false inference of parameter instability for the homoscedastic bootstrap.

To demonstrate that heteroscedastic errors are responsible for these differences, we specify an ARCH(1) and GARCH(1) model using a simple AR(p) representation on logged differenced data. Based on the SIC criterion, the specification choice for p was one for stock prices and two for earnings and dividends. The z-statistics for GARCH effects for stock prices, earnings and dividends are 8.39, 33.24 and 31.45, respectively and all are significant at the 1% level. The equations also display significant ARCH effects at the 1% level. Using a similar GARCH specification, Lee and Tse (1996) demonstrate significant size biases in the Johansen procedure do not occur unless the sum of the ARCH and GARCH coefficients are near one. In our case, however, the coefficients sum to 0.88, 1.01 and 0.99 for stock prices, earnings and dividends, respectively. Hence volatility in stock market variables is significantly persistent and implies that the assumption of homoscedasticity will lead to false inference. Note however the choice or exact specification of heteroscedasticity is not critical to the analysis since the Hansen bootstrap corrects for more general forms of heteroscedasticity in the data.

Using the same methodology on a recent sub-sample 1950–1999.4, we test for conditional heteroscedasticity in the stock market variables. GARCH effects for stock prices, earnings and dividends are 2.05, 8.90, 44.88, respectively and are also significant at the 5% level. The presence of significant heteroscedasticity implies that both the Johansen and Seo findings are not appropriate to test the present value model.

Lastly, we investigate whether including an omitted variable such as real interest rates (using a 6-month prime commercial paper rate) affect the conclusions. Results for the Johansen procedures for both time periods reject no cointegration at 1% confidence level in all six pairs. Seo tests however reject parameter stability for all three relationships since 1926, and for the sub-sample reject parameter instability between stock prices and dividends. Similar to the bivariate results, the homoscedastic bootstrap rejects parameter stability for each pair since 1926 and for earnings/dividends after 1950. The heteroscedastic bootstrap results fail to reject parameter stability for both time periods, except earnings/dividends after 1950. Hence inclusion of the interest rate does not change the conclusion that volatility of the error structure should be incorporated for correct estimation of parameter stability and cointegration.

4. Conclusion

The paper investigates the long-run stability between stock prices, dividends and earnings. Data support the presence of heteroscedasticity and a structural break in the stock market variables, and we correct for these effects by adopting a recent econometric technique by Hansen (2000). Results from the Hansen heteroscedastic bootstrap fail to reject parameter stability and suggest stable present value relationships. These conclusions markedly differ from Johansen cointegration and Seo (1998) parameter stability tests, which assume homoscedastic errors and no structural breaks.

References

Andrews, D.W.K., Ploberger, W., 1994. Optimal tests when a nuisance parameter is present only under the alternative. Econometrica 62 (6), 1383–1414.

Andrews, D.W.K., 1993. Tests for parameter instability and structural change with unknown change point. Econometrica 61 (4), 821–856.

Campbell, J.Y., Shiller, R.J., 1987. Cointegration and tests of present value models. Journal of Political Economy 95, 1062–1088.

Campbell, J.Y., Shiller, R.J., 1988. The dividend–price ratio and expectations of future dividends and discount factors. Review of Financial Studies 1 (3), 195–228.

Diba, B.T., Grossman, H.I., 1988. Explosive rational bubbles in stock prices? American Economic Review 78 (3), 520–530.

Hansen, B., 1992. Tests for parameter instability in regressions with I(1) processes. Journal of Business and Economic Statistics 10, 321–335.

Hansen, B., 2000. Testing for structural change in conditional models. Journal of Econometrics 97, 93–115.

Lee, T.H., Tse, Y., 1996. Cointegration tests with conditional heteroskedasticity. Journal of Econometrics 73, 401–410.

Poterba, J.M., Summers, L.H., 1986. The persistence of volatility and stock market fluctuations. American Economic Review 76, 1142–1151.

Schwert, G.W., 1989. Why does stock market volatility change over time? Journal of Finance 44 (5), 1115–1153.

Seo, B., 1998. Tests for structural change in cointegrated systems. Econometric Theory 14 (2), 222–259.

West, K.D., 1987. A specification test for speculative bubbles. Quarterly Journal of Economics 102 (3), 553–580.