Asymmetric Adjustment from Structural Booms and Slumps[*]

Pierre L. Siklos
Department of Economics
Wilfrid Laurier University
75 University Ave.
Waterloo ON
CANADA
N2L 3C5

[December 2001]
[Revised March 2002]

forthcoming in **Economics Letters**

[*] I am grateful to Martin Bohl for pointing out an error in a pervious draft.

Abstract

The connection between booms and slumps in economic activity and stock markets is explored with US and UK data. Based on Phelps (1994, 1999), the cointegrating relationship between stock returns and economic activity requires asymmetric adjustment in the short-run.

Pierre L. Siklos
FAX : (519) 888-1015
e-mail: psiklos@wlu.ca
Home Page: www.wlu.ca/~wwwsbe/faculty/psiklos/home.htm
JEL Classification Codes: E0, E3, E5

Key Words : booms, slumps, asymmetry, cointegration

1. Introduction

Phelps (1994) argues that there exists a long-run relationship between stock market performance and employment growth. Recent empirical work is in Phelps and Zoega (2001). They suggest, but do not test, the possibility that long-run or "structural" booms and slumps may be asymmetric in nature. We take up the possibility empirically. The technique of Enders and Siklos (2001) is well suited to the task of uncovering long-run relationships between time series when deviations from the long-run are asymmetric in nature. Quarterly data from 1960 for the US and the UK are used in support of the hypothesis of interest.[1]

2. Structural Booms, Slumps and Stock Market Performance

Phelps (1994) develops the paradigm of the structural slump. This phenomenon is characterized by a steep decline in share prices followed by a gradual rise in unemployment. Structural slumps are temporary phenomena and do not coincide with a secular rise in productivity. Similarly, structural booms reveal a steep rise in share prices followed by a reduction in unemployment. The mechanism is one where entrepreneurs calculate that, in the case of a structural boom, this signals a jump in future asset returns and, consequently, the valuation of these assets as reflected in the stock market. The resulting rise in the profitability of investment signals a falling unemployment rate. The boom ends when the productivity rise increases investment costs. The slump scenario works symmetrically in theory but this need not be the case in practice since other factors may impinge on the development of the business cycle.

There is a voluminous literature to support asymmetries in business cycles (e.g., Neftci 1984). A good deal of empirical support exists for the notion that asymmetry may be partly explained by the differential impact of monetary policies during recessions and booms (e.g., Balke and Wynne 1996). The objective here, however, is to demonstrate empirically the existence of asymmetry in deviations from the long-run equilibrium relationship between economic activity and stock market performance that is fundamental to the structural booms and slumps hypothesis. The next section argues that the technique of Enders and Siklos (ES: 2001) is ideally suited to finding a strong long-run link

[1] Empirical evidence was also generated for the remaining G7 countries but is not shown to conserve space. Broadly speaking, the asymmetry hypothesis holds for all the G7 countries except for Italy and, possibly, Germany.

between the variables of interest with short-run departures that are asymmetric in nature consistent with the vast literature on business cycle movements over time.

3. Cointegration and Asymmetric Adjustment

ES (2001) extend the Engle and Granger (1986) framework to test for cointegration (also see Enders and Granger 1998). Since the structural booms and slumps hypothesis outlined in the previous section is bivariate, as is the ES test, it is suitable approach to testing the hypothesis of interest. The cointegrating regression of Phelps and Zoega (2001) is written

$$\text{Share}_t = \alpha_0 + \alpha_1 ur_t + u_t \qquad (1)$$

where $Share_t$ and ur_t are real share prices[2] and the unemployment rate, respectively, both integrated of order 1 (i.e., I(1)) if the two series are cointegrated; otherwise the test rejects the null hypothesis of no cointegration. As the test is now well-known, we do not discuss it further. ES (2001) modify u_t to allow for two types of asymmetric error corrections based on a cointegrating relationship as depicted in (1). First, estimate, via OLS, (1) above. Next, the residuals, $\hat{u}_t$, are used in:

$$\Delta\hat{u}_t = I_t\rho_1\hat{u}_{t-1} + (1-I_t)\rho_2\hat{u}_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\hat{u}_{t-i} + \varepsilon_t \qquad (2)$$

where $I_t = [T_t, M_t]$, such that

$$T_t = \begin{cases} 1 & \text{if } \hat{u}_{t-1} \geq \tau \\ 0 & \text{if } \hat{u}_{t-1} < \tau \end{cases} \qquad (3A)$$

$$M_t = \begin{cases} 1, \text{if } \Delta\hat{u}_{t-1} \geq \tau \\ 0, \text{if } \Delta\hat{u}_{t-1} < \tau \end{cases}, \qquad (3B)$$

and τ is the threshold. Equations (2) and (3A) represent a threshold autoregressive model (TAR) where the indicator variable T_t depends on the previous period's $\hat{u}_{t-1}$. Equations (2) and (3B) represent the momentum AR, or MTAR model. The adjustment is modeled by $\rho_1\hat{u}_{t-1}$, if the residuals according to (3A) or (3B) are above the threshold and by the

[2] This series is normalized by labor productivity.

term $\rho_2 \hat{u}_{t-1}$, if the residuals of either of these two equations is below the threshold. Critical values for the *t*-statistics to test the null hypotheses $H_0 : \rho_1 = 0$ and $H_0 : \rho_2 = 0$, and for the *F*-statistic Φ to test the null hypothesis $H_0 : \rho_1 = \rho_2 = 0$ can be found in Enders and Siklos (2001). If the null hypothesis of no cointegration is rejected, the null hypothesis of symmetric adjustment $H_0 : \rho_1 = \rho_2$ can be tested using the usual *F*-statistic.

The TAR model interprets departures from the equilibrium as creating forces to restore the long-run relationship if the size the disequilibrium is larger than some threshold. The MTAR model can capture an accumulation of changes in the disequilibrium relationship between share prices and the unemployment rate below and above the threshold followed by a sharp movement back to the equilibrium position.

To estimate consistently the threshold parameter, τ, the method outlined in ES is used. The lag-length *p* in equation (2) is determined via Hall's (1994) general to specific approach starting with a maximum lag-length of $p = 10$.

4. Data and Empirical Evidence

Where possible, the same data sources as in Phelps and Zoega (2001) were used. Real share prices are national indexes found in *International Financial Statistics* (IFS, line 62) divided by the CPI (line 64). Real GDP data are also from IFS (line 99BVPzF or 99BVRZF). Labour employment and productivity data are from the University of Groningen's Conference Board, GGDC Total Economy Database, first quarter 2001, available at www.eco.rug.nl/ggdc. Unemployment rates are from the OECD *Main Economic Indicators*. The sample is quarterly from 1960 for the US and the UK.[3] Following Phelps and Zoega (2001), the basic cointegrating regression is (1), and the (log) of oil prices, and the world real interest rate, are also added as exogenous influences on the hypothesized cointegrating relationship. Data for oil prices (Producer Price Index, fuel related products and power) are from FRED (Federal Reserve Bank of St. Louis (http://www.stls.frb.org/fred). The "world" real interest rate is found by evaluating the

[3] Labour productivity (=real GDP/Employment) necessitates the use of employment data. These are not available from IFS at the quarterly frequency for a sufficiently long sample. The data source has a long time series of annual estimates and these were converted to the quarterly frequency via a quadratic with the sum matched to the source data.

(ex post) real interest rate for the US, Japan, and Germany, as the difference between the nominal interest rate on three month Treasury bills (or their equivalent) less the annual percent change in CPI. Next, we average the three countries' real rates and this serves as the proxy for the "world" real interest rate.

Cointegration tests using both the Engle-Granger and Johansen approaches are shown in Table 1. The null of no cointegration cannot be rejected at conventional significance levels regardless of the test employed.[4] If the log of oil prices or the world real interest rate are exogenous variables the results are unaffected.[5]

Table 2 considers the TAR and MTAR models. The results show that the TAR version is the only one to reject symmetry in the error corrections with positive departures from equilibrium statistically significant for the UK and negative ones significant for the US, based on the outcome of the both the *t* and F-tests (i.e., Φ for TAR and Φ(M) for MTAR).[6] Hence, real share prices above the corresponding unemployment rate are a relatively stronger "attractor" for the UK than when the situation is reversed. The opposite is found in the case of US data. Therefore, if we view share prices as "leading" the unemployment rate, in a Granger-causal sense (see Phelps and Zoega 2001), rising share prices in the UK are a stronger attractor for falling unemployment rates. In contrast, for the US, falling share prices are a stronger attractor for rising unemployment rates.

5. Conclusions

This paper has considered the link between share prices and the unemployment rate based on Phelps' theory of structural booms and slumps. We find that the adjustment back to equilibrium following a productivity shock is asymmetric. Empirical evidence for the US and the UK in support of this hypothesis is presented. While existing theories may be used to justify the type of asymmetry reported in this paper, more work is required to fully understand the dynamics of the relationship between the variables of interest.

---

[4] The conclusions were not sensitive to the inclusion of a trend in the test equation. Eight lags were used in the VAR specification for the Johansen tests. For the Engle-Granger test, the test equation was initially specified with 10 lags and then re-estimated with the number of lags shown in parenthesis in Table 1 since the augmentation terms were highly insignificant beyond the lags shown.

[5] The exogenous variables being I(1), conventional critical values are inappropriate. Critical values generated by Pesaran, Shin and Smith (2000) are the appropriate ones under the circumstances.

[6] Indeed, the signs for $\hat{\rho}_1$ and $\hat{\rho}_2$ in the MTAR case suggest no convergence. See ES(2001).

Table 1 Cointegration Tests: Share Prices and the Unemployment Rate, 1960-1999

Country	*Engle-Granger*	*Johansen*	*Johansen with exogenous variables*
United Kingdom	-0.01 (10)	9.30	12.82
United States	-0.79 (10)	11.30	17.80

Notes: Engle and Granger is the Augmented Dickey-Fuller (ADF) test equation using (1). The number of lags is shown in parenthesis. Johansen is the trace test for the null hypothesis that the number of cointegrating vectors is zero. Johansen with exogenous variables is the same null hypothesis as in the standard Johansen test , except that the log of oil prices, and the average (ex post) "world" real interest rate, defined as the average nominal interest rate less annual CPI inflation for the US, Germany, and Japan. Critical values for the Johansen test they are from MacKinnon, Haug, and Michelis (1999), while ones for the test with exogenous variables are from Pesaran, Shin, and Smith (2000). No deterministic trend is added to the ADF test equation. For both Johansen tests, the data are assumed to have a linear deterministic trend and only an intercept in the cointegrating equation. All VARs have 8 lags.

Table 2 Cointegration Tests: Asymmetric Adjustment, 1960-1999

Model	*United Kingdom*	*United States*
TAR		
$\hat{\rho}_1$	-0.151(.046)*	0.033(.026)
$\hat{\rho}_2$	-0.014(.031)	-0.087(.034)*
$\hat{\rho}_1 = 0,\ \hat{\rho}_2 = 0$	5.51(.005)	4.36(.014)
Φ	7.29*	8.54*
Consistent estimate of threshold	0.02	0.05
MTAR		
$\hat{\rho}_1$	0.159(.121)	0.030(.102)
$\hat{\rho}_2$	0.338(.109)	0.443(.116)
$\hat{\rho}_1 = 0,\ \hat{\rho}_2 = 0$	5.54(.005)	10.89(.000)
Φ	1.25	0.92
Consistent estimate of threshold	-0.004	0.02

Notes: TAR is defined by equations (2) and (3A), MTAR is defined by equation (2) with (3B). Critical values for Φ are from Enders and Siklos (2001). All versions of (2) are with p=2. Standard errors for $\hat{\rho}_1$, $\hat{\rho}_2$, are in parenthesis, significance levels in parenthesis for the $\hat{\rho}_1 = \hat{\rho}_2$ test.
*signifies rejection at the 5% level of significance.

References

Balke, N., and M. Wynne (1996), "Are Deep Recessions Followed by Strong Recoveries? Results for the G7 Economies" *Applied Economics* 28(July): 889-97.

Enders, W., and C.W.J. Granger (1998), "Unit Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates", *Journal of Business and Economic Statistics*, 16 (July): 304-11.

Enders, W. and P.L. Siklos (2001), "Cointegration and Threshold Adjustment", *Journal of Business and Economic Statistics*, 19 (April): 166-77.

Engle, R.F., and C.W.J. Granger (1987), "Co-Integration and Error Correction: Representation, Estimation and Testing", *Econometrica* 55: 251-276.

McKinnon, J., A. Haug, and L. Michelis (1999), "Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration", *Journal of Applied Econometrics* 14: 563-77.

Neftci, S. (1984), "Are Economic Time Series Asymmetric Over the Business Cycle?" *Journal of Political Economy* 92: 307-28.

Pesaran, H., Y. Shin, and R. Smith (2000), "Structural Analysis of Vector Error Correction Models with Exogenous I(1) Variables", working paper, University of Cambridge.

Phelps, E. (1994), *Structural Slumps: The Modern equilibrium Theory of Unemployment, Interest, and Assets* (Cambridge: Harvard University Press).

Phelps, E., and G. Zoega (2001), "Structural Booms", *Economic Policy*, 32 (April): 85-126.