The Relationship Between Economic Factors and Equity Markets in Central Europe

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Abstract:

This paper investigates the possibility that newly emerging equity markets in Central Europe exhibit semi-strong form efficiency such that no relationship exists between lagged values of changes in economic variables and changes in equity prices. We find that while there are connections between the real economy and equity market returns in Poland and Hungary, these links occur with lags, suggesting the possibility of profitable trading strategies based on public information and rejecting semi-strong efficiency. For the Czech Republic the situation is more complex. In recent periods little connection exists between lagged economic variables and equity market returns. Although this finding might be viewed as consistent with semi-strong efficiency, in fact there is also little connection between current economic values and stock prices in the Czech Republic. Thus, instead of processing information efficiently, the Czech market appears to be entirely divorced from the real world. It is suggested that the difference in the current status of these markets may be due to the different methods by which they were created.

Keywords: Semi-strong efficiency, emerging markets, Granger causality

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Introduction and Motivation

This paper employs the widely used technique of Granger causality to examine whether secondary equity markets in four of the most advanced former communist countries (the Czech Republic, Hungary, Poland and Slovakia) exhibit the key characteristic of semi-strong efficiency, i.e. the ability to fully reflect newly released public information in stock prices. Rather than being merely another in the long list of such studies for both developed and emerging markets,[1] the current work provides insight into the connection between how these equity markets were created and their eventual characteristics.

Following the collapse of communism, the countries of Central and Eastern Europe rapidly adopted the institutions associated with market economies. Formal stock markets were created in Hungary and Poland at the beginning of 1991 and in the two parts of the former Czechoslovakia in mid-1993, but their origins were very different. Exchanges in Poland and Hungary started with very few firms and adopted a standard process of applying regulations and listing requirements to provide for expansion of the market. The Czech and Slovak stock markets, on the other hand, came about as a by-product of voucher privatization. It was felt that individuals participating in this program needed the ability to readily dispose of their shares. The requirement that all 1,600 voucher-privatized companies be immediately tradable on the stock exchange, however, made the imposition of standard listing requirements impossible. This fact, combined with a lax regulatory environment, made the Czech and

[1] Early work of this type begins with Homa and Jaffee (1971), Rozeff (1974), Rogalski and Vinso (1977) and Huang and Kracaw (1984) for example. Some more recent studies include Darrat (1990), Kwok (1992), Lee (1992), Muradoglu-Sengul and Onkal (1992), Stengos and Panas (1992), Cornelius (1993), Gallinger (1994), Hiemstra and Jones (1994), Asai and Tsunemasa (1995), Fung, Lo and Leung (1995), Jensen, Mercer and Johnson (1996), Kearney (1996), and Ratner and Leal (1996), Leigh (1997), al-Bazai (1998), Niarchos and Alexakis (1998). The literature is summarized in Fifield, Lonie and Power (1998).

Slovak stock markets the least transparent in the region.

Given their varied histories, it is interesting to compare stock markets in these Central European countries to if they currently differ in their efficiency. In previous work (Filer and Hanousek, 1999) we have established that equity returns in the initial years of these four markets typically followed a random walk, a finding consistent with weak-form market efficiency. In this paper, we turn our attention to the issue of whether they also exhibit semi-strong market efficiency making it impossible to earn excess returns based on public information.

There are several reasons why Central and Eastern Europe should provide fruitful ground in which to test the ability of newly created equity markets to exhibit semi-strong efficiency. The differences in how they were created are reflected in substantial differences in their current size.[2] As can be seen in Figure 1, which shows the time pattern of the most representative index[3] for each of these markets, they have exhibited substantial price movements since their inception. Moreover, unlike more stable economies in the West, substantial variation in these countries' macroeconomies has occurred since the fall of communism. Table 1 shows how extensive the variation in several real economic variables has been. Finally, all of the countries under study underwent changes of government, with

[2]At the end of 1998 only about 300 of the initial 1,600 companies continued to be traded on the Prague stock exchange. Their total market capitalization was equal to 24 per cent of Czech GDP (compared with primary market capitalization of roughly 15 per cent of GDP in Austria, 20 per cent in Italy, 30 per cent in Germany, and 40 per cent in Spain and France). Despite the still relatively large number of traded firms, the market is dominated by a few firms. The 50 firms included in the PX-50 index, which we analyse below, amount to about 85 per cent of total market capitalization in 1997. In the Hungarian market, 49 traded firms have a total market capitalization equal to about 33 per cent of GDP. In Poland, by contrast, the 143 firms traded on the Warsaw Stock Exchange were valued at about 9 per cent of GDP, a figure similar to the 872 traded firms in Slovakia.

[3]The PX-50 for the Czech Republic, BUX for Hungary, WIG for Poland and SAX for Slovakia. In each case we have normalized the index to equal 100 in January 1996 (at the middle of our analysis sample).

resulting changes in expectations of policy priorities.[4]

For research to support a conclusion that a market is semi-strong efficient two results must hold:

1) a contemporaneous relationship must exist between real variables and returns market, and

2) lagged values of real variables must not enable a potential investor to predict current returns in the market.

Both of these relationships are important. Although the first is often ignored in empirical research, if it fails to hold, then the fact that the second does is not proof of efficiency. It may simply be that the variable under examination is irrelevant in determining prices in the equity market. Thus, a finding that lagged values of football scores do not the predict current stock market returns is consistent either with markets instantaneously incorporating all effects of football results in prices, or football results containing no information relevant to market prices.

We therefore estimate the following equations:

$$\Delta Y_t = \alpha + \sum_{i=1}^{r} \gamma_i \Delta Y_{t-i} + \epsilon_t \tag{1}$$

$$\Delta Y_t = \alpha + \sum_{i=1}^{r} \gamma_i \Delta Y_{t-i} + \mu \Delta X_t + \varepsilon_t, \tag{2}$$

and

[4]Both Hungary and Poland have exhibited two reversals, first replacing their initial center-right post-communist governments with coalitions headed by former communist parties, which were then, in turn, replaced by right-wing coalitions. Slovakia saw four reversals of government as a nationalist government was replaced by a right-left coalition that was, in turn, replaced by the ousted nationalists after new elections a few months later. This government, in turn, was ousted by the coalition of all opposition parties at the next scheduled elections in early 1999. In the Czech Republic a center-right government remained in power through late 1997, to be replaced by a caretaker government of similar orientation through mid 1998 and a left wing minority government since that time (although polls in late 1999 suggest that as in Poland and Hungary the center-right government may soon return to power).

$$\Delta Y_t = \alpha + \sum_{i=1}^{r} \gamma_i \Delta Y_{t-i} + \sum_{j=1}^{s} \beta_j \Delta X_{t-j} + \epsilon_t , \quad (3)$$

where Y represents the stock market index, X is one of a set of macroeconomic variables and r and s are the appropriate lag lengths. All variables are expressed in first differences to account for the high degree of serial correlation in each variable.[5]

The conventional test of Granger causality is whether or not Equation 3 better explains movements in the dependent variable than Equation 1. As suggested above, however, to ensure that a failure of lagged economic factors to have a significant effect on stock market returns results from the market efficiently processing information rather than from that information not being an important determinant of prices, we also examine whether Equation 2 better predicts returns than Equation 1. In summary, results support market efficiency if both of the following null hypotheses hold:

(A) H_0: $\mu \neq 0$ and (B) $H_0 : \beta_j = 0, \forall j$.

A finding that hypothesis (B) does not hold suggests that the market is inefficient. A finding that hypothesis (B) holds but (A) does not suggests that efficiency considerations are irrelevant.

Data and Empirical Results

The analysis is conducted on monthly data for the main stock market index in each country from the beginning of 1993 (or the beginning of trading, whichever is later) through

[5]We also ran reverse regressions with the X variables on the left-hand side and the Y variables on the right-hand side to investigate whether market movements affect the real economy in these countries. As expected, results showed little impact and are available on request.

mid-1999. Thus, for Hungary and Poland we have 78 monthly observations while for the Czech Republic and Slovakia we have 70. The issue of timing is important. Most countries in the region announce economic variables on about the tenth of each month. When we investigate a "contemporaneous" relationship, we are examining the ability to predict June stock market returns on the basis of May values of economic variables, which would be announced about one-third of the way through the trading period. Given that U.S. studies indicate that unanticipated information is incorporated into equity prices in periods as short as an hour (or even a single trade),[6] the inclusion of a two-to-three week period as a part of the current time period provides a generous allowance, and should bias results in favour of finding semi-strong efficiency. On the other hand, since there is no way to establish from theory what the "proper" time period is to use, in order to avoid issues of "specification search" we do not investigate alternative market return periodicity.[7]

We examine each of the following macroeconomic variables: money supply (M1 and M2); industrial production[8] (as a proxy for GDP which is not available monthly); government budget deficit; inflation rate; exchange rate versus the US dollar; and imports, exports and the trade deficit. Moreover, since the budget deficit in any quarter can be regarded as the change in outstanding government debt, while the trade deficit can be regarded as the change in foreign capital in the domestic market, we estimate these relationships in levels as well as differences.

Lag lengths for each equation (r and s) were established by use of the Hannan-Quinn

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[6]See Greene and Watts (1996) and Chen, et. al. (1999), for example.

[7]We are limited to monthly changes in most economic variables because of the policies of statistical offices in the countries under study.

[8] Because there is seasonality in measured industrial production in the countries under study, these figures are indexed to production in the same month of the previous year.

(1979) criteria, searching over a maximum of twelve periods.[9] In addition, because data in transition economies are notoriously unreliable, particularly at the end of each year, we have reduced the effect of outliers by minimizing the sum of the absolute value of residuals (least absolute deviation or LAD) rather than using ordinary least squares.[10]

Table 2 contains p-values from likelihood ratio tests of whether a contemporaneous relationship exists between economic factors and the equity market (i.e. whether Equation 2 above better predicts changes in stock prices than Equation 1), as well as a test of conventional Granger causality running from lagged real factors to the stock market (whether Equation 3 better predicts returns than Equation 1).

Substantial evidence of a relationship between lagged economic factors and equity returns is found for Poland and Hungary. In each country lagged values of *every one* of the twelve real economic variables we tested predicted future equity market returns at the 1 per cent or better level. Thus, investors who traded on announcements of money supply, trade statistics, foreign capital inflows, government debt, price levels or industrial production might be able to earn predictably positive returns.[11] The fact that current values of these variables are, in general, not linked to current equity market returns reinforces the suggestion that these

[9] The Hannan-Quinn criterion appears to be more accurate in determining the true order of an autoregression in moderate sample sizes than the alternative Akaike information (1969) and Schwarz minimum bias (1978) criteria. We checked the order of our estimated equations using these alternatives. The Schwarz and Hannan-Quinn criteria never differed by more than a single period although Akaike sometimes suggested three or four additional lags. Dickey-Fuller tests on the residuals from equation (3) establish that these variables are cointegrated. Standard tests for serial correlation (Q or Durbin's h test) indicate no remaining serial correlation.

[10] OLS results present a similar picture, although it is necessary to exclude the early months of the emerging market crisis of early 1998 which had enormous residuals. These are available from the authors on request.

[11] We have not conducted a formal analysis of whether potential trading gains are sufficient to compensate for transactions costs but the magnitude of the relationships suggests that they are.

markets are not efficient as conventionally understood..[12]

The pattern is very different in the Czech Republic and Slovakia. In the Czech Republic none of the twelve lagged measures are linked to equity returns, while only four significant relationships are seen for Slovakia. On the other hand, in the Czech Republic (and to a lesser extent Slovakia), contemporaneous information about real economic variables is also not linked to equity market returns. Thus, the failure of lagged economic values to Granger cause stock markets returns should not be interpreted as implying that these markets are efficient. Rather, changes in their equity markets do not reflect changes in their real economies and must, therefore, be based on other, less rational, factors.

The relative efficiencies of the Central European stock markets appear to have shifted greatly over time. Table 3 contains the same analysis restricted to the period up to December 1996 (the first 48 months for Poland and Hungary and the first 40 months for the Czech Republic and Slovakia). Relationships are similar to those seen in Table 2 for Hungary and not too dissimilar in Poland, although in both countries the links are much less strong. In the Czech Republic and, to a somewhat lesser extent, in Slovakia, however, markets appear to be moving backwards. In the early years of their existence, these markets may have posessed elements of semi-strong efficiency, with both lagged and contemporaneous relationships between real variables and equity markets. For the Czech Republic these links have disappeared. Thus, instead of becoming more efficient over time, as one might expect, the Czech stock market appears to have become increasingly divorced from reality.

There are several reasons why this may have happened. As press reports have

[12]These results are somewhat different than those fund by Zalewska-Mitura (1998), who used a limited sample of individual stocks, and claims that the Warsaw Stock Exchange incorporates information more rapidly than that in Budapest.

increasingly focussed on the lack of regulation in the Czech market,[13] a self-fulfilling prophecy may have been created whereby rational investors have abandoned the market, leaving it to those who do not treat stocks as conventional instruments for investment purposes, but rather as artificial chips to be used in a game of financial manipulation. In addition, trading patterns have shifted so that prices on the PSE may have become less indicative of true values. When trading began in 1993, almost 30 per cent of transactions went through the PSE, while by the end of 1996 this figure had fallen to below 5 per cent. Finally, there is at least some evidence that so long as those active in the Czech securities market anticipated participating in the second wave of voucher privatization (which ended in early 1995), reputation effects may have served to check the incentive to manipulate stock prices or strip assets from firms. After this point, inadequate supervisory regulations may have allowed such urges to assert themselves more easily than in the more conventionally regulated Polish and Hungarian markets.

Insight into the nature of linkages between Central European markets and the world financial system can be obtained by examining the role of foreign capital in these markets. Recent estimates are that approximately 70 per cent of trading in Budapest and 30 per cent in Warsaw involves foreign investors as compared with only a trivial fraction of trading in Prague.[14] Thus, it is not surprising, as seen in Table 4, that the Hungarian stock exchange is closely linked with global markets. Tests of Granger causality between the main German and

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[13]For example, The Economist of April 13, 1996 reported: "In the Czech stock market [in contrast with Poland and Hungary], the prices at which shares are traded are often a mystery. Investors can trade on the Prague Stock Exchange or through a chain of share shops called the RM-System. Most deals, however, are struck in private by the voucher funds. They are also given a privileged view of companies' inner workings through seats on their boards." The Wall Street Journal (May 8, 1996) characterized the Prague stock market as "anarchy to the outsider, sweet profit to those in the know."

[14] Estimates of foreign involvement are from private conversations with analysts at Wood and Co., Budapest; Wood and Co., Prague; and Patria Finance, Prague.

US indices (the DAX and Dow-Jones Industrial Average)[15] show that the Hungarian market is strongly linked to both the European (German) and US markets both instantaneously and with a lag. While there is evidence of a connection between the Polish and Slovak markets and that in the US, there is no evidence whatsoever of a link between Czech equity markets and their counterparts in the West. Again, in the first years of trading on the PSE, results (not reported but available from the authors) found a contemporaneous link to the German market and a lagged link to the Dow-Jones average. Thus, yet again, there is a strong suggestion that the Czech market has become increasingly separated from the real world over time.

Recently a number of significant changes have taken place in the Czech securities market. Among these are the introduction of a market-maker system for the most liquid stocks that has substantially increased trading on the central floor of the Prague stock exchange and the introduction of an aggressive Securities and Exchange Commission with broad regulatory powers. It will be interesting to see if these reforms (and other proposed changes (see World Bank, (1998)) can restore the initial advantageous position of the Czech market.

We turn now to the question of whether the patterns found make economic sense in addition to their statistical significance. In many cases when lagged real variables show a significant ability to predict current market returns, the optimal equation involves several lags with varying signs making interpretation difficult. In general, there is a positive relationship between money supply and equity prices, exactly as should be expected and as found in previous studies of other countries. Rozeff (1974) and Hancock (1989), for example, find a

[15] For obvious reasons, we do not investigate whether Visegrad markets Granger cause changes in the much larger Western markets.

contemporaneous relationship between these two variables for the U.S.,[16] while Darrat and Mukherjee (1986) find that in India increases in money supply cause increases in equity prices only with a lag, as does al-Bazai (1998) for Saudi Arabia, and Muradoglu-Sengul and Onkal (1992) for Turkey. Increased government debt generally forecasts higher stock prices. The explanation for our finding of a negative relationship between international capital flows and equity prices in Poland and Hungary is less intuitively obvious. Finally, we have no intuitive explanation of why increases in industrial production should result in lower stock prices, a pattern observed in three out of the four countries in the region. A similar result has been reported, however, for the U.S. and Japan by Kaneko and Lee (1995).

Summary and Conclusions

Equity markets in the most advanced post communist countries present a mixed picture. Two (and perhaps three) of these markets appear to be linked to both the real economy and the developed world. There is, however, strong evidence that they are not yet semi-strong efficient. Thus, for those willing to assume the significant risk involved it may be possible to trade profitably in these markets using public information. In the Czech Republic, on the other hand, despite early suggestions of efficiency, there currently appears to be no connection between movements in the equity market and either the local real economy or the larger world.

The implications of the difference between Poland and Hungary on the one hand and the Czech Republic (and, to a lesser extent, Slovakia) on the other are substantial. In this area, at least, the evidence seems overwhelming that the sequencing of steps is critical to

[16] Abdullah and Hayworth (1993) and Lee (1994), on the other hand, find that lagged changes in money supply also influence equity prices in the U.S.

eventual success and that gradualism may well have been preferable to a "big bang" approach. Both Poland and Hungary built their equity markets slowly and deliberately, adopting rules and procedures and only gradually allowing companies that complied with listing requirements to trade. The Czech Republic, by way of contrast, adopted a policy of trading massive numbers of firms on equity markets with the hope that appropriate institutional support structures would evolve over time. Our results suggest that this may have been a policy of "too much, too soon." Early in the development of equity markets in Central Europe, the far more massive Prague Stock Exchange appeared to be achieving semi-strong form efficiency. It was, however, unable to sustain this early lead and has since degenerated to such an extent that there is currently no apparent link between returns on the PSE and the Czech economy as a whole. In Budapest and Warsaw, however, the more methodical development of equity markets has produced exchanges that, while not yet efficient, are at least linked to the real economy and may, therefore develop into classically efficient markets over time. It remains to be seen whether recent reforms in The Czech Republic will return that market to the path towards efficient incorporation of information into stock prices.

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Table 1

Extent of Variation in Economic Indicators, Visegrad Economies

Period 1/93 or 9/93 - 6/99*	Czech Republic	Hungary	Poland	Slovakia
Monthly Inflation	mean = 0.7% s.d. = 0.7 min = -0.2% max = 4.0%	mean = 1.4% s.d. = 1.0 min = -0.3% max = 4.4%	mean = 1.5% s.d. = 1.2 min = -0.9% max = 5.6%	mean = 0.7% s.d. = 0.6 min = -0.4% max = 3.0%
Monthly Change in Industrial Production	mean = 0.2% s.d. = 5.4 min = -19.0% max = 21.8%	mean = 0.3% s.d. = 5.2 min = -9.7% max = 14.3%	mean = 0.0% s.d. = 4.4 min = -9.6% max = 10.6%	mean = 0.5% s.d. = 4.8 min = -12.3% max = 11.7%
Unemployment Rate	mean = 4.1% s.d. = 1.7 min = 2.6% max = 8.4%	mean = 10.9% s.d. = 1.2 min = 8.8% max = 13.6%	mean = 13.6% s.d. = 2.3 min = 9.5% max = 16.9%	mean = 13.7% s.d. = 1.3 min = 11.8% max = 17.7%
Monthly Returns (local currency)	mean = 1.2% s.d. = 12.1 min = -23.2% max = 57.4% skewn = 1.9 kurt = 7.2	mean = 3.6% s.d. = 12.7 min = -36.1% max = 58.6% skewn = 0.9 kurt = 4.9	mean = 5.3% s.d. = 19.9 min = -35.3% max = 105.9% skewn = 1.9 kurt = 7.9	mean = 0.8% s.d. = 17.8 min = -30.8% max = 113.8% skewn = 4.4 kurt = 25.8
Monthly Returns (US$)	mean = 0.9% s.d. = 12.0 min = -23.7% max = 55.5% skewn = 1.8 kurt = 6.6	mean = 2.2% s.d. = 12.5 min = -38.3% max = 55.6% skewn = 0.8 kurt = 5.0	mean = 4.1% s.d. = 19.7 min = -35.7% max = 103.0% skewn = 1.9 kurt = 7.8	mean = 0.4% s.d. = 17.8 min = -30.9% max = 113.8% skewn = 4.5 kurt = 26.7

* Stock market indeces for Czech Republic and Slovak Republic were introduced in April 1994, and their values are (backward) computed since September 1993.

Table 2.

Likelihood Ratio Tests of Significant Relationships between Real Variables and Market Indices

(P value of χ2-statistic, with optimal number of lags in parentheses)

Period 93:1 to 99:6	Czech Republic		Slovak Republic	
	Contem-poraneous	Lags Only	Contem-poraneous	Lags Only
M1	2.25	0.22 (1)	6.55**	1.06 (1)
M2	0.3	0.17 (1)	13.18***	6.97*** (1)
Exports	1.76	0.62 (1)	0.12	1.93 (1)
Imports	3.01*	0.03 (1)	0.42	0.40 (1)
Trade Balance	2.17	2.07 (1)	0.6	0 (1)
For. Cap.Inflow	3.65*	0.81 (1)	0.25	1.13 (1)
Budget Deficit	0.09	1.55 (1)	1.62	1.01 (1)
Gov. Debt	0.41	1.13 (1)	1.35	0.92 (1)
Price Level (CPI)	1.67	0.12 (1)	2.02	6.55** (1)
Price Level (PPI)	0.54	0.14 (1)	0.7	4.95** (1)
Exch.Rate (US$)	0.52	1.01 (1)	0.44	0.17 (1)
Ind. Production	0.48	0.16 (1)	53.80***	60.83*** (3)
Period 93:1 to 99:6	Hungary		Poland	
	Contem-poraneous	Lags Only	Contem-poraneous	Lags Only
M1	19.79***	70.65*** (5)	36.65**	114.54*** (5)
M2	129.43***	183.10*** (5)	2.24	90.96*** (5)
Exports	0.54	70.45*** (5)	1.18	85.98*** (5)
Imports	0.33	69.40*** (5)	0.25	86.97*** (5)
Trade Balance	0.01	69.17*** (5)	1.55	90.98*** (5)
For. Cap.Inflow	13.35***	83.82*** (5)	18.69***	110.62*** (5)
Budget Deficit	0	71.61*** (5)	3.05*	86.80*** (5)
Gov. Debt	13.20***	85.19*** (5)	20.84***	106.98*** (5)
Price Level (CPI)	2.84*	74.88*** (5)	1.62	99.11*** (5)
Price Level (PPI)	2.68	70.84*** (5)	1.8	88.84*** (5)
Exch.Rate (US$)	0.66	66.81*** (5)	0.08	75.39*** (5)
Ind. Production	0.44	69.30*** (5)	0.99	89.63*** (5)

***Significant at 1% level **Significant at 5% level *Significant at 10% level.

Table 3.

Likelihood RatioTests of Significant Relationships between Real Variables and Market Indices

(P value of $\chi 2$-statistic)

Period 93:9 to 96:12	Czech Republic		Slovak Republic	
	Contem-poraneous	Lagged	Contem-poraneous	Lagged
M1	2.74*	1.4	0.58	0.01
M2	2.61	0.13	0.98	0.95
Exports	13.03***	0.01	2.19	2.61
Imports	10.66***	0.6	1.58	5.02**
Trade Balance	0.01	1.4	6.03**	5.21*
For. Cap.Inflow	0.59	4.80*	4.28**	2.54
Budget Deficit	11.13***	4.32**	0.63	0.09
Gov. Debt	8.09***	4.34**	0.27	0.03
Price Level (CPI)	0	0.42	7.51***	3.42*
Price Level (PPI)	0.7	0.5	0	4.41**
Exch.Rate (US$)	4.45**	7.70**	9.16***	14.64***
Ind. Production	1.93	1.48	1.15	15.11***
Period 93:1 to 96:12	Hungary		Poland	
	Contem-poraneous	Lags Only	Contem-poraneous	Lags Only
M1	1.27	1.04	1.26	75.34***
M2	3.60*	6.64***	1.38	0.39
Exports	0.08	55.28***	1.39	0.63
Imports	0.41	51.63***	4.72**	0
Trade Balance	0.71	0.06	2.60**	0.08
For. Cap.Inflow	2.16	63.36***	1.05	89.47***
Budget Deficit	0	56.71***	0.58	0.42
Gov. Debt	0.17	62.29***	1.31	88.99***
Price Level (CPI)	6.49**	57.78***	3.56*	75.80***
Price Level (PPI)	0.78	61.77***	1.15	1.43
Exch.Rate (US$)	7.02***	54.20***	1.68	76.35***
Ind. Production	0.33	47.40***	0.01	0

***Significant at 1% level, **Significant at 5% level *Significant at 10% level.

Table 4.

Likelihood Ratio Tests of Significant Relationships between Western and Visegrad Market Indices (P value of χ2-statistic)

	Czech Republic		Hungary	
	Contem-poraneous	Lags Only	Contem-poraneous	Lags Only
DAX	0.02	0.06	31.60***	8.19***
Dow-Jones Industrial Average	0.32	1.49	31.61***	59.74***

	Poland		Slovakia	
	Contem-poraneous	Lags Only	Contem-poraneous	Lags Only
DAX	2.52	1.17	0.04	1.01
Dow-Jones Industrial Average	2.42	0.02	5.14**	1.88

***Significant at 1% level **Significant at 5% level *Significant at 10% level.

Figure 1.
Visegrad Stock Indices, 1993-1998, January 1996=100