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The Emerging Financial System of Poland: Institutional Constraints and External Links

Warsaw, 1999

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This paper was prepared for the research project "Sustaining Growth through Reform Consolidation" No. 181-A-00-97-00322, financed by the United States Agency for International Development (USAID).

Printer's Corrections: Dorota Kowalczyk

Graphic Design: Agnieszka Natalia Bury

DTP: CeDeWu – Centrum Doradztwa i Wydawnictw "Multi-Press" Sp. z o.o.

ISSN 1506-1701, ISBN 83-7178-105-9

Publisher:
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Contents

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Abstract

Krzysztof Rybiński
Impediments to the Development of Polish Financial Markets

Polish financial markets developed very quickly over the past eight years. However there are still numerous obstacles restraining further grow and development of financial markets. This paper discusses the most important impediments and argues that they create significant distortions and result in existence of a "grey zone". Several impediments have already been removed, Monetary Policy Council increased the exchange rate flexibility and the NBP fixing does not distort the market any longer; the settlement of bond transactions has been improved resulting in a much more liquid market; mandatory reserve requirement computing rules will change in 1999, which will make the reserve avoidance impossible. Some impediments are still in place, despite offical ban on short-sale of Polish zloty by non-residents zloty is often shorted through foreign exchange swaps. The repo market does not exist due to reserve requirement on repo transactions, while an informal so-called "buy-sell-back" transactions continue to thrive. Also the new foreign exchange law to come in force in 1999 will impose several restrictions on short-term inflows, which in the longer run may create substantial distortions on Polish capital account.

Thomas Linne
The Links Between Polish and International Financial Markets

The financial markets in Poland and other countries in Central and Eastern Europe have been gradually liberalised in recent years. This paper examines the degree of international integration of emerging equity markets in Central and Eastern Europe and mature equity markets in industrialised countries. Cointegration analysis is used to examine the time series properties of stock market indices from various stock exchanges. The analysis provides some evidence that the East European stock markets were over the last few years not very closely linked to the world portfolio as represented by the MSCI index, suggesting that domestic factors were predominantly driving these markets.

Section I

Impediments to the Development of Polish Financial Markets

1. Introduction

The institutional development of financial markets has played a crucial role in facilitating the process of the economic transformation in the economies of Central Europe. These markets were essentially non-existent at the start of transition from central planning to a deregulated market economy. Yet, capacity building and institutional advancement of these markets are essential for allocation of resources to the most productive uses and for a sustained economic growth of these countries in the future. Transitional economies privatize state owned assets which in turn triggers large capital inflows. Therefore well functioning financial sector is needed to channel these inflows into their most productive use. If financial markets fail to function well, then a country may loose confidence of foreign investors and may slump into recession, with Asian countries and Czech Republic as best and most recent examples.

The purpose of this paper is to present the impediments to the growth of financial markets in Poland. Some obstacles discussed here have already been addressed by decidents, but some obstacles are also being developed.

The paper is organized as follows. Section 2 discusses the NBP fixing mechnism and changes in exchange rate policy. Section 3 presents how commercial banks can avoid paying the mandatory reserve requirement. Section 4 shows that non-resident can go short on Polish zloty through currency swaps. We also show that in February 1998 NBP granted an arbitrage possibility to foreign speculators by offering nine-month NBP bills. Section 5 discusses improvement and deficiences of the bond market. Section 6 shows how reserve requirement on repo transactions led to the growth of informal "buy-sell-back" market. Section 7 argues that new foreign exchange law imposes numerous and distortionary restrictions on capital flows, but we also argue that these restrictions can be avoided by smart investors. Section 8 concludes.

2. NBP Fixing Mechanism Hampers the Growth of Foreign Exchange Market

From 16 may 1995 the exchange rate policy of the National Bank of Poland (NBP) has been based on three pillars: central parity rate, crawling peg and fixing. Central parity is the exchange rate of Polish zloty against the basket of five currencies: USD – 45%, DEM – 35%, GBP – 10%, CHF – 5% and FRF – 5%. The market rate is allowed to fluctuate within the (-10%,+10%) [1] band from the central parity. The crawling peg mechanism means that the zloty central rate is devalued with a target set on a monthly basis, presently at 0.65% per month [2]. The fixing is a special settlement operation which enables the commercial banks to square their foreign currency positions at the NBP determined exchange rate. The NBP fixing rates for USD and DEM are rates used for transactions with the NBP, while the remaining currencies' rates are used only for the revaluation purposes. The NBP receives commercial banks' orders to buy/sell foreign currency and on this basis decides what should be the proper fixing exchange rate. Assuming that commercial banks behave rationally, their aggregate demand/supply of the foreign currencies at the fixing should reflect international market trends. In particular, the daily USD/PLN and DEM/PLN exchange rates movements should reflect the USD/DEM exchange rate movements.

On international money and capital markets we observe a phenomenon called "volatility clustering". Days of high volatility of an observed asset are very often grouped together and form "clusters". These high volatility clusters are separated by corresponding low volatility clusters. There are many theories explaining the volatility clustering phenomenon. The most frequently used models assume that the information arrival to the markets in not uniformly distributed but comes in groups. Therefore periods with a lot of new information are characterized by high volatility while periods when there is a little information exhibit low volatility.

Volatility clustering is a very common phenomenon on the international foreign exchange markets. Information about inflation, interest rates, productivity, unemployment, GDP, wages affects immediately the prospects of traded currencies. The more actual information deviates from market expectations the more volatility is induced by this information.

Volatility clustering drew attention of many researchers and in 1982 R.Engle presented the idea of ARCH models (Autoregressive Conditional Heteroscedasticity), modified by T.Bollerslev in a form of GARCH (Generalized ARCH). GARCH models closely rely on the volatility clustering

[1] Until 24 February the band was (-7%,+7%).

[2] Craling peg was lowered from 1% to 0.8% on 24 February and from 0.8% to 0.65% on 17 July.

effect, therefore these effects are often called "GARCH effects". However before an appropriate GARCH model is estimated one has to make sure that GARCH effects are present in the data. In figures1 and 2 we presented the results of LM test for GARCH effects. We provide the value of the test, its P-value and the conclusion. P-value describes the empirical significance level of the conducted test. In other words it tells how often we make a mistake by rejecting the hypothesis of no GARCH effects in the data. For example in table 1 the P-value for GBP/USD exchange rate is 0.0797, therefore when we state that weak GARCH effects are present in GBP/USD data we make a mistake 7.9 times in one hundred, while typically researchers accept the error tolerance level of 5 times in one hundred.

Forecasting of the future level of exchange rates is a very difficult task, often "toss a coin" models give as good results as a very complicated econometric models. However in the case of future volatility, due to the GARCH effects, we are able to forecast volatility much better than by coin-tossing. This is a very important result, as by accurate future volatility forecasting we are able to predict the foreign currency risks and we are able to price options with better accuracy.

We investigated the volatility clustering phenomenon on Polish foreign exchange market. Our data include the zloty fixing exchange rates against USD and DEM. For comparison we also tested the exchange rates of the NBP basket currencies against US dollar. All data series cover the period 16 May 1995 – 21 July 1998. Results of econometric tests are presented in Table 1.

Table 1. Testing for GARCH effects, 16 May 1995 – 21 July 1998

	Number of obs	Lambda test	Chi-squared p-value	Garch effect
USD/DEM	951	44.01	0.0000	Strong
GBP/USD	911	12.70	0.0797	Weak
USD/FRF	885	38.17	0.0000	Strong
USD/CHF	883	64.31	0.0000	Strong
USD/PLN	796	55.94	0.0000	Strong
DEM/PLN	796	94.43	0.0000	Strong

Source: ING Barings.

As presented above we found strong GARCH effects in all series with the exception of GBP/USD which exhibited only weak GARCH effects. However the analyzed period was very heterogenous for the Polish zloty. Until Czech crisis in May 1997 the foreign exchange market was dominated by NBP while large external shocks in second half of 1997 and first half of 1998 made the market less centally planned. Also the February 1998

decision of Monetary Policy Council to stop intervening inside the band improved the activity and liquidity on the FX market (see Table 1). Therefore we decided to analyze two periods: before and after the Czech crisis, separately. Results are presented in Table 2.

Table 2. Testing for GARCH effects, subsamples

	Number of obs	Lambda test	Chi-squared p-value	Garch effect
USD/PLN – 1st subsample	490	7.54	0.375	None
USD/PLN – 2nd subsample	298	23.48	0.0014	Strong
DEM/PLN – 1st subsample	490	12.89	0.0748	Weak
DEM/PLN – 2nd subsample	298	36.13	0.0000	Strong

1st subsample: 16 May 1995 – 30 April 1997
2nd subsample: 5 May 1997 – 21 July 1998
Source: ING Barings.

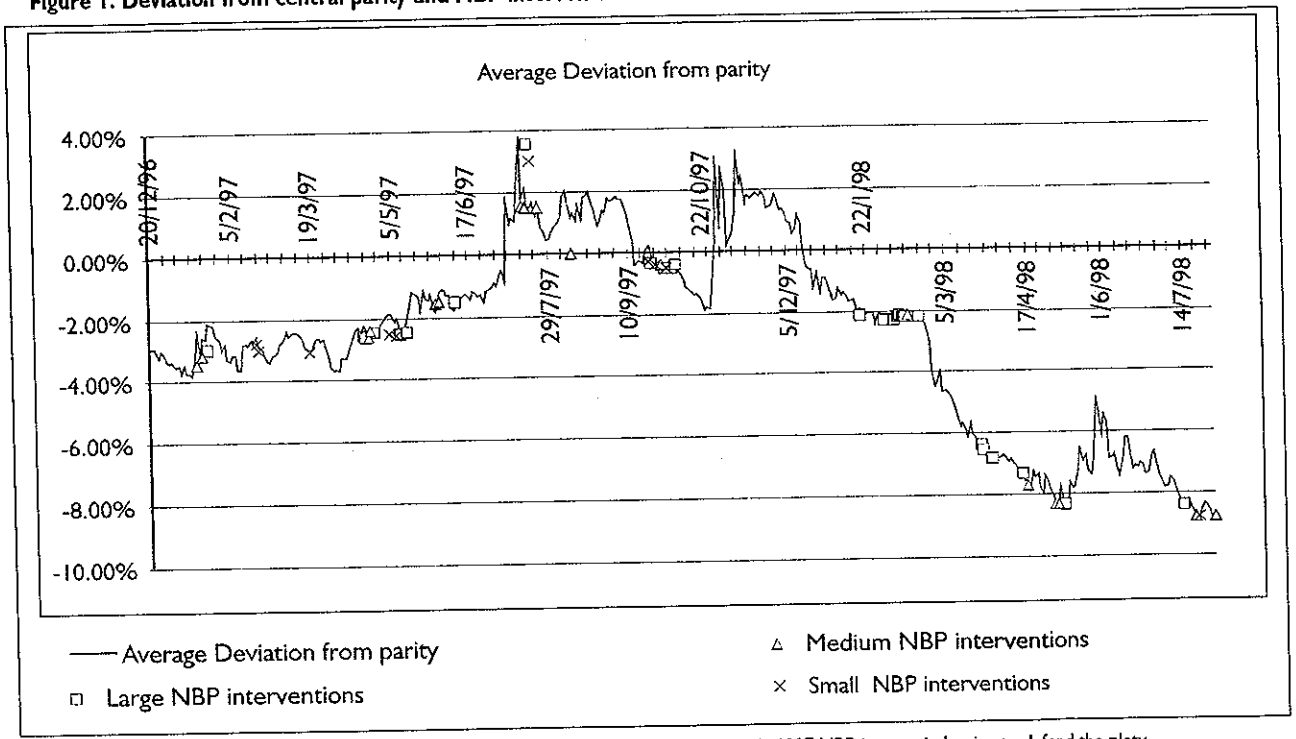
As we expected we found no GARCH effects for USD/PLN in the first subsample, and weak GARCH effects for DEM/PLN. These results are consistent with NBP policy in that period, which intervened heavily on USD market, while USD/DEM volatility was transmitted, in a very distorted way, into DEM/PLN volatility. However, the above mentioned factors: large external shocks and greater NBP flexiblity led to improvement and in the second subsample both USD/PLN and DEM/PLN exhibited strong GARCH effects. We conclude, that in the past 12 months Polish FX market became much more mature and less controlled by the central bank.

Despite these positive developments still NBP fixing mechanism remains an obstacle to the further development of the FX market in Poland. Often NBP conducts so-called "interventions at fixing" ie. fixes the rate that is very different from the pre-fixing closing price. In few cases NBP released a statement that such intervention at fixing was conducted to punish the currency speculators. Such practises have important impact on banks who run large portfolios of currency options and hedge their FX exposure though delta method [3]. Reference exchange rate for delta hedging is NBP fixing, so if NBP intervenes at fixing, banks have to rebalance their portfolios which leads to losses. Banks have to cover these losses by increasing the volatility and/or spread for option pricing, which limits the growth of FX derivative markets.

Moreover, fixing allows many domestic banks to remain inactive on the FX market. Rather than deal on the market they place their orders only at the NBP fixing. Such practises limit FX market liquidity and make domestic banks vulnerable to future FX market development, as they will lack FX trading experience.

[3] For a discusion of delta hedging see for example Hull (1997).

Figure 1. Deviation from central parity and NBP interventions



Almost all showed interventions supported USD and DEM. Only during the flood in July 1997 NBP intervenied twice to defend the zloty.
Source: ING Barings.

3. Mandatory Reserve Requirement (or How to Avoid Paying it)

Mandatory reserves have been actively used by NBP as a tool for adjusting the monetary policy. They were increased significantly last year: on foreign exchange deposits from 2% to 5%, on zloty demand deposits from 17% to 20% and on zloty time deposits from 9% to 11%.

Reserve requirement for commercial banks is computed three times per month in ten-day intervals. Some commercial banks successfully avoid paying the reserve by offering to their clients so-called "inter-decade deposits". Bank accepts deposit for nine days from the client, then on the reserve reporting day it offers a so-called "buy-sell back" transaction (transaction is described in section 6) to the client for one day in order not to report the deposit and avoid paying the reserve requirement. The next day the bank can again offer a "reserve-free" nine day deposit to its client.

Inter-decade deposits are a clear example of "grey economy activity" in the banking sector. Some banks conduct this activity some choose not to engage in such practices. This results in unfair competition, as banks with good level of services can loose clients only because they decided not to move to "grey economy activities", their deposit rates bear the reserve cost and are some 2% lower than "reserve free" inter-decade deposit rates.

Moreover, "inter-decade deposits" cannot be offerd to retail clients as they require large amounts (for buy-sell-back transaction) and some sofistication of the client. Therefore banks with large retail customer base have to pay the reserve requirement while banks with corporate client base may avoid paying the reserve. On top of that corporate clients receive attractive interest on their "inter-decade deposits" so they are less interested in purchases of another instruments, such as Treasury papers. Therefore the government target to increase the share of non-financial sector in Treasury paper holding may be more difficult to achieve.

This issue was addressed by the Monetary Policy Council and commercial banks were told to report the reserve requirement on daily basis from February 1999, which will eliminate the "inter decade deposit" problem. There is, however, one more issue.

If a commercial bank buys a troubled bank, the NBP waives the mandatory reserve requirement. Such a bank can offer some 2 – 3% higher deposit interest rate. This is nothing else but a hidden subsidy. For example commercial banks with a reserve requirement waiver offered some 22.5% on nine-month deposits in January-February this year (some 2% above the market "reserve included" rate). Then acquired funds

could be used to buy nine month NBP bills yielding 23.5%, and a hefty 1% margin was achieved. Such a transaction would not yield a profit if "a reserve included" deposit rates were used. It is difficult to assess the scale of such "subsidies" in the past, but they distort the money market and in result some banks may loose their market share to their subsidized competitors.

4. Currency Swaps: short-sale of Polish Zloty and Easy Profit Opportunity

According to present and drafted new foreign exchange law the short-sale of Polish zloty is not allowed. It means that non-resident cannot borrow a zloty deposit from commercial bank in Poland which then could be used for a speculative buy of foreign exchange and could lead to a forced devaluation of the zloty. However at the same time currency swaps are very popular among foreign investors. Through currency swap foreign investor can borrow zloty deposit from Polish bank and can use it to cover debit on its zloty account or can speculate on weaker zloty. Lets assume that today's exchnage rate is 3.54 and that two week forward rate is 3.568. Foreign speculator will receive PLN 3.54m for US$ 1m in a swap transaction today. If she sells zloty at spot market, and the amounts sold will be large, then in few days zloty may weaken to, for example, 3.8 per US$. Speculator can buy zloty at 3.8 and receive PLN 3.8m. Then he will have to buy back US$ 1m at the forward date of swap transaction, paying PLN 3.568 for one dollar. The profit will be PLN 0.214m and US$ 0.056m per each US$ 1m engaged in the speculation. Of course, if these speculations were large, the forward rate (assumed 3.568) would go up in the first place, as Polish banks engaged in the swap transaction would seek zloty deposits on the market, and growing demand would bid up the price – two week interest rate – and consequently the forward rate. The scale of such speculation cannot be large. We estimated that in late 1997 swap transactions limits at resident banks able to deal swaps were not larger than US$ 850m in total. Such limits tend to increase rapidly but they will still remain at a very low levelin comparison with some US$ 24bn of foreign exchange reserves held by the central bank.

Currency swaps also led to another profi table activity in early 1998. In January – February period the central bank offered 9 month NBP bills yielding 23.5%. These bills could be bought only by resident commercial banks. At the same time long term NDFs (six and nine month) were traded in London below 22%. Therefore in February foreign

speculators offered large amounts of zloty deposits to Polish banks through currency swaps. In such swaps zloty nine month deposit was typically priced at 22.5%. Then foreign speculator would close the trade by buying zloty through NDF, while Polish bank would buy nine month NBP bills yielding 23.5%. Everybody was making profit while NBP had to sterilize and incurred large costs. The net liquidity absorption in February amounted to PLN 15.3bn while in the previus months did not exceed PLN 7bn. Currency swaps also showed up in the balance of payments. In February the balance of payments category "Polish foreign assets, cash and deposits" showed a net inflow of US$ 1,037m.

5. Improvement in Bond Market Liquidity

Settlements of T-bills transactions are conducted by NBP in real time. T-bond settlement system is run by National Depository of Securites and is less efficient. Until May'98 banks could not buy and sell the same bond on the same day. They had to park the bond on their books for at least three days which resulted in high financing costs of such position. On top of these costs were also fees for compulsory brokerage. Therefore the total costs ammounted for some 25% of the spread on T-bond market and more than 100% of the spread on T-bill market. However since May, due to changes in legislation, banks have been able to trade the same bond on the same day. The spread narrowed significantly, and sometimes did not exceed 5 – 10bps (figure 3). In result the liquidity of the bond market improved, however it still does not match the T-bill market liquidity. The low liqudity premium demanded by investors has declined and long end of the yield curve shifted from 21.5% in January 1998 to below 14% in July 1998, much more than it could be explained by a change in inflation and real interest rate expectations.

This improvement in liquidity and sharp decline in yields may allow the ministry of finance to issue longer term paper and fulfil its target to increase the duration of domestic public debt. ING Barings LSC zero coupon yield curve model [4] suggests that if the ministry of finance issued a ten year fixed rate bond the yield should be 12.8% in late July as compared to 19.8% in January 1998 (figure 4). Moreover, foreign investors buy bonds with highest duration on the back of the next covergence play, ie. Poland joining EMU in 2006 – 2008. A ten year bond would allow them to take such a convergence bet which would imply that they would accept a duration discount and the yield on a ten year bond could be set below 12%.

[4] Based on R. Wilner (1996).

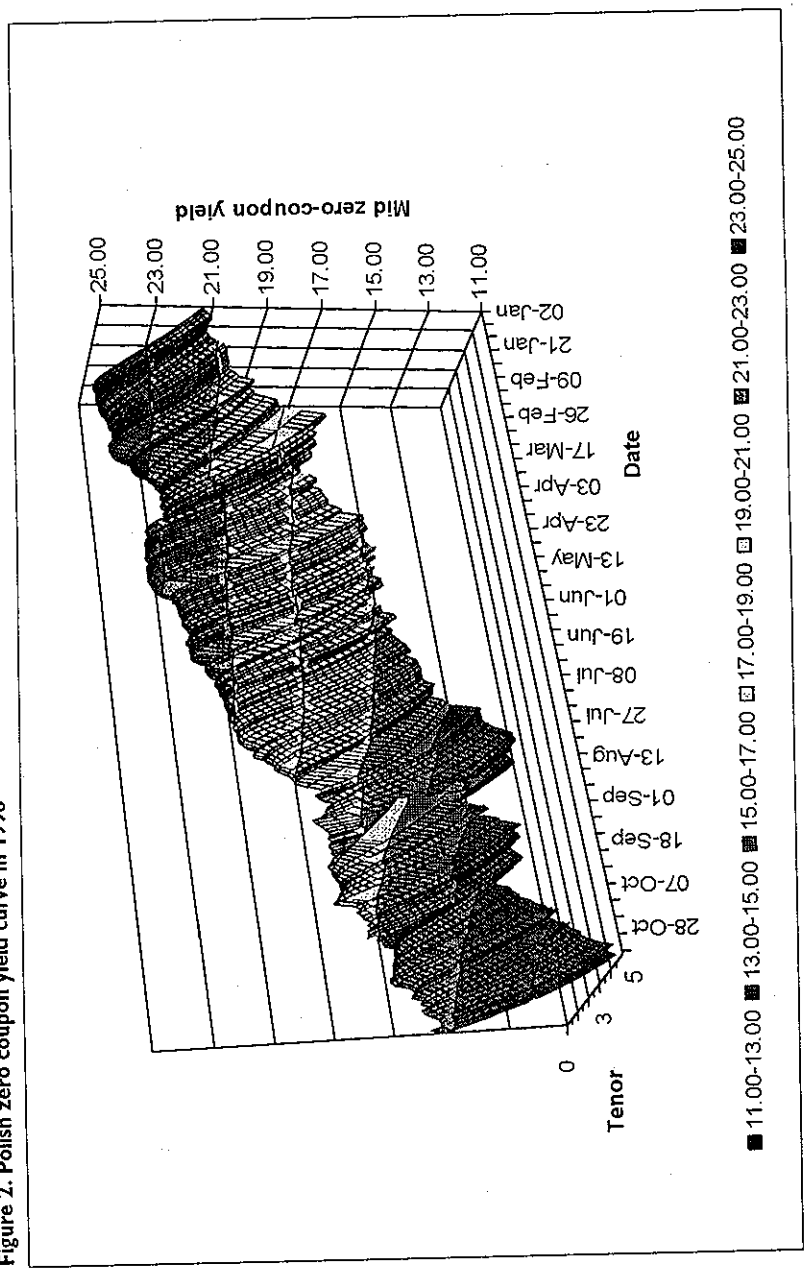


Figure 2. Polish zero coupon yield curve in 1998

Source: ING Barings.

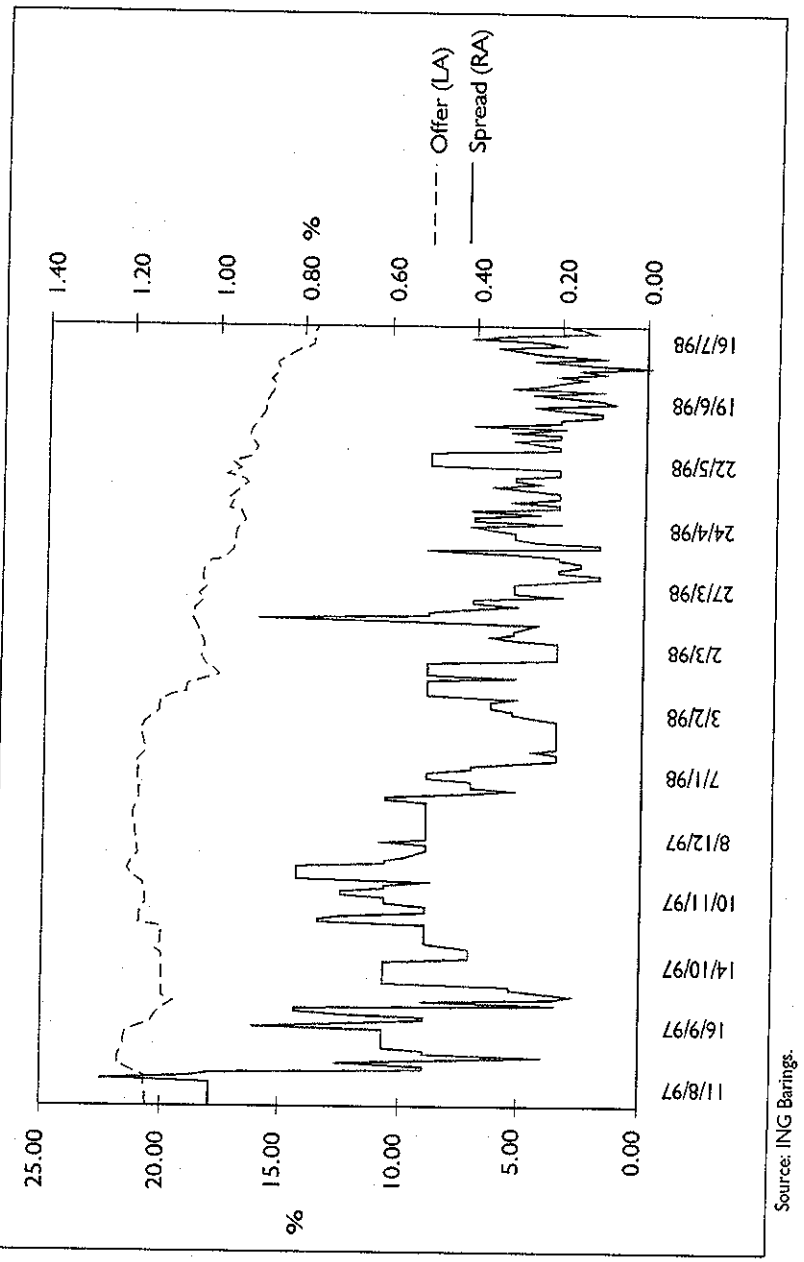


Figure 3. Five year bonds: secondary market offer rates and bid/offer spread

Source: ING Barings.

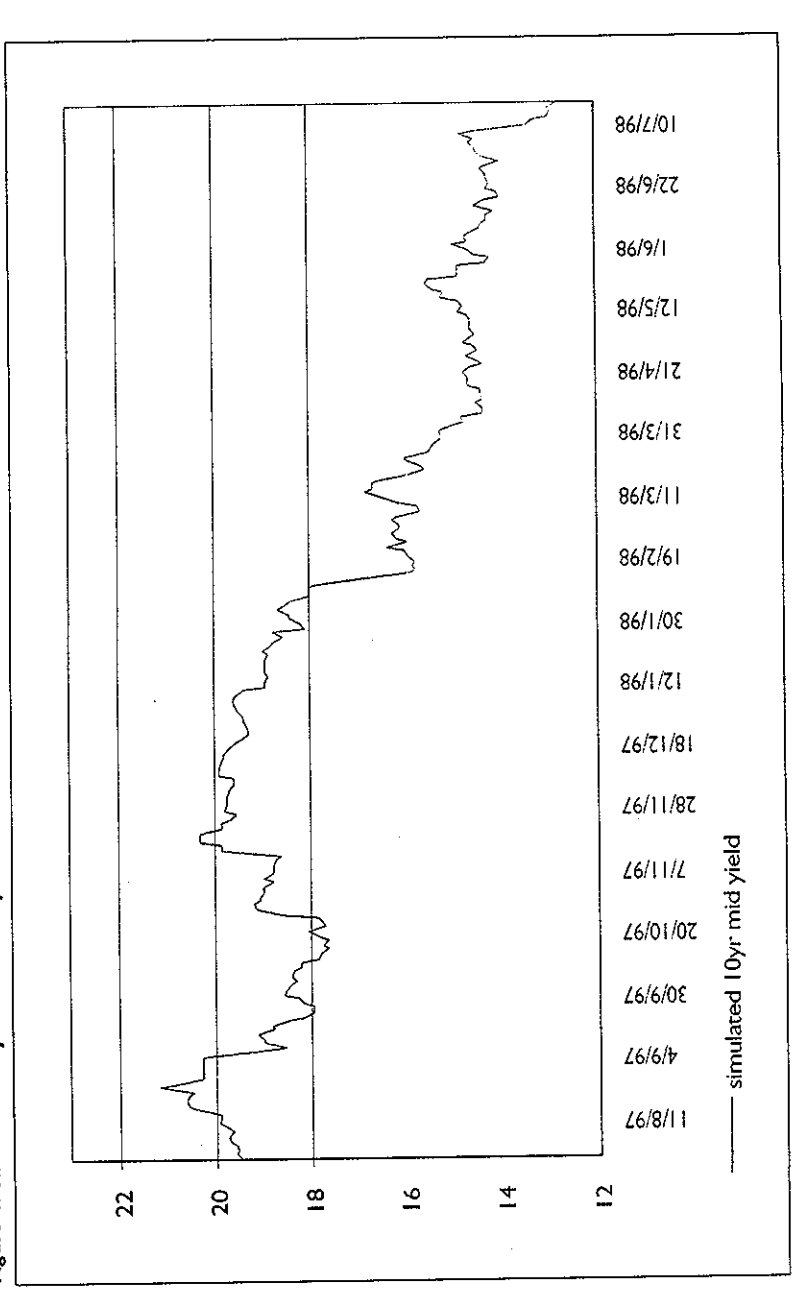


Figure 4. Simulated ten year bond mid yield

Source: ING Barings.

6. Lack of Repo Market, Developmet of Informal buy-sell-back Market

If commercial bank sells T-bills to its client with a certain promised repurchase price and date (so called repo transaction) then such a trasaction is subject to mandatory reserve requirement. Therefore the repo market based on T-bills does not exist. T-bond repo market also cannot develope because compulsory brokerage fee would be caclulated fourfold which would kill the repo rate.

However banks are very inventive. They sell T-bills to corporate clients and informally promise them to repurchase these T-bills at certain rate which is called a "buy-sell-back". But the transaction itself is booked as two separate sell and buy transactions and therefore is not subject to mandatory reserve requirement. However such transaction is based on a gentleman's agreement not on a lawful contract. One could easily picture that if a hypothetical financial crisis hit Poland, prices of T-bill would stone-fall and banks could refuse to repurchase T-bills at previously informally agreed higher prices. If central bank decided to waive the reserve requirement on repo transactions, then the "buy-sell-back" market would vanish overnight. Moreover, treasury paper portfolios at banks active on "buy-seel-back" market are limited as compared to market potential. Therefore if real repo market was launched these banks would seek more securities, and securities lending market would also emerge. Thus banks who were inactive could become a more active player on repo market, demand for T-bills would increase and the yields would decline, which would lead to a lower cost of financing of the public debt.

7. New Foreign Exchange Law Restricts short-term Capital Flows, but Restrictions can be Avoided

Foreign exchange law is a very sensitive issue. According to liberalization calendar agreed between Poland and OECD, Poland should fully liberalize its balance of payments in 1999. However, the recent draft of foreign exchange law does assume severe restrictions on the movement of short-term capital. The World Bank, IMF and OECD have always been advocating for full liberalization of capital flows. However recently after the Asian crisis the voices split. While some, like Lawrence Summers, recommend further liberalization, others, like Andrew Crockett, BIS managing director, favor the introduction of the Tobin tax. Also the hard evidence is not very telling. Rodrik (1998) found no

evidence that countries which liberalized their balance of payments grew faster. It seems that the restricitve mood is prevailing among Polish decidents and the draft of the new law to be implemented early next year will introduce severe restrictions on the mobility of the short-term capital. Namely, non-residents will not be allowed to invest in short-term fixed income instruments (tenors shorter-than one year), will not be allowed to trade currency and interest rate derivatives (such as NDFs, options or FRAs), and money market deposits with tenor shorter than than months. Resident companies will not be able to borrow abroad if a tenor of such loan is shorter than one year. Such restrictions will put a halt to development of derivative financial markets in Poland, which will make hedging of interest rate and exchange rate exposure much more difficult.

At the same time current account will become fully convertible and there will be no restrictions on FDI. One can easily see that it will create possibilities to avoid restrictions. Firstly, loans extended to resident firm by non-resident who owns more than 10% of capital of the resident firm are considered as foreign direct investment and booked as such in the balance of payments statistics. Secondly, the structure of the loan does not matter. If for example the loan is 100, of which 99 is to be repaid in 3 months and 1 in 5 years, the whole loan is considered as a five year loan and with be considered as such until the maturity. Thirdly, with full convertibility of the zloty for current account transactions non-resident may resort to export advances (as was in the case of Chile) to avoid restrictions on short-term investments.

Therefore the restrictions will not be binding, they will create distortions in financial markets and will delay the development of the financial sector.

8. Conclusions

The purpose of this paper was to present some deficiences of financial markets in Poland. One has to acknowledge that development of financial markets in Poland is very rapid and in most cases is strongly supported by decidents. Bond market liquidity improved due to simpler settlement rules, foreign exchange market turnover rose from US$ 300 – 400m in 1997 to well over US$ 1bn in 1998. Commercial paper market will double in size in 1998, but will still represent only some 5 – 6% of total fixed income market capitalization. Fixing mechanism became more market related and volatility clustering triggered by large external shocks can be observed now. On the other hand, foreign exchange law may impose new distortionary restrictions, mandatory reserve requirement on repo transactions stops the repo market development, compulsory brokerage limits liquidity on bond market.

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Section II

The Links Between Polish and International Financial Markets

1. Introduction

This paper examines the degree of international integration of emerging equity markets in Eastern Europe and mature equity markets in industrialised countries. Foreign investors seem to increasingly recognize the chances looming in the East European equity markets. Rising foreign portfolio flows have spurred an investment boom in these markets recently. And it contributed in 1996 to the extraordinary good performance especially of the Russian and the Hungarian stock markets rising more than 140 per cent and 120 per cent in dollar terms, respectively.

Although the equity markets in Eastern Europe are still small compared to the advanced markets in industrial countries, they have strongly increased in terms of market capitalisation in recent years. The rapid growth was also the result of the ongoing and partially accelerating privatisation process. Table 1 indicates that the industrial country markets were more liquid – measured as turnover per listed company – than the other markets. The average size of a listed company on a mature market is also considerably larger than the one on an East European stock exchange. Nevertheless, the equity markets in Eastern Europe provide an important instrument for mobilizing resources and allocating them to productive investments. The liberalisation of the East European financial markets has presumably deepened the integration of their equity markets into the international capital markets. It is therefore important to know if this process is already empirically detectable.

There have been a number of studies assessing the integration among mature stock markets but the analysis of linkages between emerging and mature equity markets has been quite limited (e.g., Cashin and McDermott 1994, Chan and Lai 1993, Chou et al. 1994). Specifically, there have not been any studies which have examined the interdependencies between the ascending equity markets in Eastern Europe and the ones in industrial countries.

The rest of the paper is organized as follows. The next section discusses the cointegration methodology. This is followed in section III by a description of unit root and

stationarity tests which have to be carried out to ensure that the price indices are integrated of the same order. This is a prerequisite for the cointegration analysis, whose basic concept is laid down in section IV. The data are described in section V. Section VI reports the results of both the univariate and multivariate cointegration tests. The main findings are presented in the concluding section.

2. Methodology

The paper uses cointegration methodology, in particular the augmented Dickey-Fuller (1981) and Johansen/Juselius (1990) cointegration tests, to evaluate the extent to which equity prices have tended to move similarly across countries [1]. The former test examines if there is a cointegrating relationship between two variables while the latter procedure allows the number of cointegrating vectors to be determined in a multivariate setting. In addition, the augmented Dickey-Fuller test is also used to determine the order of integration of the variables.

The basic idea of cointegration analysis is to examine whether there exists a long-run relationship among non-stationary time series. Intuitively, if two random walk series have a long-run equilibrium relationship they cannot drift apart indefinitely. Deviations from the equilibrium are stationary and have constant mean if the two variables are cointegrated. Cointegration relationships between price indices would imply that the indices have a strong tendency to move together in the long-run. In such instances, an overperformance in one market relative to another would be followed by an offsetting period of underperformance.

However, prior to testing for cointegration it is necessary to ensure that all time series have the same order of integration. A series is said to be integrated of order d (I(d)) if, the resulting process is stationary after differencing d times. This is done by employing unit root and stationarity tests.

3. Unit Root Tests

The augmented Dickey-Fuller (ADF) test is carried out by estimating the following regression:

[1] Strictly speaking, there is no direct relationship between the time series concept of cointegration and the capital markets concept of integration of financial markets; the latter only requires that assets of similar risk have similar returns even if traded in different markets (Richards 1995).

$$\Delta S_t = \beta_0 + \beta_1 t + \alpha S_{t-1} + \sum_{p=1}^{k} \gamma_p \Delta S_{t-p} + e_t , \qquad (1)$$

where S_t denotes the stock price indices for the various markets, $\Delta S_t = S_t - S_{t-1}$ is the first difference of the time series and e_t are the residuals [2]. The inclusion of lagged difference terms should help avoid autocorrelation in the residuals. The null hypothesis is $\alpha = 0$ which means that if the null cannot be rejected the variable, S_t, is non - (trend)stationary and integrated of order 1, i.e. I(1).

However, inferences with the ADF test are problematic when the series, S_t, contains a significant positive first-order moving average coefficient. Therefore, Kwiatkowski's et al. (1992) suggestion is followed of using tests of the null hypothesis of a unit root in conjunction with a test of the null hypothesis of stationarity. The test suggested by Leybourne/McCabe (1994, hereafter LMC) is used to test the robustness of the results from the ADF test. The LMC test has a stationary null hypothesis against the alternative of a unit root [3]. Although the LMC test also involves choosing a number, p, of autoregressive components to include, the test is quite robust by selecting p.

4. Tests for Cointegration

An approach to testing for cointegration or testing for evidence of a long-run relationship between non-stationary variables is to construct test statistics from the residuals of a cointegration regression. The ADF test is used to test for cointegration.

With two time series of stock market indices, S_i and S_j, each of which is I(1), the following cointegration regression is estimated by ordinary least squares:

$$S_{it} = \beta_0 + \beta_1 t + \beta_2 t + \beta_2 S_{jt} + e_t \qquad (2)$$

where S_{it} and S_{jt} are the series to be tested for cointegration, t is the time trend and e are the residuals. The cointegration residuals, $\hat{e}_t$, are recovered and the ADF test is conducted by running the following regression:

[2] Pretesting justified the inclusion of a constant and a time trend.

[3] The test is similar to the Kwiatkowski et al. (1992) test but the two tests differ in their approach to handling autocorrelation under the null hypothesis.

$$\Delta\hat{e}_t = \alpha_0 \hat{e}_{t-1} + \sum_{p=1}^{k} \Phi_p \Delta\hat{e}_{t-p} + u_t, \qquad (3)$$

where $\hat{e}$ are the estimated residuals, Δ is the difference operator i.e. $\Delta\hat{e}_t = \hat{e}_t - \hat{e}_{t-1}$ and u_t are the residuals.

The null hypothesis is that there is no cointegration among stock prices or formally it is tested if $\alpha_0 = 0$. The ADF statistic is a t-statistic which is associated with the estimated coefficient α_0. The number of lags, p, to be included are determined by examining the residuals, u_t, with a Ljung-Box-Pierce Q(6) statistic. The number of lags is increased until the Q statistic does not reject the null that u_t follows a white noise process.

In addition, the Johansen/Juselius (1990) methodology is used to test for a cointegrating system among the four East European countries (Poland, Czech Republic, Russia, Slovakia). The analysis is expanded by including the Morgan Stanley Capital International (MSCI) world index to test whether the East European market indices are linked by a long-run relationship to a world portfolio.To carry out the Johansen/Juselius cointegration test it is necessary that the univariate series are integrated of the same order. This is already ensured by having used the ADF and LMC tests for unit roots. The lag length for the vector autoregressions is determined by the likelihood ratio test suggested by Sims (1980). The lag length is two. An advantage of the Johansen/Juselius procedure is that it allows the number of cointegrating vectors to be determined empirically.

The Johansen/Juselius test assumes the null hypothesis that an $n \times 1$ vector process $\mathbf{X}_t$ has $r \geq 0$ linear independent cointegrating vectors against the alternative that it has $k > r$ linear independent vectors. Thus if $r = 0$, the procedure tests the null hypothesis of no cointegration against the alternative of cointegration. The trace statitic provides a test of the null hypothesis H_0: $r \leq r_0$ against H_A: $r > r_0$ where r refers to the number of cointegrating vectors. The maximum eigenvalue is a test of H_0: $r = r_0$ against H_A: $r = r_0+1$. Johansen/Juselius suggest that the maximum eigenvalue test has greater power than the trace test. Nevertheless, both tests are used to check for consistency.

5. Data

The study uses end-of-week data of stock market indices for the major stock markets of industrialised countries and indices for the most advanced stock markets of East European countries. The data set includes eleven indices from established stock exchanges in Western industrialised countries and eleven indices from five

emerging East European markets. A description of the indices is given in Table 2. The data were obtained from Datastream and DRI/McGraw-Hill. If Friday data were not available data from the previous trading day were used. At the beginning of the trading activities there were on some East European markets only one trading day per week. The data set for the mature markets spans from the beginning of 1990 to the beginning of 1997 comprising 367 observations. The set for the emerging markets begins at the earliest in 1991:1 (Hungary: 314 observations) and the latest in 1994:26 (Russia, 133 observations) [4]. In order to ensure cross-country comparability of the results, all tests are conducted using indices measured in U.S. dollars. The corresponding exchange rates were obtained from the same sources. All indices are transformed into natural logarithms.

6. Empirical Results

6. 1. Unit Root Tests

The results of the ADF unit root test are presented in Table 3. The null hypotheses of unit roots in stock prices could not be rejected at the 5 per cent significance level for all but one market. The exception being the CAC 40 price index (France) which appears to be trend stationary in levels. In addition, unit roots in the first difference of stock prices (ie the stock returns) are rejected for all indices. Thus, the stock prices are I(1) – except for the CAC 40 Index –, which implies that the stock prices in these markets may follow a random walk such that the prices at time t solely depend on the prices at time $t-1$ plus some random error.

6. 2. Stationarity Tests

Table 4 shows the results of the LMC stationarity test. The null hypotheses of stationarity is rejected at the 5 per cent significance level for fifteen of the nineteen price indices. Moreover, stationarity of the stock returns is rejected for three indices indicating that twelve indices are I(1).

Using two different approaches to determine whether a set of stock prices is integrated of the same order has lead to conflicting results in six cases (SMI, BUX, SAX 12, SIX 50, SIXALL, PX 50). In three cases (BUX, SAX 12, PX 50) the conflict stems from rejecting the null of stationarity when testing the stock returns while in these instances the ADF test also rejects the null of a unit root. This is quite severe as some

[4] Where 1991:1 means that the time series begins in the first week of the year 1990. The other abbreviations should be interpreted in the same manner.

kind of misspecification may be suspected, since at least one of the tests must be suffering from a Type I error (i.e. rejecting a true null hypothesis). While for the other three cases (SMI, SIX 50, SIXALL) neither test rejects the null in levels, which suggests that the data are not sufficient to distinguish between a unit root and stationarity. For further examination only those price indices are considered which are I(1) according to both tests. In cases where two price indices from the same market have proven to be integrated of the same order the longer time series was considered for further examination.

6. 3. Cointegration Tests

The augmented Dickey-Fuller (ADF) cointegration test results are shown in Table 5. Seventeen of the sixty statistics are significant at the 5 per cent level. The Slovakian stock index, SEVIS, shows the most cointegration relationships among the East European stock indices. It is cointegrated with all mature Western stock markets under consideration but not with any of the other East European markets. The only other two markets which are linked to a Western market, namely the Italian (MSI), are the Polish (WIGG) and the Czech (HNW) stock market. Only the Polish market (WIG 20) is linked to the world portfolio approximated by the MSCI. The two Polish indices (WIG 20 and WIGG), do not show any evidence for a cointegrating relationship with each other – although, they basically depict the same market. An explanation for this phenomenon might be that the WIGG – which covers all shares on the main market – is a return index, i.e. capital increases and dividend payments are taken into account when calculating the index. While the WIG 20, which comprises the 20 leading companies on the main market, is a pure price index. However, the two Russian price indices, ASP and ROS are cointegrated with each other, as it could be expected.

The results of the Johansen/Juselius test presented in Table 6 suggest the presence of two cointegrating vectors in the system of four East European markets. Both hypotheses of no cointegrating vector and only one cointegrating vector are rejected while the hypothesis of no more than two vectors is not rejected. Based on the results of the ADF test the rejection might be due to the relationships between the index for Poland and the indices for Slovakia and the Czech Republic. Table 7 shows the results of the Johansen/Juselius test when the MSCI is added to the four East European markets. Again, the test statistics only indicate the presence of two cointegrating vectors suggesting that these two vectors are the same ones as in the previous test excluding the MSCI. Thus, no cointegration relationship could be detected between the four markets and the world portfolio.

7. Concluding Remarks

Stock prices for seven major international and five emerging East European stock markets were examined using unit root and cointegration tests. The analysis provides some evidence that nine of these markets show some cointegration relationships with other markets. The East European stock markets were over the last few years not very closely linked to a world portfolio as represented by the MSCI index, suggesting that domestic factors were predominantly driving these markets.

Another explanation for the relatively weak results may stem from the cointegration analysis itself. Cointegration analysis makes the strong assumption that the parameters are being constant over the whole sample period. Indeed, most of the equity markets experienced at different points in time hikes in their equity prices which did have parallels in the rest of the world. Even if there had been phases of integration they would have gone undetected by applying cointegration analysis for the whole period because of the structural breaks due to the boom periods. Moreover, the power of cointegration tests fall sharply in the presence of unaccounted regime shifts [5]. This calls for a refinement of the analysis. One way to incorporate more flexibility into the analysis is to allow the parameters to vary over time. This can either be done by applying ML estimation using the Kalman Filter or by FLS. However, this is reserved for future research.

[5] See Hall/Psaradakis/Sola (1997), p. 156.

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Appendix

Table 1. Listed Companies, Trading Volume and Market Capitalisation for selected Stock Exchanges in 1996 (in Mio. US dollars)

	No. of listed companies[a]	Trading Volume[b]	Market Capitalisation
Central and East European Emerging Markets			
Czech Republic	1,722	5,445	18,423
Hungary	49	412	3,645
Poland	66	2,777	8,596
Russia[c]			
Slovakia	671	837	6,519
Industrial Markets			
France	738	237,925	583,942
Germany[d]	589	1,329,500	657,790
Italy	326	99,001	245,493
Switzerland	294	345,130	466,065
U. K.	2,596	590,454	1,587,026
U. S.[e]	2,936	3,178,713	6,568.823
Japan[f]	1,782	785,196	3,232,148

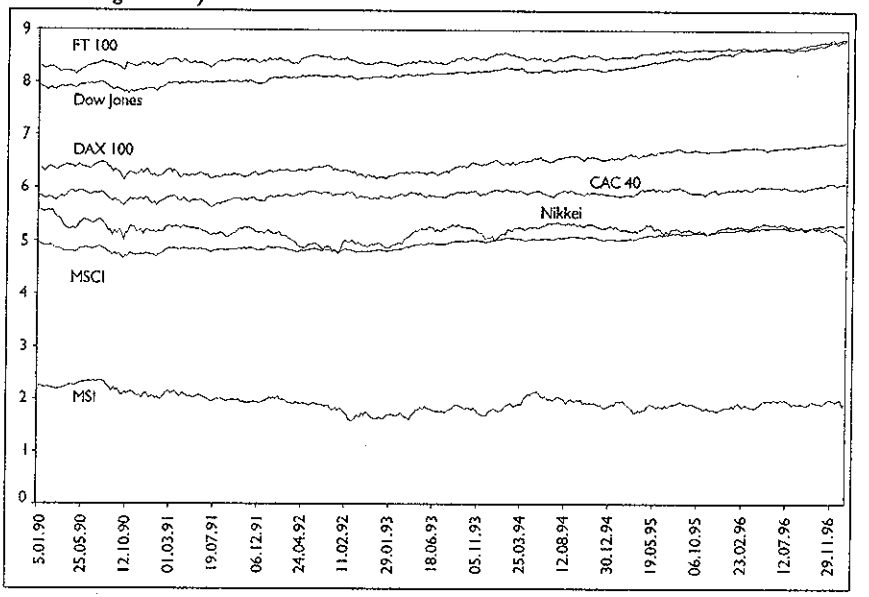
[a] Domestic shares – [b] single counted – [c] MICEX, Moscow – [d] Frankfurt – [e] NYSE, New York – [f] Tokyo.
Source: FIBV, Monthly Bulletin, various issues; Stock Exchanges.

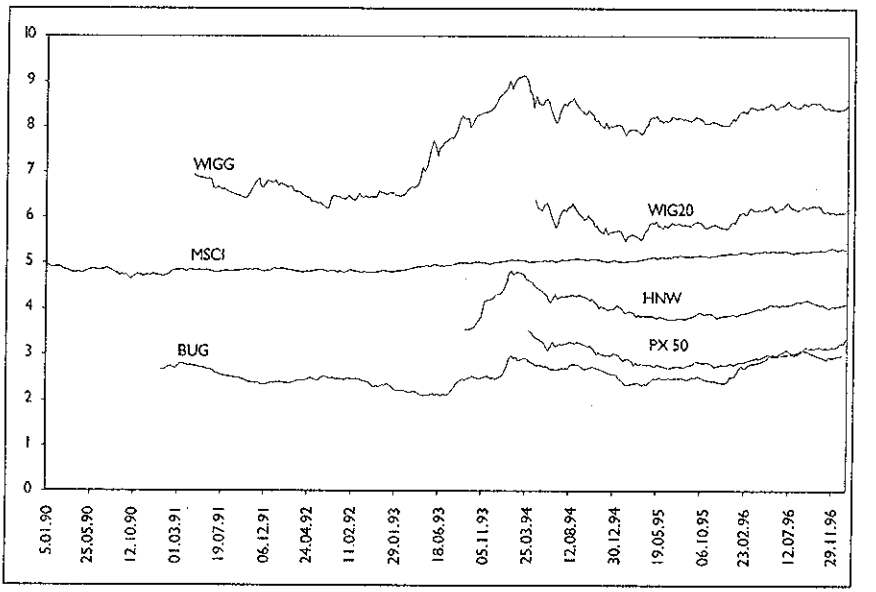
Table 2. Description of the Stock Market Indices

Index		Starting Date[a]	Country
DAX 100	Deutscher Aktien Index 100	1990:1	Germany
FT 100	Financial Times Index 100	1990:1	U.K.
CAC 40	Compagnie des Agents de Change Index 40	1990:1	France
MSI	Milan Stock Index	1990:1	Italy
SMI	Swiss Market Index	1990:1	Switzerland
Dow Jones	Dow Jones Industrial Average	1990:1	U.S.
Nikkei 225	Nikkei Shimbun 225	1990:1	Japan
MSCI	Morgan Stanley Capital International World Index	1990:1	
PX 50	Prague Stock Exchange Index 50	1994:15	Czech Republic
HNW	Hospodarske Noviny Wood Index	1993:37	Czech Republic
SAX 12	Slovensky Akciovy Index 12	1993:38	Slovakia
SEVIS		1993:38	Slovakia
SIX 50		1994:16	Slovakia
SIXALL		1994:16	Slovakia
WIGG	Warszawski Indeks Gieldowy	1991:16	Poland
WIG 20	Warszawski Indeks Gieldowy 20	1994:17	Poland
BUX	Budapest Stock Exchange Index	1991:1	Hungary
ASP	Agency Skate Press Index	1994:26	Russia
ROS	Russian Ordinary Share Index (by CSFB Bank)	1993:49	Russia

[a] 1990:1 means that the time series begins in the first week of the year 1990. The other abbreviations should be interpreted in the same manner.

Graph 1. Price Indices for selected Stock Markets 1990 – 1997 (in US$ and natural logarithms)





Graph 1. Price Indices for selected Stock Markets 1990 – 1997 (in US$ and natural logarithms)

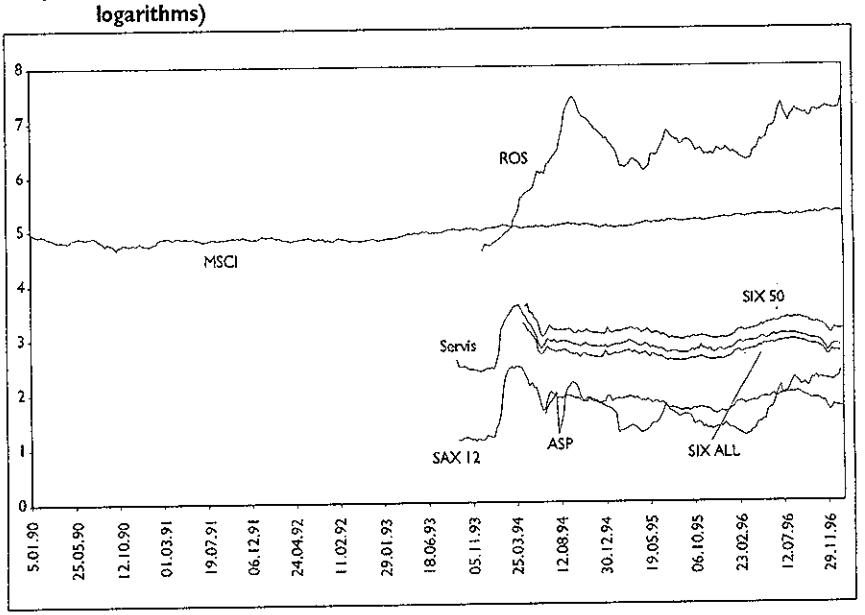


Table 3. Augmented Dickey-Fuller (ADF) Test for a Unit Root

	Level[a]	First Difference[b]
DAX 100	-2.848	-4.536*
FT 100	-1.907	-5.561*
CAC 40	-4.123	-5.171*
MSI	-2.307	-5.385*
SMI	-3.077	-5.323*
Dow Jones	-1.384	-4.812*
Nikkei 225	-2.527	-6.040*
MSCI	-3.170	-5.712*
BUX	-2.334	-3.973*
WIG 20	-2.257	-4.696*
WIGG	-1.918	-4.173*
SAX 12	-1.883	-4.552*
SEVIS	-1.881	-4.072*
SIX 50	-2.362	-4.761*
SIXALL	-2.432	-4.437*
PX 50	-2.363	-4.024*
HNW	-1.734	-4.368*
ASP	-2.362	-4.099*
ROS	-1.816	-5.623*

[a] The column contains the t-statistics for the parameter a in equation (1).

[b] The column contains the t-statistics for the parameter a when first differences are used in equation (1).

* Significant at 5% level. Critical values are taken Dickey/Fuller (1981).

Table 4. Leybourne/McCabe (LMC) Test for Stationarity

	Level	First Difference
DAX 100	7.350*	0.046
FT 100	1.714*	0.049
CAC 40	0.058	0.022
MSI	1.550*	0.037
SMI	0.042	0.072
Dow Jones	26.130*	0.052
Nikkei 225	46.710*	0.069
MSCI	1.056*	0.033
BUX	8.890*	0.756**
WIG 20	4.840*	0.034
WIGG	2.460*	0.110
SAX 12	15.500*	0.937**
SEVIS	84.550*	0.061
SIX 50	0.076	0.088
SIXALL	0.110	0.034
PX 50	97.350*	0.786**
HNW	4.070*	0.092
ASP	0.980*	0.047
ROS	0.820*	0.124

* Significant at 5% level (critical value 0.463).
** Significant at 5% level (critical value 0.146).

Table 5. Augmented Dickey-Fuller (ADF) Cointegration Tests of weekly Stock Price Indices in US-Dollar

	DAX 100	FT 100	MSI	Dow Jones	Nikkei 225	MSCI	WIG 20	WIGG	SEVIS	HNW	ASP	ROS
DAX 100	-											
FT 100	-2.744	-										
MSI	-4.017	-2.616	-									
Dow Jones	-1.582	-3.045	-2.589	-								
Nikkei 225	-2.948	-3.003	-3.895	-2.752	-							
MSCI	-4.109	-3.668	-4.586	-3.616	-1.674	-						
WIG 20	-2.356	-2.504	-3.931	-2.670	-2.820	-3.560	-					
WIGG	-1.459	-1.813	-1.594	-2.119	-2.067	-1.475	-1.779	-				
SEVIS	-3.784	-3.834	-3.668	-3.873	-3.861	-3.314	-2.986	-4.163	-			
HNW	-2.970	-3.016	-3.684	-3.167	-2.836	-3.239	-2.727	-3.923	-2.815	-		
ASP	-1.696	-1.944	-2.323	-1.824	-1.594	-1.679	-2.010	-2.188	-1.724	-2.561	-	
ROS	-2.315	-2.074	-2.283	-2.259	-1.494	-2.358	-2.569	-2.378	-2.305	-2.288	-4.673	-

Indicates significance at 5% level. Critical values are taken from Davidson/MacKinnon (1993).

Table 6. Test of Cointegration among the Central and East European Stock Markets

Trace			Maximal eigenvalue		
H_0	Test Statistic	Critical value	H_0	Test Statistic	Critical value
$r \leq 0$	74.83*	47.21	$r = 0$	39.87*	27.07
$r \leq 1$	34.96*	29.68	$r = 1$	21.28*	20.97
$r \leq 2$	13.68	15.41	$r = 2$	13.49	14.07
$r \leq 3$	0.19	3.76	$r = 3$	0.19	3.76

* Significant at 5% level. Critical values are taken from Osterwald-Lenum (1992), Table 2, n=4.

Table 7. Test of Cointegration between the Central and East European Stock Markets and the World Index

Trace			Maximal eigenvalue		
H_0	Test Statistic	Critical value	H_0	Test Statistic	Critical value
$r \leq 0$	106.84*	68.52	$r = 0$	44.65*	33.46
$r \leq 1$	62.18*	47.21	$r = 1$	34.16*	27.07
$r \leq 2$	28.02	29.68	$r = 2$	16.26	20.97
$r \leq 3$	11.76	15.41	$r = 3$	6.42	14.07
$r \leq 4$	2.34	3.76	$r = 4$	2.34	3.76

* Significant at 5% level. Critical values are taken from Osterwald-Lenum (1992), Table 2, n = 5.

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