

# **The Extent of Efficiency in Central European Equity Markets**

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## **Abstract:**

This paper investigates the possibility that the newly emerging equity markets in Central Europe exhibit a degree of efficiency similar to that which prevails in more developed markets. The different privatization strategies adopted by the various countries in the region are shown to have created equity markets of vastly different sizes, with the largest market, that in the Czech Republic, being similar in coverage to many in Western Europe. Disclosure requirements appear to be sufficient for efficiency although there are differences across countries in whether these requirements are based in law or depend on voluntary action, as well as the extent to which they are enforced. Both distribution based and distribution-free tests do not reject the hypothesis that equity market returns are random walks in the four Visegrad countries. This finding is consistent with these markets being weak-form efficient. The paper concludes with a discussion of ways in which other forms of efficiency could be tested for these markets.

## **Abstrakt:**

Článek se zabývá otázkou, zda-li nově vzniklé finanční trhy ve střední Evropě mohou vykazovat podobný stupeň eficiency jako pozorujeme na rozvinutých trzích. Rozdílné privatizační metody aplikované v tomto regionu vztvořily, co do velikosti, velmi rozdílné finanční trhy; český trh je největší z nich a proporcionálně odpovídá finančním trhům v západní Evropě. Požadavky na informace o finanční situaci podniků se ukazují jako dostatečné pro eficiency těchto trhů, nicméně zde existuje řada rozdílů mezi jednotlivými zeměmi, a to jak v (zákonných) požadavcích, tak i v různých sankcích. Parametrické i neparametrické testy nezamítají hypotézu, že se výnosy na finančních trzích Visegrádské skupiny chovají jako náhodná procházka. Tento fakt je konzistentní s hypotézou slabé eficiency těchto trhů. V závěru jsou uvedeny další metody pro testování této hypotézy.

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## D) INTRODUCTION

Perhaps one of the most controversial issues in modern economics is the extent of efficiency in capital markets. Dozens of papers each year address some aspect of this debate. In general three forms of market efficiency are discussed. Each asserts that it is impossible to make predictable excess returns beyond the level justified by a security's riskiness on the basis of a particular information set. The difference between them lies in the information sets that prices are asserted to reflect.

- (1) A market is *weakly efficient* if prices fully reflect all information contained in historic price series. Such efficiency implies that stocks follow a random walk and that it is, therefore, impossible to earn excess returns by using information in the pattern of stock prices, a technique known as technical analysis.
- (2) A market is *semi-strongly efficient* if security prices fully reflect all publicly available information that might influence the value of a given company. This form of efficiency implies that fundamental analysis of a firm's situation and the economy in general will not enable an investor to earn excess returns.
- (3) Finally, a market is *strongly efficient* if all information that is known to *any* investor, including insiders, is reflected in security prices. This implies that there is no way any market participant can predictably make excess returns.

Although there is a great deal of controversy as to whether securities markets exhibit each of these forms of efficiency, a consensus seems to be emerging that while temporary pricing anomalies may exist, in the end "one has to be impressed with the substantial volume of evidence suggesting that stock prices display a remarkable degree of efficiency (Malkiel (1996) p. 222)."

A number of studies in recent years have investigated the efficiency of emerging equity

markets, primarily in Asia and Latin America. Among these are Claessens, Dasgupta and Glan (1995), Cornelius (1995), Harvey (1995), Urrutia (1995), Zychowicz, Binbasioglu and Kazancioglu (1995), Agbeyegbe (1994), Agrawal and Tandon (1994), Ajayi and Meyhdian (1994), Annuar, Ariff and Shamsheer (1994), Ayada and Pyun (1994), and Stengos and Panas (1993). Although the results of these studies can best be characterized as mixed, they find a surprising amount of evidence that emerging markets are approximately as efficient as those in developed countries such as the U.S. Claessens, Dasgupta and Glan, for example, find that "stock price behavior in the twenty stock markets represented in the International Finance Corporation's Emerging Markets Data Base displays few of the anomalies found for industrial economies,"<sup>1</sup> while Urrutia concludes that investors in Latin American markets would "not be able to detect patterns in stock prices and develop trading strategies that would allow them to earn abnormal returns." In general, the strongest evidence against efficiency in emerging markets is the presence of autocorrelation in returns, a phenomenon that some have suggested is an "indicator of economic growth rather than evidence against the efficient market hypothesis."<sup>2</sup>

The past half decade has seen one of the most extraordinary changes in economic systems ever recorded. Commonly called the transition, the shift from command to market economies in Central and Eastern Europe including the Former Soviet Union has radically altered the lives of nearly 10% of the world's population. A major component of this transition has been the rapid privatization of formerly state assets. By the end of 1995 between two-thirds and three-quarters of economic output in the Visegrad countries (Poland, the Czech Republic, Slovakia and Hungary) was produced in the private sector, an increase from virtually nothing in 1989..

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<sup>1</sup>Claessens, Dasgupta and Glan (1995) p. 150.

<sup>2</sup>Urrutia (1995) p. 308.

A natural question is the extent to which the equity markets of Central Europe have achieved a degree of efficiency comparable to markets in developed countries or emerging markets with much longer histories. Efficient markets may play an important role in the success of the transition. There are obvious advantages to efficient markets, especially of the strong form. The transition economies need large amounts of capital for restructuring. Banks are weak and undercapitalized and will have, therefore, limited ability to finance investment activity. Many firms are not yet profitable enough to finance necessary restructuring through retained earnings. This situation suggests that there must be a great deal of reliance on equity finance. Investors who have confidence that markets can not be manipulated by insiders will be more willing to invest in such markets, thereby lowering the cost of capital. Similarly, especially in countries such as the Czech Republic where large-scale distribution of shares has played a major role in privatization, public support for the transition is likely to be a function of public perception of the fairness of the market in which they must dispose of their shares when they want cash. Thus, a finding of significant deviations from efficiency would be troubling for the transition process.

There are, however, other reasons why efficient markets may actually hamper the transition to a market economy in Central Europe. One of the biggest problems in the region is the need for effective mechanisms of corporate control. This may be especially important in countries such as the Czech Republic where voucher privatization has created a large number of dispersed owners. Without mechanisms for corporate control, privatization may fail because insiders from the former regime can strip firms of their valuable assets or otherwise hamper evolution to a market economy. Left unchecked, insiders in a firm (workers and managers) will tend to operate the firm for their private benefit, ignoring the owners' interests. Thus, such firms may pay excessive wages and salaries, sell assets to managers at below market prices, or sign "sweetheart deals" with insiders or their relatives for materials and services at above-market

prices<sup>3</sup>. Diffuse individual owners, each with only a small stake in the firm, cannot effectively monitor and control such practices. Large holders such as mutual funds, on the other hand, have both the power and the incentive to oversee managers. Thus, the evolution of mutual funds that can exercise corporate control is typically regarded as one of the success stories of Czech privatization and is a component in many countries' privatization plans.

Mutual funds can only exist, however, if they charge their shareholders a fee to cover operating costs. If markets are strongly efficient, so that the return available from funds is no greater than that available through individual investing, there is no reason for an individual investor to join a fund. This would necessitate paying a management fee for no added return. Even though investors as a whole would be better off with effective corporate control, there is a classic prisoners' dilemma problem with each individual investor seeing that he or she would be better off outside the fund, no matter what other investors opted to do. Thus, few investors could be expected to join funds. This behavior implies that the more efficient the capital market, the more important it is for alternative institutions of effective corporate governance to develop in transition economies.

Thus, the issue of the extent to which equity markets in Central Europe are or are not classically efficient is not only of intellectual interest since these markets may play a critical role in the future development of the region. This essay first discusses the extent to which the structure and operation of Central European equity markets approximates the conditions required for efficiency. It then reports results of the some initial tests of various forms of market

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<sup>3</sup>Another problem comes from the fact that the government retains a significant stake in many "privatized" firms. Without countervailing large stakeholders, the shares retained by the governments (typically in the privatization agencies or national property funds) become a controlling interest that may be used to direct firm behavior in the interest of the government rather than the firm's owners. There are several instances in the Czech Republic where the Fund for National Property has used its influence to force supposedly private firms to invest in potentially failing firms at above market prices in order to enable the government to avoid having to rescue these firms from the public purse.

efficiency and suggests future approaches for evaluating other types of efficiency. Finally, it concludes with a discussion of the extent of efficiency in the artificial closed equity market created by the Czech voucher privatization process. The efficiency of this artificial market is of more than theoretical interest since other countries such as Romania, Bulgaria and Ukraine are in the process of implementing similar privatization mechanisms.

## II) INSTITUTIONAL MARKET STRUCTURE

For markets to be efficient, it is widely assumed that they must possess certain fundamental characteristics. In particular:

- (1) there must be a reasonably large number of profit-seeking investors who actively participate in the market; and
- (2) information must be freely available to all participants at approximately the same time.<sup>4</sup>

In short, markets are likely to exhibit a reasonable degree of efficiency if there is active trading, disclosure of relevant information, and prohibitions on taking advantage of inside information. To what extent do Central European equity markets exhibit these characteristics?

Table 1 gives an indication of the extent of and degree of liquidity in Central European markets at the end of 1995 compared with other emerging markets and markets in Western Europe. Figure 1 presents one aspect of market extent, the ratio of market capitalization to GDP for selected countries for 1995 as well as for the Central European markets for the three years from 1993 to 1995. Several things stand out in this table and figure. The first is that the choice of free distribution of vouchers as the primary mechanism of privatization in the Czech Republic has resulted in a vastly different capital market than prevails in other Central European countries,

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<sup>4</sup>Note that this can be achieved either if there is no inside information (an unlikely occurrence) or if trading on the basis of inside information is effectively prohibited.

where direct sales of enterprises played a much larger role.<sup>5</sup> At the end of 1995 over 1,600 firms were traded on the Czech equity market as opposed to 42 firms in Hungary and 65 in Poland.<sup>6</sup> The aggregate value of these firms (market capitalization) amounted to 35% of GDP in the Czech Republic but only 6% of GDP in Hungary and 4% in Poland.

The Czech ratio of market capitalization to GDP is similar to that in many Western European countries and significantly higher than in southern members of the European Union.<sup>7</sup> On the other hand, it lags behind the “Asian tiger” economies as well as Chile in Latin America where the shift to private, fully-funded pensions has created an equity boom over the past decade. It is interesting to speculate whether this difference in market capitalization per dollar of current GDP represents a speculative bubble in the emerging markets or an appropriate valuation of future growth rates in these largely unregulated and low-tax economies compared to the slow-growth environment of the European Union. Assuming that a similar share of GDP is produced by traded firms in each country,<sup>8</sup> the implication is that the Czech Republic has perhaps been too successful in achieving its desire to resemble the EU. The market may be judging, therefore, that its growth rate is more likely to resemble the stagnant European environment than the dynamic Asian one.

In addition to its relatively large size, there is also a good deal of trading activity in the

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<sup>5</sup>Slovakia represents an intermediate case, paralleling the Czech use of vouchers prior to the splitting of the former Czechoslovakia on January 1, 1993 but relying on direct sales (often to politically connected insiders) since then.

<sup>6</sup>The number of traded companies in the Czech Republic was greater than in any developed economy except Japan, the U.K. and the U.S.

<sup>7</sup>Comparable figures were 17% in Austria, 28% in Germany, 39% in France and Denmark and 45% in Belgium. Among southern EU members market capitalization was 20% of GDP in Portugal, 21% in Greece and Italy, and 37% in Spain. The U.S. is exceptional in the value of its equity markets, with total market capitalization exceeding GDP, a feature it shares with only the United Kingdom and the Netherlands among developed economies.

<sup>8</sup>Something we have tried, but so far have been unable, to verify.

Czech equity market, with turnover ratios similar to those in much of the world. Although turnover ratios are higher than average in Poland and Slovakia, this ratio must be evaluated in light of the very small markets in these countries. Apparently the Czech Republic has done a better job than other Visegrad countries in achieving the first precondition for market efficiency, the existence of an active market with many participants. The interesting question is whether this difference in structure translates into a difference in performance as well.

Before addressing this issue we turn to a discussion of the second important condition for market efficiency, the prompt and public disclosure of relevant information. There is a great deal of debate in the academic literature regarding whether mandatory disclosure requirements are needed in order to overcome incentives by firms to be overly restrictive in releasing information for strategic competitive reasons (see Dye (1990) and Demski and Feltham (1994)) or whether firms have sufficient incentives to voluntarily provide the optimal amount of disclosure so that regulations would at best be irrelevant and at worst interfere with optimal contracting and impose costly burdens on financial markets (see Bentsen (1973), Leftwich (1980), and Phillips and Zecher (1981)). The Visegrad countries have divided sharply regarding which side of this debate has guided their policies. In Poland, disclosure requirements are derived from an order of the Council of Ministers (cabinet) and apply to all publicly traded shares in manner similar to that in the U.S. In the Czech Republic and Hungary, on the other hand, legally required disclosure is minimal. Instead, the stock exchanges have issued requirements for firms desiring to be listed for trading in the main-market.<sup>9</sup>

In each country there is also a so-called “free” or “parallel” market where firms may trade without meeting the disclosure requirements for listed firms. Recently there have been

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<sup>9</sup>Interestingly, these regulations were issued by the Stock Exchange Chamber in the Czech Republic and the Stock Exchange Council in Hungary. In each country, therefore, regulations may carry some hidden prima facie weight because they were issued by the “S.E.C”. a set of initials that may register in investors’ subconscious. We have no indication regarding whether the choice of names yielding these initials was deliberate.



proposals in these countries to create securities commissions with the power to extend disclosure requirements to all firms. In the meantime, the stock exchange in the Czech Republic has announced its intention to extend disclosure requirements by creating a formal secondary market (with slightly less restrictive disclosure requirements, mainly in that firms must file reports semi-annually rather than quarterly) and over time eliminate trading in the free market with no disclosure requirements in an attempt to persuade firms to shift to the primary or secondary markets.<sup>10</sup> By mid-1996 75% of market capitalization and 71% of trading volume in the Czech Republic were in stocks where extensive disclosure requirements applied. The coverage of these requirements is indicated in Appendix I, which reproduces selected sections of the December 1995 “Requirements for Admission of a Security to Trading at the Prague Stock Exchange.” Requirements for listing in Hungary and Slovakia and for all firms in Poland are similar. Thus, for listed firms at least, disclosure rules seem to be as extensive as those in the U.S. (and probably more comprehensive than in most of Western Europe). They would appear to be sufficient to promote market efficiency provided that these rules are enforced.

In Central Europe, however, we must always ask if rules as written are followed in practice. There is at least some evidence that regulations that appear to offer sufficient requirements for timely disclosure are not adhered to. In particular, firms assembling blocks of shares for the purpose of taking control of a firm have reportedly decided that shares bought by wholly owned subsidiaries do not count towards the requirement that intentions must be announced once a certain number of shares have been purchased on the grounds that these shares are owned by independent legal entities.

It is also clear that no market can be strongly efficient without effective prohibitions on insider trading. Once again, the Visegrad countries have adopted rules against insider trading

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<sup>10</sup>It remains to be seen, however, how effective this procedure will be or when, if ever, firms will actually be delisted.

that mirror those in more developed markets although once again these often rely more on the stock exchange for application of sanctions than national law enforcement agencies. The regulations of the Prague Stock Exchange, for example, state that:

Any person who, due to his/her job, profession, position, and/or function, is authorized to acquire a confidential information on economic and/or financial position of an issuer and/or other facts important for the development of either the financial market and/or prices of securities is neither allowed to conclude trades in these securities nor to exploit his/her information for his/her own benefit or benefits of other persons until this information becomes generally public.

The sanctions the exchange can impose, however, are limited. Maximum fines are about \$2,000. The most serious sanction involves a prohibition against future trading on the exchange. Once again, the face validity of the sanctions would be greater if they were codified in criminal law and applied by the public authorities. Here again Poland has far more stringent rules than the other countries, with the law providing for between 6 months and 5 years imprisonment for anyone “who uses insider information while trading in securities,” where insider information is defined as any “information which has not been made public but which after publication could substantially influence the value or the price of a security.”

In summary, the extent of the Czech stock market seems to be the most conducive to market efficiency, but the institutional structure of the Polish market contains more extensive disclosure requirements and prohibitions against insider trading. It is clear, however, that there are numerous reasons why these markets may fall short of efficiency, implying that no conclusion can be reached regarding which, if any, of them approximate the degree of efficiency found in the West without empirical tests. In the only published work on efficiency in Visegrad stock markets to date, Gorden and Rittenberg (1995) show that limit trading rules (which suspend trading when a share price rises or falls by a given amount in a single session) create positive serial correlation in daily returns among Polish stocks, with the mean price change on days following coming near the upper limit of plus 10% being 3.32% as opposed to a 0.43%

change on other days. This is not a surprising result and is likely to exist in all the markets in the area since they all have similar limit move rules. This type of serial correlation does not, however, necessarily represent market inefficiency since it may not be possible to earn excess returns by following a trading strategy based on buying stocks that hit the upper movement limit. Suppose that all such stocks simply opened at a significantly higher price the following day so that buy orders entered at the end of day one were executed **after** the full move on day two. Obviously, in this case serial correlation in daily returns would not enable an investor to earn excess returns.

### III) TESTS OF WEAK-FORM EFFICIENCY

As discussed above, weak-form efficiency implies that stock prices should follow a random walk. One common way of testing whether this is the case is by examining variance ratios (Lo and MacKinlay (1988)). This test is based on the fact that if the natural logarithm of a time series is a pure random walk, then the variance of its  $q$ -differences will increase in direct proportion to the length of the difference  $q$ . The variance ratio is defined as:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)}$$

where  $\sigma^2(q)$  is  $1/q$  times the variance of the  $q$ -differences and  $\sigma^2(1)$  is the variance of the first-differences.<sup>11</sup> Standard normal test statistics are provided by Liu and He (1991) under both homoskedasticity and heteroskedasticity.<sup>12</sup> Table 2 presents the results of variance ratio tests of

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<sup>11</sup>Formulae for calculating  $\sigma^2(q)$  and  $\sigma^2(1)$  were taken from Lo and MacKinlay (1988) and are not reproduced here. Note that since these are the differences in log prices the test is one of whether returns (not prices) are predictable or follow a random walk.

<sup>12</sup>Again the reader is referred to the original source for the exact form of the test statistics. Both produce a z-score that is distributed  $N(0,1)$ .

the hypothesis that securities prices follow a random walk in each of the Visegrad countries. In each case the test was performed on monthly returns of the main index for each country<sup>13</sup> from the date the index was first calculated to July, 1996.<sup>14</sup> As can be seen in Table 2, the pattern of statistical significance is mixed under the assumption of homoskedasticity if we consider each lag length independently. Technically, rejection of a variance ratio equal to one for any lag length is sufficient to reject the random walk hypothesis. However, given that multiple tests are being performed the appropriate significance level is not given by reference to the standard normal tables (see Chow and Denning (1993) and zzzz). Thus, the final row in the table reports the maximum z score across all lag lengths examined along with an indication of statistical significance using appropriate Studentized Maximum Modulus (SMM) confidence intervals (see Stolin and Ury (1979)). Although we are frequently unable to reject the random walk hypothesis, in all cases the actual variance ratios are greater than one. We must ask, therefore, if the results found are due to positive autocorrelation in returns or heteroskedasticity where if we model the returns in any of the Central European markets as a mean value plus a random "error" term, the magnitude of the random term is growing over time. This would not be a surprising finding in a world where markets are developing rapidly. Both volume and frequency of trading has been increasing in each of the markets under study, with all markets moving from trading one or two days a week with a single price fixing per day to daily trading with continuous pricing. It is to be expected that the more fully functioning markets might exhibit more price movement per unit of time. In addition there have been frequent non-regular "interventions" into the equity markets in the region by the local agencies charged with

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<sup>13</sup>The PX-50 for the Czech Republic, BUX for Hungary, WIG for Poland and SAX for Slovakia.

<sup>14</sup>We report results for  $q=3, 6, 9$  and  $12$ . We have also performed the test for the intervening lag periods with no change in the pattern of results. Complete results are available from the authors on request.

privatizing former state enterprises, typically in the form of selling blocks of shares in these enterprises on the secondary market as a part of the privatization process. These features suggest that heteroskedasticity may be characteristic of returns in Central European markets. Indeed, once heteroskedasticity is allowed, in no country do we reject the hypothesis that variance ratios are equal to one, suggesting that returns in Central European equity markets follow a random walk.

Although the literature testing for random walks often uses monthly data, as we did in Table 2, there is generally a longer time period over which to test the hypothesis than is available in Central Europe where we have at most three and a half years of data. Table 3 reports the results of repeating the analysis using weekly returns for differences in  $q$  of one month, two months, three months and six months. With the larger sample size the results are unambiguous. If we did not allow for heteroskedasticity, the random walk hypothesis would have been rejected for every country for every time difference. Once heteroskedasticity is allowed for, however, we are never able to reject the random walk hypothesis.

One potential problem with variance ratio tests of the random walk hypothesis is that they rely on an assumption of normality in the random component of returns. Table 4 presents the first four moments of the distribution of returns for each Central European market. Since the distribution of returns consisting of a constant term plus a normally distributed random component will also be normal, rejection of normality for the distribution of returns indicates that variance ratio tests may be inappropriate for this data. As can be seen in Table 4, with the possible exception of Poland, the assumption of normality in returns is rejected for every country. The pattern of positive skewness and kurtosis indicates that returns are more flattened to the right and more highly peaked than would be the case if they were normally distributed. An alternative, distribution-free test for the independence of successive returns relies on the number of runs (Levene (1952)), where a run is defined as a sequence of consecutive changes

in returns in the same direction. We report the results of such a test in Table 5. In general there are fewer runs in returns than would be expected if returns followed a random walk (e.g. were not predictable based on prior returns), indicating some persistence in returns. However, only in the case of monthly returns in Slovakia is this difference statistically significant at the 5% level. Thus, once again, the preliminary evidence is that equity markets in Central Europe are close to being weak-form efficient. Our results for monthly returns are similar to those reported for emerging markets in Latin America (Urrutia (1995)) and Turkey (Zychowicz et. al. (1995)). Interestingly, we also find Central European equity markets weak-form efficient using weekly data, an hypothesis rejected by Zychowicz et. al. for Turkey.

#### **IV) TESTS OF SEMI-STRONG AND STRONG-FORM MARKET EFFICIENCY**

Semi-strong efficiency requires that no public information be useful in predicting the future course of stock prices. In other work (Hanousek and Filer (1996)) we have found that lagged values of neither monetary nor fiscal policy variables are significantly related to overall market indices in the Central European markets. Thus, basing investment decisions on government policies would not provide excess returns, a finding consistent with semi-strong market efficiency.<sup>15</sup> For three of the four countries in the region, however, (the Czech Republic, Hungary and Slovakia) we found that the trade deficit did Granger-cause stock index levels. Why this should be so is unclear since trade balances are widely known and followed in the region. Whether the link flows through capital account surpluses that offset trade deficits or through changes in the exchange rate, it appears that domestic investors in Central Europe could profit from following trading strategies based on trade figures. If so, this represents a substantial

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<sup>15</sup>Note that the overall state of the economy will affect stock prices. Obviously there is strong influence between monetary and fiscal policy and market value. This relationship is, however, contemporaneous so that a change in money supply in a given period is immediately reflected in stock prices in that period.

departure from efficiency.<sup>16</sup>

Other tests of semi-strong efficiency are possible for all of the markets under study but have not been carried out yet. By the summer of 1997 many of the securities involved in the first wave of Czech voucher privatization will have been traded for up to 48 months (208 weeks), with trading for firms in the second wave having taken place for over 112 weeks.<sup>17</sup> Although considerably smaller than the Prague Stock Exchange, the exchanges in Budapest and Warsaw have been in operation for a longer period (since 1990 and 1991 respectively). Thus there will soon be sufficient observations to calculate betas for all publicly-traded firms<sup>18</sup>, enabling the investigation of whether returns are related to factors such as capitalization or price/earnings ratios after accounting for conventional measures of risk. Similarly, trading anomalies such as day-of-the-week effects should begin to be visible in series of this length if they are characteristic of these markets.<sup>19</sup>

Tests of strong-form market efficiency are more problematic. By definition, it is impossible for the researcher to observe inside information. Thus, tests of this form of efficiency have typically relied on comparing the performance of those who might be supposed to have inside information with that of other investors. The most widespread form of such a study asks whether professionally managed mutual funds are able to outperform random

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<sup>16</sup>In no case did we find a causal relationship going the other way such that equity prices predicted macroeconomic variables. Thus it is clear that these markets are not efficient enough to rationally anticipate future policies or economic developments. This finding is not surprising given the number and magnitude of the external shocks markets in these countries have faced as they have evolved towards a market economy over the past five years.

<sup>18</sup>Low liquidity for some issues means that analysis of daily returns may be problematic in the Central European context. Estimation of betas will have to adjust for biases introduced by the failure of some securities to trade in a given interval. Techniques for such adjustments are well established (see, for example, Bartholdy and Riding (1994)).

<sup>19</sup>End-of-the-year effects will obviously be more problematic to detect with only three or four years of observations.

investment strategies. Of course, this leaves open the question of whether such funds actually have access to inside information rather than simply having an incentive to hire the best analysts of public information.

Unfortunately, the limited number of mutual funds in most Central European countries will make such traditional tests impossible for countries other than the Czech Republic, where the special situation created by voucher privatization makes such tests practical. In fact, one of the most significant features of Czech voucher privatization was the role of mutual funds, known as Investment Privatization Funds (IPFs). Before the bidding process started, each voucher holder had the option of assigning all or part of his points to one or more of these funds. About three-quarters of citizens eligible to participate in voucher privatization did so, with approximately 72 percent of voucher points being placed with one of 264 IPFs, while 28 percent were retained by individuals. There was substantial concentration among the IPFs, with over 56 percent of their points controlled by the largest 13 funds. Behavior in the second wave was similar, with about the same fraction of those eligible participating but somewhat fewer (63.5 percent) points being assigned to one of the 354 investment funds.

In terms of tests of strong-form efficiency, one additional aspect of the structure of these funds is important. They were created and operated by a wide variety of entities including foreign banks and investment firms, local banks, and individuals. Given the concentration of banking in the Czech Republic and the interlocking relationship created by prior lending patterns, it is logical to assume that funds managed by local banks would have greater access to inside information than those managed by outsiders. Thus, a finding of no difference in the performance of these two types of funds would be suggestive of strong-form efficiency.

## **V) THE EFFICIENCY OF CZECH VOUCHER PRIVATIZATION**

Although it is still very early in their development, the results discussed above at least



suggest that the emerging equity markets in Central Europe may exhibit a remarkably high degree of efficiency equivalent to the level that prevails in more developed markets. The implication is that efficiency can emerge quickly in new markets. Perhaps the best test of the speed at which a *de nova* market can reach reasonable levels of efficiency is the artificial bidding market involved in the Czech voucher privatization process. The first wave of voucher privatization took place in five bidding rounds while the second had six rounds. Prices in the first round were the same for all stocks (since the number of shares issued was determined by a firm's book value). In each successive round prices were adjusted up or down as a function of the excess demand for or supply of the stock in the previous round.<sup>20</sup> We are in the process of conducting several related inquiries into the workings of the voucher process. The first investigates the relative performance of professional investors (i.e. mutual fund managers), individual investors, and a naïve random strategy based on simply bidding for a representative portfolio of all available shares. Since the constructed prices in the first rounds of the bidding process are unlikely to capture the true value of the firms up for auction, we would expect to find that a random buying strategy should not perform as well as conscious investment choices in the early phase of each wave. The interesting question for these rounds is whether or not professional investors, on average, do better in picking stocks (as reflected by their eventual market value) than individuals. A finding that they did would support the assertion that elites may be in a position to profit from inside information or other positional advantages.

We do find such a pattern (Filer and Hanousek (1996)). In the first wave of voucher privatization the average market value per voucher point<sup>21</sup> of shares bought in the first three

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<sup>20</sup>See Svejnar and Singer (1994) and Hlavsa (1996).

<sup>21</sup>We calculate market value as the traded price on the Prague Stock Exchange several weeks after shares opened for trading since initial prices were determined by the final voucher price, which may not be reflective of true value. Results are insensitive to the exact time at which values are determined and hold even several months later when many new investors had entered  
(continued...)

rounds by individual investors was only 76 percent of the value of shares bought by mutual funds. In the second wave, the performance of individuals improved somewhat, with the average value per point of shares they bought in the first three rounds being equal to 85 percent of the value of shares bought by funds. By way of contrast, a random selection of stocks<sup>22</sup> would have bought shares worth 75 percent of what funds purchased per point in the first three rounds of the first wave and 66 percent of the value of funds' purchases in the first three rounds of the second wave. Thus, individuals acted as if they had no information at all in the first wave but performed with a fair degree of investment savvy in the second wave.

The efficiency of this artificial market is better assessed by observing the outcomes of the later rounds in each wave. If this artificial market is strongly efficient, we would expect to find that by the end of the voucher process neither professional investors nor individuals would be able, on average, to perform better than a random purchasing strategy. While they did not do quite as well as professionally managed funds, individuals averaged 97 percent of the value purchased per point by investment funds in the final two rounds of wave one and the final three rounds of wave two. Even a random purchase of shares achieved results equal to 91 percent of the value per point of shares purchased by funds in the final two rounds of wave one and 93 percent of the professionals' performance in the final three rounds of wave two. This suggests that if this artificial market were not strongly efficient, it was not far from it.

A unique feature of the voucher process was the collection of a uniform set of information for every firm that was made available to bidders in either published or electronic form. Thus, it is easy to control for publicly available information. Hanousek and Kroch (1996)

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(...continued)

the market and much new information had become available.

<sup>22</sup>We constructed random portfolios based on allocating a fixed number of points in proportion to the price-weighted shares available in each round and assuming that the portfolio bought those shares that were actually sold in that round and retained for future rounds the points bid on shares that were not sold in a given round.

found that this public information is important in explaining demand in the early rounds of the process but has no additional explanatory power once price is controlled for in later rounds. More interesting for our purposes is their finding that the demand for a firm by individuals was strongly influenced by demand for that firm by investment funds in previous rounds (something that was widely published) even after controlling for price and other public information.<sup>23</sup> This suggests that, despite the findings reported above, individuals may have believed that the market was not efficient and that funds had additional nonpublic information.

## **VI) SUMMARY AND CONCLUSION**

The new equity markets of Central Europe present a decidedly mixed picture with respect to their efficiency. The markets are very different in their size and structure. There is a widespread belief that they can be manipulated by insiders who certainly have ample incentive to attempt to appropriate assets in the privatization process. Yet despite all this, the markets in these countries are similar in that, to the extent it is possible to test conventional types of efficiency with the limited data available to date they do not appear less efficient than far more developed equity markets. If these preliminary results hold as more sophisticated tests become possible, it will provide strong evidence of the power of markets to achieve proper pricing in the most difficult of circumstances.

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<sup>23</sup>See also the analysis by Ma and King (1996).

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Table 1  
Extent and Liquidity of Equity Markets (1995)

	Central Europe				Asia					
	Czech	Hungary	Poland	Slovakia	Malaysia	Korea	Taiwan	Indonesia	Thailand	Pakistan
Number of Traded Firms	1,635	42	65	18	529	721	347	238	416	764
Market Capitalization (millions of US\$)	15,664	2,399	4,564	1,235	222,729	181,955	187,206	66,585	141,507	9,286
Market Cap/GDP	.35	.06	.04	.08	3.07	.49	.79	.39	.99	.18
Turnover (millions of US\$)	3,630	355	2,770	831.7	6,883	10,832	383,099	14,403	3,917	3,210
Turnover/Market Cap	.25	.17	.72	.70	.03	.06	1.75	.25	.03	.29

	Latin America					Other Europe				
	Argentina	Brazil	Chile	Mexico	Venezuela	Greece	Portugal	Turkey	France	Germany
Number of Traded Firms	149	570	284	185	90	212	169	205	450	678
Market Capitalization (millions of US\$)	37,783	147,636	73,860	90,694	3,655	17,060	18,362	20,772	522,053	577,365
Market Cap/GDP	.13	.27	1.36	.24	.06	.21	.20	.16	.39	.28
Turnover (millions of US\$)	4,594	5,493	11,072	34,377	510	6,091	4,233	51,392	729,099	1,147,097
Turnover/Market Cap	.12	.04	.15	.33	.10	.37	.23	2.26	1.40	1.99

<b>Table 2</b> <b>Variance-Ratio Tests of Random Walk Hypothesis</b> Monthly Returns Variance Ratio (z assuming homoskedasticity) (z' robust to heteroskedasticity)				
Number of Lags	Czech Republic	Hungary	Poland	Slovakia
q=3	1.89 (3.48)* (1.01)	1.27 (1.19) (0.40)	1.35 (1.53) (0.54)	1.64 (2.50)* (0.44)
q=6	1.61 (1.46) (0.38)	1.40 (1.04) (0.33)	1.80 (2.09)* (0.67)	1.16 (0.38) (0.06)
q=9	1.81 (1.49) (0.40)	1.51 (1.04) (0.29)	2.21 (2.48)* (0.78)	0.84 (-0.30) (-0.05)
q=12	2.47 (2.28)* (0.65)	1.74 (1.27) (0.32)	2.57 (2.72)* (0.83)	0.93 (-0.11) (-0.02)
max z (q = 3..12) max z' (q = 3..12)	(3.49)* (1.01)	(1.27) (0.40)	(2.99) (0.83)	(2.50) (0.44)

\*Indicates that variance ratio is significantly different from 1 at the 5% confidence level, thereby implying a rejection of the random walk hypothesis.



<b>Table 3</b> <b>Variance-Ratio Tests of Random Walk Hypothesis</b> Weekly Returns Variance Ratio (z assuming homoskedasticity) (z' robust to heteroskedasticity)				
Number of Lags	Czech Republic	Hungary	Poland	Slovakia
q=4	2.07 (6.85)* (1.21)	1.71 (5.19)* (1.34)	1.29 (2.15)* (0.71)	2.31 (8.53)* (1.09)
q=8	3.07 (8.39)* (1.25)	2.20 (5.53)* (1.18)	1.49 (2.28)* (0.63)	3.16 (8.91)* (1.00)
q=13	3.78 (8.50)* (1.17)	2.59 (5.55)* (1.03)	1.91 (3.17)* (0.75)	3.55 (7.94)* (0.78)
q=26	3.26 (4.75)* (0.59)	2.93 (4.61)* (0.70)	2.60 (3.82)* (0.71)	2.24 (2.64)* (0.23)
max z (q = 4..30) max z' (q = 4..30)	(8.53)* (1.25)	(5.63)* (1.34)	(4.00)* (0.78)	(8.91)* (1.09)

\*Indicates that variance ratio is significantly different from 1 at the 5% confidence level, thereby implying a rejection of the random walk hypothesis.

**Table 4**  
**Distribution of Returns in Central European Equity Markets**

	Czech Republic PX-50		Hungary BUX		Poland WIG		Slovakia SAX	
	Weekl y Return s	Monthly Returns	Weekly Returns	Monthly Returns	Weekly Returns	Monthly Returns	Weekl y Return s	Monthly Returns
Mean	0.36%	1.5%	0.71%	3.2%	1.3%	6.0%	0.53%	2.2%
Standard Deviation	4.8	13.3	3.6	11.3	8.6	21.5	6.2	18.1
Skewness	1.82*	1.36*	0.95*	1.15*	-0.14	0.45	3.13*	3.09*
Kurtosis	10.43*	2.99*	2.34*	4.47*	1.80*	1.22	22.34*	13.74*
Number of Observations	144	34	187	42	187	42	149	34
Period of Observation	9/93 - 7/96		1/93 - 7/96		1/93 - 7/96		9/93 - 7/96	

\*Significantly different from 0 at the 5% confidence level. Standard error of skewness computed as  $[6/N]^{1/2}$  and of kurtosis as  $[24/N]^{1/2}$  where N is the number of observations.

**Table 5**  
**Runs Tests of Weak Form Efficiency**

	Czech Republic		Hungary		Poland		Slovakia	
	Weekl y Return s	Monthl y Return s	Weekl y Return s	Monthl y Return s	Weekl y Return s	Monthl y Return s	Weekl y Return s	Month ly Return s
Number of Runs	87 <sup>1</sup>	20	121	26	117	29	92	17
Expected Number of Runs	95.67	22.33	124.33	27.67	124.33	27.67	99	22.33
Standard Error of Expected Runs	5.03	2.39	5.74	2.67	5.74	2.67	5.12	2.39
Number of Observations	144	34	187	42	187	42	149	34
Z-score	-1.72	-0.98	-0.58	-0.62	-1.28	0.50	-1.37	-2.23*

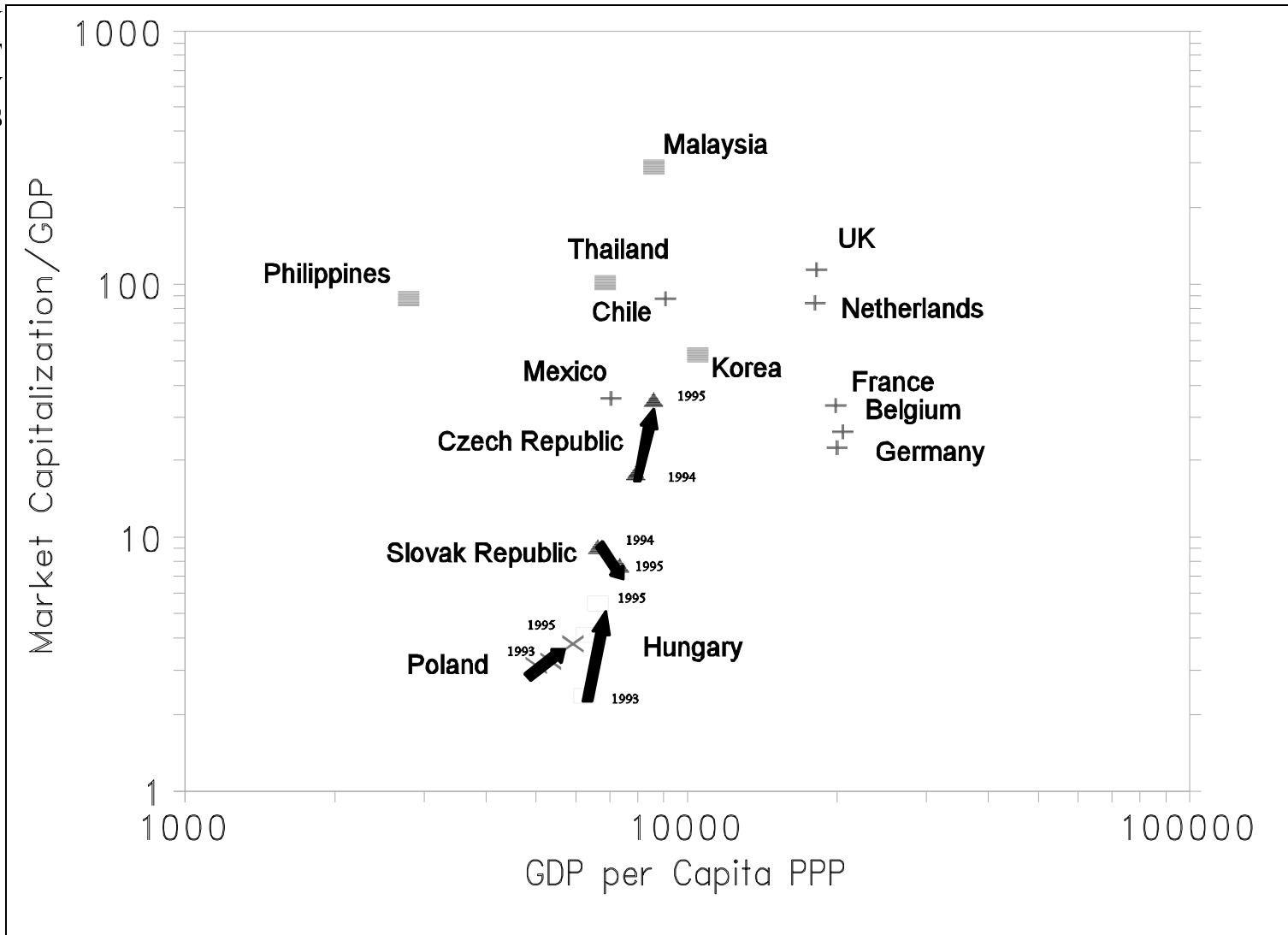
\*Significantly different from 0 at 5% confidence level. The expected number of runs was calculated as  $[2N-1]/3$  where N equals the number of observations. The standard error of expected runs was calculated as  $[(16N-29)/90]^{1/2}$ .

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<sup>1</sup>There is an issue regarding how to calculate the number of runs for the Prague Stock Exchange. There are periods during which the exchange did not trade for a week or more due to holidays. Since we are focusing on weekly returns we must decide whether to ignore the "dark" weeks or to apportion the total return among them. We have done the latter in calculating the level of return but excluded constructed weeks in determining whether a run occurred. Thus, a total return of 3% over three weeks was reduced to 1% per week but only considered as one week in calculating the number of runs so as not to create an artificial pattern by the equality of the created weekly returns.

FIGURE 1

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## Appendix I

### Disclosure Requirements of the Prague Stock Exchange\*

A Prospectus for registration must include:

- a) Introductory Provisions:
  - i) legal basis for issuing the security,
  - ii) a copy of the decision made by relevant Ministry on granting permission to issue the security or to trade it publicly,
  - iii) purpose of the issue,
  - iv) other relevant information important to investors (e. g. how the issuer discloses information on his business activities and position),
  - v) a disclaimer by the Stock Exchange stating that by having admitted the security to its Main Market it assumes no liabilities attached to such securities.
  
- b) Characteristics and conditions of the securities issue:
  - i) type, form and sample of the security,
  - ii) ISIN,
  - iii) total value of the issue and nominal value of the security,
  - iv) price at issue or anticipated price,
  - v) business names of stock traders who either were or are arranging for the issue,
  - vi) date, place and way of releasing the issue (public offer, through a commission agent or within the framework of a firm overtake),
  - vii) type of subscription (free/open, preferential/with priorities, combination),
  - viii) place of payment,
  - ix) description of all rights associated with the security ownership (preemption and exchange rights inclusive),
  - x) method, deadlines and place of payment of the yields on the security and/or its repayment,
  - xi) method of keeping records on status and movements of the security, provided the issue has only been made as registered (in book-entry form),
  - xii) shares structure (individual shares or bulk certificates),
  - xiii) development in the share price for the last three years or from the time when the shares were introduced to other public markets (this also applies to both convertible and option bonds),
  - xiv) periods for holding General Meetings of Shareholders of joint stock companies,
  - xv) a list of changes in all the facts subject to recording in the Commercial Register which have taken place since the last entry,
  - xvi) the way of disclosing the facts important for claiming holder's rights to

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\*Sections applicable to stocks only. Omission of non-applicable material has resulted in renumbering for consistency.



- dividends paid per share for the last three trading years or from the company foundation, ratio of "dividends paid" to "post-tax profit" in percentage,
- v) bank and other loans received and payables with indication of their maturity, broken down as follows: short-term, long-term, non-performing credits (I. e. loans with payment overdue), type and extent of default in payment (insolvency),
  - vi) registered capital: structure by individual type of shares, share holding capital structure by type of shares, registered capital pending payment (not paid up yet), the option and exchange rights the registered capital of the company is subject to,
  - vii) reserve funds
  - viii) amount of dividends and all changes in the registered capital for the last three years (dividend paid per share),
  - ix) any and all rights of lien/mortgage tied to the company assets if exceeding 5 % of the company registered capital (state their total book value),
  - x) characteristics of all impacts arising from long-term contractual relationship which may affect company business results,
  - xi) all company liabilities existing to the application date and implying from the guarantees issued.
- f) Issuer's administration and management bodies:
- i) statutory bodies,
  - ii) supervisory bodies,
  - iii) management bodies - managers (directors) the following details are to be stated for individual members of these bodies: name, position (function), education, qualification/skills, professional competence/fitness, data proving their "unblemished personal record" and/or the length of sentence imposed for any property-related criminal act committed, information about their business activities outside the company scope of business and about their jobs, membership in bodies of other companies, share of these members in the company registered capital,
- g) Closing provisions:
- i) names of persons who prepared the prospectus, including the date on which this was produced,
  - ii) statement by persons responsible for the information stated in the prospectus confirming that this is complete, true and accurate,
  - iii) declaration of the issuer that he is assuming full responsibility for the correctness of the prospectus and signature of the issuer's statutory body,
  - iv) statement by bank on verification of the prospectus, including its business name, principal office address. and signatures of authorized persons.

Once a security is listed on the main market, the issuer is obliged to submit to the Exchange:

- a) quarterly income development indicators to the extent of a complete balance sheet and profit and loss statement - within 8 weeks from end of a given quarter,

- b) a copy of semi-annual business report encompassing a complete balance sheet and profit/loss statement together with the company comments - within 3 months from end of the respective 6-month period,
- c) as many copies of annual report as there are Exchange members - without reasonable delay, after holding the Annual General Meeting of Shareholders,
- d) a copy of closing statements of accounts to the extent of a complete balance sheet and profit and loss statement, including an enclosure with the cash flow statement as its integral part - immediately after these have been verified by the auditor but no later than 6 months from end of the respective year,
- e) in the course of the year, also the information about income development, including comments on the company financial position, in accordance with the requirements of the Exchange Chamber.

In addition, the issuer of the security admitted to trading in the Exchange Main Market is obliged to submit to the Exchange without delay the following:

- a) records taken of both regular and extraordinary General Meetings held by issuer's company,
- b) any changes in the Articles of Incorporation, by-laws (the Statutes), or Articles of Foundation (Association or Deed of Foundation) of the issuer,
- c) changes in entries kept on the issuer in the Commercial Register.

The issuer of a security admitted to trading in the Exchange Main Market is also obliged, without delay, to publish and notify the Exchange of any changes in his financial position as well as other facts which may directly or indirectly invoke a change in the price of the security or adversely affect the issuer's ability to comply with the obligations arising from the issue of this security. The issuer is not allowed to inform any other person about such changes and facts until these have been notified by him to the Exchange.

Among the specific items qualified as such changes and other facts are:

- a) Changes in the terms of issue and trading in the security admitted to trading in the Exchange Main Market,
- b) Changes in the issuer's statutory, supervisory and management bodies,
- c) Changes in structure and size of the issuer's decisive (majority) shareholders, if known to him,
- d) Any new issue of securities,
- e) Any and each change in issuer's assets or net trading (employed) capital values by 10 % or more,
- f) Receipt or cancellation of important allotments and subsidies,
- g) Any disputes before the court of law or trade disputes if disputed subject value exceeds 5 % of issuer's trading (employed) capital,
- h) Any decisions on a consolidation, merger, split, abolition and other important organizational changes as well,
- i) Suspension or restrictions to issuer's activities on the basis of an official authorization (order),
- j) Declaration in bankruptcy or approval of settlement proceedings,
- k) Acceptance or cancellation of important commercial orders,
- l) Market-sharing standing,
- m) Acquisition or disposal of significant patents or inventions,
- n) Shares in exports and imports,
- o) Changes in trading policy,



p) Changes in production structure.