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The Czech stock market – its effectiveness and economic consequences

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Abstract

This paper examines features of the Czech stock market's development in the course of the last eight years and tries to unveil the macroeconomic consequences of stock price development. The analysis of the stock market's behaviour supports a cautionary stance on the hypothesis of the efficient market theory even in its weak form. The Czech equity market proved to fluctuate substantially since political factors as well as market speculations rule the market. It is also evident that market participants process economic information inefficiently because they tend to incorporate changes in economic factors with a time lag and not immediately. The other finding referring to the macroeconomic consequences of stock price development undermined the assumption of a positive wealth effect of rising stocks since the relationships between PX50 and inflation proved to be negative. In relation to GDP growth, the prediction power of the stock index turned out to be very limited, nevertheless, it is not excluded that PX50 can serve very well as one of the leading indicators of future economic development. The Czech stock market can also function as an instrument of a portfolio's diversification, at least in relative terms, since the correlation to the Czech bond market proved to be weak. Contrariwise, in the course of time the correlation between the Czech, US and European stock market increased, restricting the room for a portfolio's diversification. Though, certainly, it mirrored the ongoing process of economic integration into the European Union, the relation to the US stocks became stronger than to European counterparts. Thus, global market integration seems to have a bigger impact on the CEE stock indexes than the integration process on the European continent.

JEL Classification: E44, G11, G12, G14

Keywords: Czech stock market, PX50, efficient markets theory, behavioural finance theory, portfolio theory, and European integration.

Content

Introduction

It seems to be a long time ago, since the Czech economy experienced a deep economic transformation. At that time all market institutions, including the stock market, had to be established. Since then many things have changed. A legal and regulatory framework has been improved step by step, trade volume went up and hundreds of illiquid stocks were delisted. Though a lot of effort has gone into making the market more efficient, most of its participants consider the assumption about stock market effectiveness to be at least brash. Over the course of the 1980-90s, anomalies and discrepancies between the efficient market theory and the reality of the main stock markets became more and more evident. This raised the question whether the Czech stock market can ever display conformity with the already eroded theory of efficient markets or be "effective" in the sense of above theory. Apart from answering this question, this paper tries to find a solution to many others, e.g. if the theory of behavioural finance matches Czech stock market performance better than the concept of the effective market or if Czech stock development has any significant consequences for macroeconomic development and monetary policy or vice versa. Although the Czech stock market is still viewed as a marginal economic factor and attracts little attention from foreign/domestic investors and local policy-makers, its future as one of the EU countries' stock exchanges might, under some conditions, be very promising. European economic integration is expected to more closely link local markets and to cause both nominal and real convergence. In an effort to verify whether the portfolio theory is valid not only on the local but also the international scale, the paper examines, apart from the "original" portfolio theory, which comes with the idea of portfolio diversification within a local financial market, the "modern" concept of the portfolio theory assuming optimum diversification across all international financial centres.

The rest of the paper is organised in three sections. The first one mentions the theoretical background for analysing and assessing stock development. The second section is divided into four separate chapters and describes the data sources and results of empirical analysis. In the first chapter, the reliability of the efficient markets theory using Czech data is verified. In the second chapter, the test of the behavioural finance concept follows. The third and final chapter examines the macroeconomic consequences of stock price development and finally, the effects of European integration on stock price development are explored. The last section summarises and highlights the main conclusions of the above-mentioned analyses.

Theoretical background

Recent dynamic stock price development and rising discrepancies between the observed reality and ***the efficient markets theory*** have brought the issue of stock markets and their economic consequences to the forefront of academic attention. The prominent finance model of 1970s was inspired by the rational expectations revolution in economic theory that helped tie together finance and the entire economy in one elegant theory. The concept of the efficient market theory assumes that stock prices always incorporate the best information about fundamental values and that any price changes fully reflect available information. Under such a condition, market participants, generally rational, cannot earn unusual, or risk adjusted profits. As such, market prices should be considered to be the best possible reflection of available information. So the markets are simply the messengers conveying the news of underlying and anticipated exogenous variables, flexibility of the economy, or other factors that determine market price. The protagonists of the efficient markets theory are e.g. Fama, Miller, Sharpe and Levich.[1] In the literature, one distinguishes three types of market efficiency depending upon the information set: (1) a weak form, (2) a semi strong and (3) strong form. Weak form efficiency assumes that the current asset price reflects all historic information and thus it is a useful test of technical trading models. In the semi strong form, the current price reflects all publicly available information, thus we can examine how prices respond to public announcements. Finally, there is the strong form of efficiency assuming that the current prices reflect virtually all available information, including proprietary and insider information.

Already in the 1970s some doubts about the accuracy of the efficient markets concept arose. Then, over the past several decades important academic discussion about the consistency of the efficient markets theory with empirical experiences with asset prices behaviour developed. Of particular concern was whether the recorded stock market volatility could be explained and predicted by the efficient markets model. The changes in stock prices that did contradicted the concept of efficient markets and called into question the basic underpinnings of the entire theory. The failure of empirical analyses[2] to convincingly confirm the validity of the efficient markets hypothesis stirred up a serious discussion regarding the presumption of market participants' rationality and shifted the academic focus towards models of human

[1] See Fama (1970) and (1991) for a review of the literature and studies.

[2] For the survey see Beechey at al (2000).

psychology that relate to financial markets. In the 1990s, a number of empirical works, summarised in Campbell at el (1996), laid the foundation for a revolution in finance theory. ***Behavioural finance***, the new approach to financial markets, argues that some financial phenomena/anomalies can be better-understood using models in which some participants are not fully rational (because of e.g. mass psychology, "animal spirits" or "sunspots") and where more or less rational and irrational traders interact. Thus, the irrationality can have a substantial and long-lasting impact on prices. While the effective markets theory assumes that fully rational traders quickly undo any mispricing by irrational ones, the behavioural finance theory believes that the consequent strategies designed to correct mispricing can be both risky and costly, thus unattractive. As a result, the dislocation can remain unchallenged (see Barberis and Thaler, 2002). Or the rational traders are not necessary "arbitrages" and the process of arbitrage is disrupted. Limits of arbitrage are one of behavioural finance's two pillars. The second one is the investor psychology that draws an inspiration from cognitive psychologists. Behavioural finance focuses on the biases that arise when people form their beliefs, and on their preferences, or on how they make decisions, given their beliefs. For example, extensive evidence shows that people are overconfident in their judgements. Also most people are unrealistically optimistic and thinking wishfully and display a systematic planning fallacy. They are conservative and once an opinion is formed, they cling to it very tightly and for too long a time. The others biases are anchoring expectations or availability biases.[3] During the time, the behavioural finance theory had been improving and many sophisticated models were formed.[4] One of the oldest and simplest theories of financial markets, the feedback model, will be applied to the Czech stock price index in the following section.

Via the presumption that the market is perfect and agents are fully rational, ***the portfolio theory*** – in its basic form represented by the Markowitz's selection model - is linked to the theory of an efficient market. Nevertheless, the idea of portfolio diversification is not unfamiliar to the behavioural finance concept that, however, does not assume the full rationality of diversifying investors and fully effective investment portfolio. Markowitz was among the first to attempt to quantify risk and demonstrated quantitatively why and how portfolio diversification works to reduce risk for investors. He showed that based on

[3] For details of psychology in the behavioral finance concept see Barberis and Thaler, 2002.

[4] For the overall surveys of the behavioral finance concept see e.g. Shefrin (2001).

evaluation of risk for a given level of expected return and correlations among assets in the portfolio basket, everybody can establish an optimal portfolio. This idea laid cornerstones of other theoretical concepts such as capital market theory or the capital asset pricing model. The modern portfolio theory, which demonstrates how to manage the portfolio, was extended to the international, global level. Taking the fact that optimum diversification could be achieved only if the components of the portfolio had imperfect co-movements with one another and in terms of their expected sensitivity to change in the values of the market, the correlation and integration between local and foreign indexes has to be modest.

The dynamic development of financial markets over the last couple of decades enhanced the role of asset prices for (monetary) policy making but also for the economy as a whole. The mainstream of the current monetary theory has gradually paid bigger and bigger attention to assets' prices. However, the Bank for International Settlement (BIS) stressed that the role of asset prices as an information medium of the monetary policy should not be exaggerated (see BIS, 1998). ***Macroeconomic theory*** assumes that asset prices, particularly equity indexes, contain information regarding future expected trends in interest rates, inflation, output etc. They are expected to react very flexibly to any change in the economic environment and vice verse. Equity indexes can be used as indicators of an incorrect monetary policy stance, or as a guideline for timing monetary policy steps, or as a benchmark of policy effectiveness, respectively. Stocks also enter the monetary policy transmission mechanism perpetually from the begging to the end. Also monetary policy affects equities through interest rate or money supply adjustment. While money supply effects equities more or less directly, via the link between money market and the market of other financial assets, interest rate changes are transmitted indirectly through credit demand, savings supply and inflation. Any imbalance in the money market automatically means an imbalance in the market of the other financial assets. Surplus in money demand, caused by e.g. monetary expansion, stirs up among economic agents displeasure with the structure of their financial portfolio. They sell other financial assets, asset prices go down and the interest rate (the price of the money) rises. The higher price of money reduces money demand and the money equilibrium is restored. Monetary policy also affects credit issues and if credit demand is reduced (e.g. by higher interest rates), assets are sold in an effort to preserve the existing consumer level and their prices fall. Additionally, assets play an irreplaceable role in credit creation as collateral. Declining asset prices heighten credit risk and lower credit supply. The further macroeconomic variable influencing asset prices is savings rate. Saving surplus over demand

on financial sources creates room for asset price growth, since the saving excess is invested into assets. Nevertheless, the monetary policy follows most closely the relation between assets and inflation. Rising price level affects asset returns and vice verse higher asset prices raise price level directly or through higher aggregate demand. Unfortunately, economic research has not yet yielded any unambiguous evidence of the existence and the intensity of these effects.

Channels that transmit changes in asset prices into a real economy and cause changes in output, price level, external balance etc. are explained by the Tobin's q-theory of investment and the wealth-effect theory. The investment theory based in Tobin's q (a ratio market value of a unit of capital to its replacement costs) assumes that monetary policy, affecting capital costs via interest rates, has an impact on the market prices of companies and their investment decisions. Lower interest rates mean lower capital costs and higher value of a company compared to capital costs. However, the reality showed that the link between investment and Togin's q is at most indirect (see e.g. Bond and Cummins, 2000). The wealth-effect theory is based on a presumption that gains in wealth spur consumption, since households feeling richer consume more. According to Metzler's wealth effect, an increase in real money balances causes a rise in aggregate demand, because lower price level increases real wealth of economic agents that afterwards increase demand on assets. Higher buying interest on asset prices raises their prices and enhances aggregate demand, as agents feel richer. Unfortunately, it is still not certain, how strong the effect wealth could have on consumption is. However, some papers (see e.g. Case at al, 2001) stressed the disparity between asset markets, housing and stock markets particularly, and came to the conclusion that the housing wealth effect appears to be more important than the stock market in influencing consumption.

Data and empirical results

The analysis below was conducted on monthly data for the main Czech stock index, PX 50, Frankfurt DAX, Bratislava SAX, Budapest BUX and Warsaw WIG from the beginning of

1995 to the middle of 2003.[5] The long-term correlation between the main world markets was verified on the long-term time series of the main stock indexes from Austria, Belgium, Denmark, France, German, Greece, Italy, Ireland, Luxembourg, Portugal, Spain, United Kingdom and United States. All equity indexes were normalised to equal 100 at January 1995. For the purpose of verifying the above mention theoretical postulates, the following monthly macroeconomic variables were applied: 1) money supply M2, 2) industrial output as a proxy variable for quarterly GDP data, 3) unemployment rate 4) retail sales as a proxy for quarterly household demand, 5) CPI and PPI, 6) government budget balance (as a proxy of fiscal policy stance), 7) monthly change in export, 8) trade balance (as a proxy indicator of external balance), 9) crown exchange rate to the Euro and dollar (also normalised to equal 100 at January 1995), 10) 3m and 1Y PRIBOR, 11) 3M and 1Y Frankfurt money market rates (as a proxy for international interest rates) and 12) Reuters' Czech bond market index (total return index). All data were monthly and the time series began in January 1995 except the last mentioned, which has been available since March 1998. The economic relations that were examined are expected to be in a logarithmic form. Thus, all variables except interest rates, foreign deficit and state budget are expressed logarithmically.

The efficient markets concept

The first step of the analysis is to verify the validity of the efficient markets theory on the time series of the Czech stock market index. The weak form of market efficiency, assuming that the current price reflects all information in the historic series of prices, can be written as:

$$Y_t = Y_{t-1} e^{(c+u_t)} \tag{1}.$$

Taking the natural logarithm, we have:

$$\ln(Y_t) - \ln(Y_{t-1}) = c + u_t \tag{2},$$

if c=0 and the distribution of the error term "u" is independent and distributed identically over time, then we say that prices follow a random walk without drift and if c≠0, then prices follow a random walk with drift.

[5] Data source: Bloomberg, July 2003.

The results of the Augmented Dickey-Fuller and the Phillips and Perron tests that examine the stationarity of time series did not rule out that the Czech stock market is nonstationary.[6] Given the fact that the true AR parameter was closer to one, one cannot exclude that the PX50 index runs a random walk with a drift. As such, historic data or events should be fully incorporated in the prices in line with the weak form of market efficiency. To examine the explanatory power of the PX50 random walk equation, the Error Correction Model for the Czech stock market index was estimated with the following results:[7]

$$lgpx50 = 0.6 + 0.87lgpx50(-1) \quad Adj.\ R^2 = 74.1\%;\ DW = 1.86 \qquad (2')$$
$$(0.23) \quad (0.05)$$

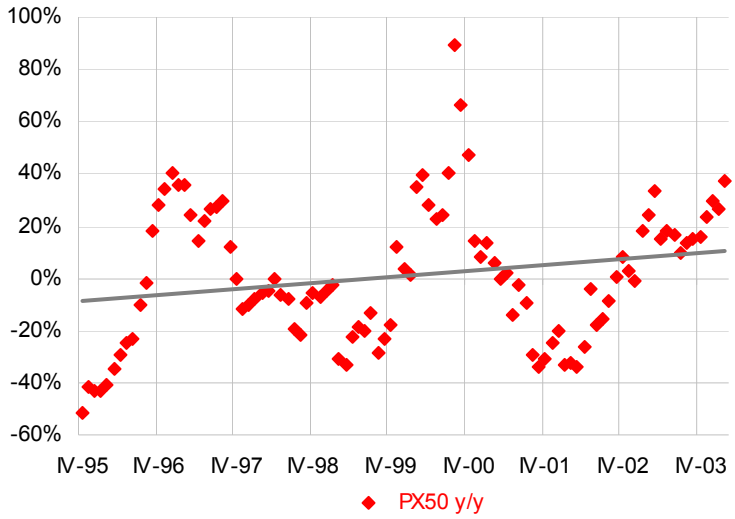
Instrument list: c, lgpx50(-1).

The random walk with a drift is able to explain 74% of the PX50 variability, which is satisfactory. The constant and the lagged variable proved to be statistically significant at the 5% significance level (the numbers in brackets are the estimated standard errors of the coefficient estimates). The Durbin-Watson statistics lay close to 2, thus the residuals seem not to be serially correlated. From the statistical and graphical analysis it is more or less evident that the Czech stock market prices wander substantially around a drift. The existence of a drift in the random walk of PX50 can be explained by the rising economic performance of the Czech economy and real convergence to the European countries.

Figure 1 PX50 and its random walk with a drift

[6] The ADF and PP test found that the PX50 time series are integrated of order one. The ADF test equation with no time lag was specified as follows: dlgpx50 = 0.6-0.13lgpx50(-1).

[7] Due to nonstationarity of the PX50 time series, the estimation to the ADF test equation (see the footnote 6) is misleading.



Source: Bloomberg, July 2003.

The other technique for testing the weak form of market efficiency is to compute the probability of various mechanical, or technical trading strategies (see Levich, 2001). This paper examines three basic technical trading rules: two filter rules and the moving average crossover rule as representatives of such rules. A filter rule generates a signal when the prices move more than a certain percentage over the period. For example, to buy an instrument whenever it rises x-percent above its most recent trough or to sell whenever the instrument falls below its most recent peak. For testing, the Alexander's Filter defined by Reuters was applied. Plus and minus 10% were the levels being used to generate buy and sell signals and the length of the observed time period was set at 120 from 1-400 range to testify the mid-term price trend. One of the most frequently used rules is a Relative Strength Index that indicates when the market is overbought or oversold, or when prices have risen or fallen too far and are therefore likely to retrace. If for example, the RSI rose above 70 then the market should be overbought, and an RSI below 30 indicates that the market is oversold. Finally, a moving average crossover rule generates buy signals when the short term moving average (e.g. 5 days) rises above the long-term moving average (e.g. 30 days) and sell signals when the short-term moving average drops below the long-term moving average.

The results summarised in Table 1 demonstrate that the technical trading rules produce not only profits but also losses more or less with the same frequencies. Considering the costs of taking on the position, it seems that technical trading is not able to produce a net profit sufficiently different from zero. Thus, the null hypothesis of market efficiency that no trading

strategy might produce net profits is neither excluded nor fully confirmed. The results of the simple test of technical trading also suggest that the more famous the technical trading rule is, the less successful it proves to be (see e.g. RSI). But it does not automatically mean that there is not a more sophisticated, though less popular, trading rule that can, for a time period, produce a net profit, particularly if many parameters of such technical rules are based on subjective specification and the interpretation of trading signals is ambiguous (see for example popular behavioural finance models).

Table 1 Results of technical trading strategies

	No. of proper signals	1. No. of wrong signals	No. of neutral positions
Alexander's Filter	83	57	47
RSI	22	31	134
Moving average rules	85	102	NA

Source: Reuters, July 2003.
Note: The propriety of signals is defined in the relation to the next market price, or the sell signal was proper if the next price went down and wrong if the price went up. The test was run for the time period of Jan 2, 2003 and Sep 23, 2003.

A possibility that PX50 might be consistent with the weaek form of market efficiency raised the question as to whether the market can even be semi-efficient. Semi-strong efficiency assumes that the current market prices reflect all (historical and current) publicly available information. Empirical verification of semi-strong efficiency tests whether lagged economic variables do "Granger cause" equity market returns and whether there is a contemporaneous relationship between an economic variable and market prices. To conclude that the market is semi-strong efficient, there must be a contemporaneous relationship between a real variable and the market returns, while at the same time lagged values of the real variable must not enable a potential investor to predict current returns in the market (Hanousek and Filer, 1997).

As such, the following four equations were estimated:

$$\Delta Y_t = c + \sum_{m=1}^{n} \lambda_m \Delta Y_{t-m} + \sum_{i=1}^{j} \mu_i \Delta X_{t-i} + \varepsilon_t \quad (3),$$

$$\Delta Y_t = c + \sum_{m=1}^{n} \lambda_m \Delta Y_{t-m} + \nu \Delta X_t + \varepsilon_t \quad (4),$$

$$\Delta Y_t = c + \sum_{m=1}^{n} \lambda_m \Delta Y_{t-m} + \nu \Delta X_t + \sum_{i=1}^{j} \mu_i \Delta X_{t-i} + \varepsilon_t \quad (5),$$

where "Y" represents the stock market index, "X" is one set of macroeconomic variables and "m" and "i" are appropriate time lengths. All variables were transformed into the first differences to meet the condition of time series stationarity.

To test semi-strong market efficiency, all four equations are estimated and their explanation power is compared with equation (2). Said in other words, one tests if e.g. there is additional benefit from knowing past information on a set of economic variables (see equation 3) or from knowing current information on economic factors (see equation 4). Equation 5 tests whether past information improves the ability to predict current returns that would, however, imply that the market may not be processing information efficiently. To fulfil the assumption of semi-strong market efficiency, the "ν" coefficient must be different from zero and at the same time the "μ" coefficient must be equal to zero.

The regression analysis of the first differences of the PX50 index and economic variables identified the following outcomes:

dpx50=-0.17dpx50(-2)+0.12dindustry(-2)-0.11dger3(-1)-0.08dger12(-1)+4.02dppi(-1)+ 0.27dretail(-1)
(0.09) (0.14) (0.05) (0.04) (1.74) (0.16)
Adj. R^2 = 17.2%; h=0.76 *(3'),*

dpx50=-0.75deur-0.1dger3+2.64dppi
(0.42) (0.05) (1.79)
Adj. R^2 = 6.1%; DW = 2.21 *(4'),*

dpx50=-0.09dger3-0.11dger3(-1)+3.61dppi+ 0.38dretail(-2)-0.64deur
(0.05) (0.05) (1.74) (0.15) (0.40)
Adj. R^2 = 16.3%; DW = 2.12 *(5').*

The results are clear – the hypothesis of a semi-strong form of markets efficiency was excluded. The lagged values of economic variables seemed to improve our ability to predict price development of PX50, since equation 3 better explains movement in PX50 than

equation 4 or 5. Moreover, the coefficients of lagged variables "μ" are statistically significant and markedly different from zero. So the Czech stock market seems to process information inefficiently. German 3M and 1Y money market rates as well as producer prices and retail sales seemed to influence PX50 with one time lag and Czech industrial output growth even with two time lags. The signs of these relationships implied that increases in industrial activity and consumer demand (represented by retail sales data) raise the domestic equity prices. Contrarily, monetary tightening by ECB (see German money market) pushes Czech equity prices down, since market participants believe in a tight link of the Czech monetary policy to the EMU one.

The relative low explanatory power of the models based on real economic fundamentals indicates that the market fluctuates substantially and that political factors (such as privatisation decisions) as well as market speculations rule the market. So, it is evident that the Czech stock market is far from the concept of the strongly efficient market where all information, including proprietary and insider information, are fully incorporated into the prices.

The Behavioural finance concept

The vague results of the verification of the efficient markets hypothesis on the PX50 data motivate a further investigation into whether the behavioural finance concept better fits the Czech equity market. The feedback model, simply said, assumes that upward/downward price movement propels further movements in the same direction, promoting word-of-mouth optimism/pessimism until the market reaches an unattainable level. While it is hard to find the feedback theory in finance and economics textbooks, historical evidences, research in cognitive psychology and natural experiments support its existence.[8] Economists widely thought that there is a problem with feedback theories because they are supposed to imply that market prices are strongly serially correlated through time and that price shows strong momentum continuing uniformly in one direction day by day. According to R. Shiller, simple feedback doesn't imply strong serial correlation but can be expressed as an equation of these variables: (1) distributed lag with exponentially declining weights on past price changes through time and (2) other factors that affect demand. The model assumes that people react gradually to historical, but not necessary yesterday's price changes, and besides this, there are

[8] For more details of the feedback model theory see Shiller, 2002 p.14-22.

other factors that affect demand. Since the past experiences showed that the momentum in stock prices tends to reverse itself over a longer time period, the cornerstone of the effective market theory – the approximate random-walk character of the stock should not be used as evidence against the feedback model.

The simple feedback model was testified in the form:

$$Y_t = c + \sum_{m=1}^{n} \alpha_m Y_{t-m} + \beta X_t + \sum_{i=1}^{j} \delta_i X_{t-i} + \varepsilon_t \qquad (6),$$

where "Y" represents the PX50 index and "X" economic fundamentals. The parameter "α" is expected to decline over time.

The econometric analysis reached the following conclusion:

px50 =0.89AR(1) – 0.21AR(2) + 0.21AR(3) - 0.68eur – 0.11ger3(-1) +1.29ppi+ 0.45retail(-2)

(0.11) (0.14) (0.11) (0.37) (0.05) (0.40) (0.15)

Adj. R^2 = 78%; Inverted AR Roots = 0.91 *(6'),*

where "AR" represents an autoregressive root.

The outcomes seem to be favourable for the behavioural finance concept of the feedback model. The model, based on lagged equity prices and a few contemporaneous or lagged economic factors, is expected to explain almost 80% of the PX50 volatility. An additional test of residuals excluded serial correlation (or autoregression) in residuals and the parameter of inverted AR roots confirmed the stationarity of the AR model. In line with the assumptions of the behavioural finance concept, the contemporaneous PX50 development is affected by its own price history as well as the contemporaneous and lagged value of economic factors. Although even those outcomes are far from perfect, their reliability appears to be stronger compared to the efficient markets concept in view of the econometric results as well as when confronted with the empirical evidence. Companies that have launched a series of behavioural finance funds in the US and in the Europe exhibit the possibility to pinpoint the behavioural anomalies in the market and exploit them. Nevertheless, there are no easy riches in using computer models that point at profitable opportunities.

Macroeconomic consequences of stock price development

The dynamic development of financial institutions and financial mediation has increased the role of stock prices development not only for companies alone and their institutional or

individual investors but also for all economic agents including political authorities. Stock price development has gradually gained in its significance for general economic development. This fact created an interest in investigating the links between stock prices and macroeconomic variables. For example, central banks that are responsible for maintaining price stability dealt with the information merit of stock prices. The stock prices might be, for example, used as a leading indicator, since they are likely to bear information about the future development of economic activity, interest rates and inflation. Or monetary policy might influence the stock prices in avoiding an unsustainable development (e.g. an equity bubble).

Although in the Czech Republic, stocks holding is still not as popular as it is in the more developed European market, the following paragraphs examine the basic links between the Czech stock market and macroeconomic variables such as CPI, interest rates and GDP in an effort to verify the information merit of stock prices.

At first, the link between PX 50, CPI and interest rates was testified. Recalling the above-mentioned outcomes (see equations 3-6), we can conclude that the CPI did not prove to be a significant factor of the past equity prices. To testify the reverse relationship, a single equation including just CPI and particular "asset prices" (PX50 and interest rates) was applied, since this paper has no ambition to model inflation development:

$$\Delta Y_t = c + \sum_{m=1}^{n} \eta_m \Delta Y_{t-m} + \kappa \Delta X_t + \sum_{i=1}^{j} \lambda_i \Delta X_{t-i} + \varepsilon_t \qquad (7).$$

The econometric analysis came to this outcome:

$$\Delta cpi = 0.3\Delta cpi(-1) + 0.0\Delta dif3\_12 - 0.0\Delta pri3(-6) - 0.01\Delta px50(-1)$$
$$(0.09)\quad (0.00)\qquad (0.00)\qquad (0.01)$$
$$Adj.\ R^2 = 24\%;\ h=1.29 \qquad (7'),$$

where "dif3_12" represents the differential between 3M and 1Y PRIBOR and "pri3" 3M PRIBOR.

According to the analysis, PX 50 affects consumer price development with a short time lag, but the effect is weak and limited reflecting a negligible share of equities in the financial

wealth of Czech individuals.[9] The negative, statistically significant parameter on PX50 points to the fact that rising equity prices instead boost consumer expenditures and afterwards consumer prices draw free money balances and thus reduces any excess in domestic demand. So the Czech data don't confirm the existence of the wealth effect in the Czech Republic. Further, the relationship between PX50 and interest rates also proved to be weak and in the direction of interest rate to PX50 even statistically insignificant (see equations 3-6). The monetary policy and its interest rate decisions appeared to be minor factors that determine stock price. Although the Czech economy is an economy where the financial sources are distributed mainly through banks and marginally through the capital markets, the companies listed on the Prague stock exchange and included in the PX50 index are generally cash-rich firms that are not reliant upon bank credits. Thus, the interest rate policy affecting lending costs has a negligible or indirect impact on companies' performance. The reverse relationship, from PX50 to interest rate, was not testified as empirical experiences show that the Czech National Bank has not directly followed the development in equity prices and has not reflected it in interest rate policy.

The last examined relationship was PX50 and GDP, which should verify whether the stock price index could serve as a leading indicator of economic development. The econometric test was, for this purpose, run on quarterly data applying a basic equation that includes just these two variables and dummies for the first and third quarters:

$$\Delta Y_t = c + \sum_{m=1}^{n} \mu_m \Delta Y_{t-m} + o\Delta X_t + \sum_{i=1}^{j} \varpi_i \Delta X_{t-i} + \varepsilon_t \qquad (8).$$

The regression results are:

$$\Delta GDP = 0.04\Delta PX50q(-1) - 0.01 dummy2 \qquad Adj.\ R^2 = 14.1\%;\ DW=2.3$$
$$(0.03) \qquad (0.01) \qquad (8a'),$$

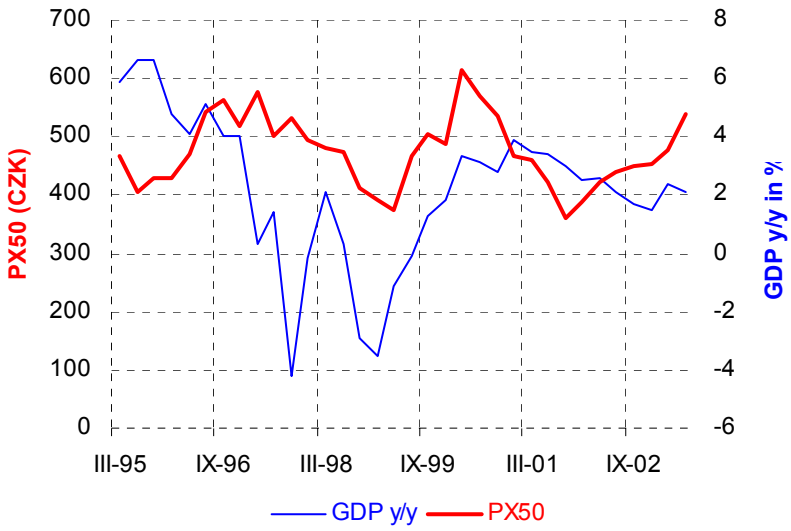
$$\Delta PX50q = 1.67\Delta GDP(-1) + 0.06 dummy1 \qquad Adj.\ R^2 = 15.7\%;\ DW=1.8$$
$$(0.91) \qquad (0.03) \qquad (8b'),$$

where "dummy1" represents the dummy variable for the first quarters and "dummy2" the dummy variable for the third quarters.

[9] According to the Czech System of National Accounts, the share of stocks in the total financial assets

The econometric analysis as well as the graphical examination (see Figure 2) confirms the existence of a joint trend of GDP and PX50. The relation seems to be reciprocal, however, economic performance proved to have a stronger impact on the stock index than vice verse. Nevertheless, the change in the PX50 index is likely to signal a change in economic growth one quarter beforehand but it indicates, unfortunately, less than 15% of a GDP's change. Such poor results limit the prediction power of the stock price index but it doesn't mean that it couldn't serve as one of leading indicators of future economic development.

Figure 2 PX50 and economic activity



Source: Bloomberg, July 2003.

Portfolio theory – relationships between asset prices

In the past the portfolio theory promoted the diversification of investors' portfolios in respect to risk and returns on individual financial instruments reacted to the dynamic development on the international markets and, in the context of market institutionalisation and globalisation, started to espouse the concept of international diversification over different markets. Optimum diversification on the local market presumes that the components of the portfolio had imperfect co-movements with one another and in terms of their expected sensitivity to changes in the values of the market. The diversification can be materialised not only through financial instruments such as equities and bonds but also through the foreign markets of a particular financial instrument.

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of households reached 0,2% in 2000.

To testify the benefits of local diversification, an investigation of relationships among asset price was carried out. As no data regarding property price in the Czech Republic are available, the test focused on four basic financial markets: equity markets (represented by PX50), the bond market (Reuters' bond market index CZBI), money market rates (PRIBOR 3M and 1Y) and the foreign exchange market (CZK/EUR and CZK/USD).[10]

The economic theory takes equities and bonds as substitutes and in the long run there should demonstrate an inversion relation with each other. Stock prices also follow interest rates development, since it might have an impact on business profitability, investment activity etc. Thus, monetary policy indirectly determining market interest rates can also be mirrored in stock price development. Finally, bond prices follow a change in the money market rate and tend to move in the opposite direction. Thus, the interest rate effect might cause a co-movement in bond and equity prices as e.g. a drop in interest rates is expected to push the bond prices up and simultaneously support equities when economic revival is expected to come.

According to correlation and regression tests, the Czech bond market doesn't behave as a substitute for the Czech equity market. Both tests pointed at an extremely weak, positive relationship between Czech bond prices and stocks. This finding is, however, more or less consistent with the requirements of a modest correlation. Thus, both these markets allow diversification of the investment risk at least in relative terms. The Czech forex market does not offer a diversification opportunity against the other financial instruments because of the ambiguous currency effects and relationships to other instruments. For example, the crown's weakening against the Euro seems to support an equity rise with a time lag. Contrariwise, the dollar's weakening to the crown seems to have an immediate positive impact on PX50. Money markets, which strongly influence bond market performance, demonstrated a weak relation to the stock index as well as to the CZK/USD exchange rate reflecting primarily EUR/USD development. All in all, it is apparent that domestic investors should diversify the

[10] The tests were run on monthly, unadjusted data in the time period of January 1995 to May 2003, except from bond index available since March 1998. The relations are again expected to be in logarithmic form, except interest rates. The PX50 index, exchange rates and bond market index are expressed as base indexes (100 in January 1995, in March 1998 respectively).

portfolio either through domestic individual stocks or internationally through different countries and instruments but not locally through domestic financial instruments.

Table 2 Correlation matrix among financial instruments

	LGCZBI	LGEUR	LGPX50	LGUSD	PRIBOR12	PRIBOR3
LGCZBI	1.00	-0.80	0.02	-0.12	-0.93	-0.92
LGEUR		1.00	0.16	0.44	0.56	0.54
LGPX50			1.00	0.11	-0.12	-0.16
LGUSD				1.00	-0.06	-0.11
PRIBOR12					1.00	1.00
PRIBOR3						1.00

Source: Bloomberg and Reuters, July 2003; own estimations.

$$px50 = 0.69px50(-1) + 0.71eur(-2) - 0.41usd + 0.03czbi - 0.1pribor3 + 0.1pribor(-1) \quad (9)$$
$$(0.08) \quad (0.19) \quad (0.12) \quad (0.08) \quad (0.04) \quad (0.04)$$
$$Adj.\ R^2 = 77\%;\ DW=2.05$$

An international portfolio's diversification is based on the presumption that financial instruments in different economies around the continent or the world are less than perfectly correlated each other. Globalisation, information technologies and the dynamic rise in foreign investments have ruined national borders, intensified cross-border trading and enhanced the effectiveness of information channels. At the same time, the European integration effort is approaching target -- European Monetary Union. The progress toward EMU step by step links the EU countries closer together. EU integration was expected to increase the importance of cross-border equity trading as pricing mechanism would converge and the acceptance of foreign investment products would rise.

To test whether international portfolio diversification is feasible in the real conditions of world markets and if the hypothesis about the EU integration is valid, the correlation among the US and European stock markets was analysed. The entire time period 1987-2003 was diverted into four sub-periods reflecting the process of EU integration. Such segmentation should help to verify if the integration within EU countries was stronger than with the rest of the world.

Correlation analysis, summarised in the tables below, confirmed the assumption that European economic integration has brought the European equity indexes closer together. The correlation between European stocks strengthened in the course of European economic

integration more visibly than between EU and US equity indexes.[11] From the correlation test it is also evident that the relationship between US and EU indexes relaxed a little in the last couple of years, while among the EU markets it strengthened. As such, the EU markets are now tied more closely to each other than to the US market. Additionally, it is also evident that the strategy of optimal portfolio diversification can't be based only on the main stock indexes but should go deeper into the market and diversify also among sectors or companies. This conclusion fits to the current practice of financial houses that have taken more and more importance in the sector's factors, as opposed to country ones, in determining equity prices in the Euro area.

Table 3 World stock market indexes 1987-1992 (excluding Lisbon and Paris Index)

	AS	ATX	DAX	IB	IS	MIB	UK	NDX	SPX
AS	1,00	0,74	0,89	0,84	0,84	0,79	0,83	0,85	0,85
ATX	0,74	1,00	0,66	0,54	0,60	0,54	0,63	0,53	0,59
DAX	0,89	0,66	1,00	0,97	0,98	0,90	0,96	0,95	0,96
IB	0,84	0,54	0,97	1,00	0,99	0,93	0,91	0,93	0,93
IS	0,84	0,60	0,98	0,99	1,00	0,92	0,95	0,94	0,95
MIB	0,79	0,54	0,90	0,93	0,92	1,00	0,79	0,82	0,81
UK	0,83	0,63	0,96	0,91	0,95	0,79	1,00	0,94	0,97
NDX	0,85	0,53	0,95	0,93	0,94	0,82	0,94	1,00	0,99
SPX	0,85	0,59	0,96	0,93	0,95	0,81	0,97	0,99	1,00

Note: Stock price indexes: AS Athens; ATX Vienna; DAX Frankfurt; IB Madrid; IS Dublin; MIB Milano; UK London; NDX Nasdaq and SPX Standard&Poor's. All equity indexes were normalised to equal 100 at January 1995.
Source: Bloomberg, July 2003; own estimations.

Table 4 World stock market indexes 1993-1998

	AS	ATX	BV	CA	DAX	IB	IS	MIB	UK	NDX	SPX
AS	1,00	0,72	0,95	0,96	0,94	0,95	0,92	0,94	0,90	0,89	0,88
ATX	0,72	1,00	0,83	0,79	0,83	0,81	0,81	0,75	0,83	0,63	0,72
BV	0,95	0,83	1,00	0,97	0,98	0,99	0,98	0,97	0,96	0,89	0,92

[11] The conclusion is generally valid except Vienna, Madrid and Athens during 1999-2001, when the local equities were driven by strong domestic factors (e.g. upgrading of the Greek stock market from the category of emerging markets to that of developed markets in the 1H2001).

CA	0,96	0,79	0,97	1,00	0,97	0,98	0,95	0,97	0,93	0,88	0,89
DAX	0,94	0,83	0,98	0,97	1,00	0,99	0,99	0,95	0,98	0,92	0,95
IB	0,95	0,81	0,99	0,98	0,99	1,00	0,99	0,96	0,97	0,92	0,95
IS	0,92	0,81	0,98	0,95	0,99	0,99	1,00	0,94	0,99	0,93	0,97
MIB	0,94	0,75	0,97	0,97	0,95	0,96	0,94	1,00	0,90	0,86	0,87
UK	0,90	0,83	0,96	0,93	0,98	0,97	0,99	0,90	1,00	0,93	0,97
NDX	0,89	0,63	0,89	0,88	0,92	0,92	0,93	0,86	0,93	1,00	0,98
SPX	0,88	0,72	0,92	0,89	0,95	0,95	0,97	0,87	0,97	0,98	1,00

Note: Stock price indexes: BV Lisbon and CA Paris.

Source: Bloomberg, July 2003; own estimations.

Table 5 World stock market indexes 1999-2003

	AS	ATX	BV	CA	DAX	IB	IS	MIB	UK	NDX	SPX
AS	1,00	-0,22	0,80	0,71	0,74	0,87	0,33	0,68	0,84	0,86	0,76
ATX	-0,22	1,00	-0,28	-0,24	-0,19	-0,15	-0,02	-0,22	-0,14	-0,34	-0,35
BV	0,80	-0,28	1,00	0,92	0,94	0,96	0,58	0,94	0,91	0,89	0,80
CA	0,71	-0,24	0,92	1,00	0,99	0,88	0,72	0,98	0,90	0,80	0,76
DAX	0,74	-0,19	0,94	0,99	1,00	0,92	0,74	0,97	0,93	0,81	0,78
IB	0,87	-0,15	0,96	0,88	0,92	1,00	0,61	0,89	0,95	0,87	0,82
IS	0,33	-0,02	0,58	0,72	0,74	0,61	1,00	0,72	0,70	0,29	0,47
MIB	0,68	-0,22	0,94	0,98	0,97	0,89	0,72	1,00	0,90	0,79	0,76
UK	0,84	-0,14	0,91	0,90	0,93	0,95	0,70	0,90	1,00	0,80	0,83
NDX	0,86	-0,34	0,89	0,80	0,81	0,87	0,29	0,79	0,80	1,00	0,85
SPX	0,76	-0,35	0,80	0,76	0,78	0,82	0,47	0,76	0,83	0,85	1,00

Source: Bloomberg, July 2003; own estimations.

Table 6 World stock market indexes 2001-2003

	AS	ATX	BV	CA	DAX	IB	IS	MIB	UK	NDX	SPX
AS	1,00	0,01	0,94	0,96	0,95	0,95	0,92	0,95	0,95	0,67	0,54
ATX	0,01	1,00	0,03	0,04	0,09	0,15	0,08	0,09	0,09	-0,22	-0,23
BV	0,94	0,03	1,00	0,96	0,95	0,96	0,87	0,97	0,95	0,72	0,60

CA	0,96	0,04	0,96	1,00	0,99	0,97	0,96	0,98	0,99	0,72	0,63
DAX	0,95	0,09	0,95	0,99	1,00	0,97	0,96	0,98	0,99	0,70	0,62
IB	0,95	0,15	0,96	0,97	0,97	1,00	0,94	0,98	0,98	0,72	0,60
IS	0,92	0,08	0,87	0,96	0,96	0,94	1,00	0,93	0,96	0,67	0,58
MIB	0,95	0,09	0,97	0,98	0,98	0,98	0,93	1,00	0,98	0,72	0,62
UK	0,95	0,09	0,95	0,99	0,99	0,98	0,96	0,98	1,00	0,70	0,62
NDX	0,67	-0,22	0,72	0,72	0,70	0,72	0,67	0,72	0,70	1,00	0,94
SPX	0,54	-0,23	0,60	0,63	0,62	0,60	0,58	0,62	0,62	0,94	1,00

Source: Bloomberg, July 2003; own estimations.

The proceeding integration of European markets that, however, remains, in some aspects, very slow (e.g. harmonisation of existing equity trading infrastructures) raises the question of whether the market of accessing countries such as the Czech Republic, Poland, Hungary and Slovakia demonstrate a similar process. Or, contrariwise, if it is possible to optimally diversify the portfolio through the regional equity indexes.

The investigation of correlation between Central Eastern European (CEE) stocks and their European and US counterparts did not produce such unambiguous conclusions as in the EU case. Although the correlation between CEE and German stocks (a proxy of European stocks) increased in the course of the last eight years (except the Budapest index), all CEE equity indexes demonstrated, in the last couple of years, a stronger relationship towards US equity indexes. On the contrary, the Budapest bourse developed in less dependence on the German and the other CEE stocks in the course of 2002 and 2003 because of post-election market euphoria. But generally, the correlation between CEE markets rose over time reducing the room for optimal portfolio diversification through the regional equity indexes. However, for example from a German investors' point of view, the Hungarian and Czech stock markets have remained an acceptable instrument of diversification as the correlation proved to be limited. On the other hand, the Polish and Slovak markets are very closely linked to the other markets offering little room for diversification at the level of the market index. All in all, in the case of CEE counties, it is not possible to conclude that the process of European integration lies entirely behind the gradual integration of these markets with European and world indexes, since the effect of global integration seems to have at least as strong an impact as the EU has. Besides the case of Hungary confirmed that, for the time being, local factors remain in play.

Table 7 CEE equity market correlation matrix 1995-1999

	DAX	PX50	NDX	SPX	SAX	WIG	BUX
DAX	1,00	-0,12	0,86	0,96	0,98	0,65	0,88
PX50	-0,12	1,00	-0,12	-0,13	-0,01	0,53	0,19
NDX	0,86	-0,12	1,00	0,93	0,91	0,47	0,67
SPX	0,96	-0,13	0,93	1,00	0,96	0,62	0,83
SAX	0,98	-0,01	0,91	0,96	1,00	0,70	0,89
WIG	0,65	0,53	0,47	0,62	0,70	1,00	0,85
BUX	0,88	0,19	0,67	0,83	0,89	0,85	1,00

Note: Stock price indexes: SAX: Bratislava; WIG: Warsaw; BUX: Budapest.

Source: Bloomberg, July 2003; own estimations.

Table 8 CEE equity market correlation matrix 2000-2003

	DAX	PX50	NDX	SPX	SAX	WIG	BUX
DAX	1,00	0,32	0,87	0,98	0,97	0,84	0,39
PX50	0,32	1,00	0,66	0,41	0,49	0,72	0,87
NDX	0,87	0,66	1,00	0,92	0,96	0,94	0,65
SPX	0,98	0,41	0,92	1,00	0,98	0,87	0,44
SAX	0,97	0,49	0,96	0,98	1,00	0,92	0,53
WIG	0,84	0,72	0,94	0,87	0,92	1,00	0,74
BUX	0,39	0,87	0,65	0,44	0,53	0,74	1,00

Source: Bloomberg, July 2003; own estimations.

Conclusion

Analysis of the Czech stock market index PX 50 indicates that the efficiency of the market is very weak and it might be even weaker than the concept of the weak form efficiency suggests. The fact that the PX50 development might have a character of random walk with a drift doesn't automatically exclude the possibility that the market develops in line with the

presumptions of the rival to the efficient market theory -- the behavioural finance concept. The regression analysis, in conformity with the behavioural finance concept, came to the conclusion that contemporaneous PX50 development is affected by its own price history, as well as contemporaneous and lagged economic variables. Although even those outcomes are far from be perfect, their reliability appears to be stronger compared to the efficient markets concept considering the econometric results and also the empirical evidence. In other words, the Czech equity market proved to fluctuate substantially, since political factors (such as privatisation decisions) as well as market speculations rule the market. It is also evident that market participants process economic information inefficiently because they tend to incorporate changes in economic factors with a time lag and not immediately.

The unpredictable development of the Czech stock market and its low effectiveness hasn't yet had any marked macroeconomic consequences, since the share of equity holding in financial assets of all Czech individuals is negligible and the equity supply on the Czech stock market is low. Deeper econometric analysis of the relationships between the PX50 index and macroeconomic figures reveals three interesting facts. The first, the inverse relation between a change in stock prices and consumer price growth didn't confirm the hypothesis of the positive wealth effect of a Czech stock price rise. Rising equity prices instead boost consumer expenditures and afterwards consumer prices draw free money balances and thus reduce any excess in domestic demand. The second that monetary policy and its interest rate decisions appeared to be minor factors in determining the stock price. Although the Czech economy is one of the economies where financial sources are distributed mainly through banks and marginally through the capital markets, the companies listed on the Prague stock exchange and included in the PX50 are generally cash-rich firms that are not reliant upon bank credits. Thus, the interest rate policy affecting lending costs has negligible or an indirect impact on a companies' performance. Finally, the joint trend of a country's GDP growth and stock index performance was found, however the prediction power of the stock index proved to be very limited. But nobody is saying that it couldn't serve as one of the leading indicators in future economic development.

The last examined hypothesis referred to the portfolio theory applied at the local and international scale. The investigation of diversification opportunities in local markets came to the conclusion that the Czech bond market does not behave as a substitute for the Czech equity market, since they tended to move in the same direction. Nevertheless, the positive

correlation is relatively weak; thereby it is possible to diversify the local portfolio at least in relative terms. A more reliable strategy appears to be diversifying the portfolio either through liquid domestic stocks or internationally through countries and instruments. Nevertheless, ongoing economic convergence raises the question whether this process hasn't significantly reduced the room for portfolio diversification within Europe. Considering the finding that European economic integration has brought the European equity indexes closer together, one can assume that a similar process occurs in the Central Eastern European countries. This hypothesis wasn't, however, confirmed by the correlation analysis performed on the eight-year-long time series of the CEE stock indexes. The effect of global integration proved to have at least as strong an impact as the EU has. What is more the case of Hungary confirms that local factors still have some play.

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