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**Macroeconomic factors and stock returns:
Evidence from three Central and East European countries**

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Abstract

This dissertation deals with the links between stock market returns and foreign exchange rates, industrial production and exports to Germany in three Central and East European countries (the Czech Republic, Hungary and Poland). The main questions addressed are: *“Do macroeconomic factors related to foreign exchange rates and industrial production affect stock market returns in the Visegrad-3? And what is the impact of exports to Germany on those stock returns?”* This analysis makes use of panel-data and the Arbitrage Pricing Theory (APT) to produce results. Firstly, foreign exchange rates are found to have a negative effect on stock returns. However the divergence in currency returns between the three countries means that the overall effect may be due to some factors that are not accounted for in this analysis. Secondly, there is a positive, but lagged, association between industrial production and stock returns. Thirdly, exports to Germany from the region are also found to have a positive impact on the stock returns of the Visegrad-3. Finally, there is divergence among the three countries with respect to the relationship between the macroeconomic factors and stock returns. Poland and Hungary are seen to exert a significant amount of influence over the region’s stock markets.

Keywords

visegrad, macroeconomic factors, arbitrage pricing theory, foreign exchange rates, industrial production, germany, exports

Statement:

1. This statement is to confirm that this paper is a product of my own work and also to confirm that I used the listed sources in producing it.
2. I agree that this paper can be check for research and studying purposes.

Christopher Tung	Prague, 20 May 2009
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ABBREVIATIONS

APT	Arbitrage Pricing Theory
ASEAN	Association of South East Asian Nations
CAPM	Capital Asset Pricing Model
CEE	Central and Eastern Europe
COV	Covariance
CPI	Consumer Price Index
DOT	Direction of Trade (IMF statistics database)
EM	Emerging Market
ERP	Equity Risk Premium
EU	European Union
FDI	Foreign Direct Investment
FOB	Free-on-board (Imports/Exports)
G7	Group of 7 Industrialised Countries
GNP	Gross National Product
IFS	International Financial Statistics (IMF statistics database)
IMF	International Monetary Fund
IPO	Initial Public Offering
M1	Money supply including all coins and currency and demand deposits; Liquid measure of money supply
M2	M1 money supply plus time deposits in savings and certain money market funds
MSCI-ACWI	MSCI Barra All Country World Index (equity index)
NC	National currency
NC/EUR	National currency per Euro
NC/USD	National currency per United States dollar
NPV	Net Present Value
OLS	Ordinary Least Squares
PV	Present Value
S&P 500	Standard and Poor's 500 (equity index)
USD	United States Dollar
VAR	Variance
Visegrad-3	Three of four countries in the Visegrad Group: The Czech Republic, Hungary and Poland

1. Introduction

In the three decades since the term “emerging market” (EM) was introduced, EMs have gained acceptance as suitable investment vehicles for their diversification benefits and potential for higher returns¹. Despite some literature suggesting that they have not lived up to expectations², EMs have continued to attract the attention of both investors and researchers alike as they have integrated into the global economy³. Broadly speaking, EMs have continued to provide out-of-sample data and enabled the testing of established financial and economic theories over time.

The theory related to financial integration suggests that EMs should converge with developed markets over time. More importantly, economic growth hinges on the development of efficient financial markets and the mitigation of systemic risks, which results in a lower cost of capital. There are important financial and economic ramifications associated with a high cost of capital; the most significant consequence being that it inherently deters capital investment thereby reducing economic growth.

In spite of the theory, the empirical literature provides no firm consensus as to the specific nature of convergence between EMs and developed markets. The disagreement also extends to the extent over whether macroeconomic factors affect stock markets in emerging markets. Errunza (1977) concludes that EMs remain segmented since little to no correlation exists between their stock market returns and developed countries⁴.

¹ International Finance Corporation, World Bank Group, “What role did IFC play in coining the term “emerging markets?”, provided via http://www.ifc.org/ifcext/50thanniversary.nsf/Content/Postcards_Mar_28_06, accessed January 17 2010

² Mody, Ashoka, “What Is an Emerging Market?”, International Monetary Fund, IMF Working Paper Series, No. 177, (September 2004)
According to Mody, Klingens, Weder, and Zettelmeyer (2004) find that average returns to private investment in emerging markets has been no higher than the risk-free rate for a while. Returns generated in the 1990s were either a rebound to compensate for losses in the previous decade or a genuine break from the past.

³ This attention materialised in 2001 when a new term was introduced into the jargon of finance signaling EMs arrival on the global stage: B.R.I.C., or Brazil, Russia, India and China³, from Goldman Sachs, “Dreaming with BRICs: The Path to 2050”, Goldman Sachs Global Economics, No. 99, (2003), 3

⁴ Errunza, Vihang R., “Gains from Portfolio Diversification into Less Developed Countries’ Securities”, *Journal of International Business Studies*, (Vol. 8, No. 2, 1977, pp. 83-99), 96

Bekaert and Harvey (1997), however, find that some markets in fact experience time-varying integration following market reforms and economic liberalisation⁵.

With reference to Central and Eastern Europe, it has been two decades since the liberalisation of the Czech, Hungarian and Polish capital markets – referred to here as the Visegrad-3⁶. The presence and support of the European Union’s (EU) common market, its entrenched establishments and *acquis communautaire* have collectively guided the transition economies. The opening of the region’s markets, combined with their accession to the EU, implies an inherent factor of financial, economic and political stabilisation within the region⁷.

Overall, has the process of liberalisation in the transition economies led to stock market efficiency? Full stock market efficiency implies that stock prices have priced all the publicly available information about the fundamental value of listed firms, and that there is little to no new information that can be found elsewhere that would otherwise affect stock returns. Conversely, weak market efficiency offers hedging and arbitrage opportunities to investors, leads investors to demand higher rates of return as a result of mispriced securities, and can increase the cost of capital.

One study conducted by Hanousek and Filer (2000) suggests that CEE stock markets do not exhibit semi-strong efficiency⁸. For example, they find that the Czech Republic’s stock market has become disconnected from the ‘real-world’ partly as a result of the liberalisation effort itself. In comparison to the amount of literature exploring the links between macroeconomic factors and stock markets in developed markets, there exists a limited amount of literature examining the same relationship in the transition economies. Instead, studies have generally examined the sources of risk, such as devaluations or inflation, related to each individual macroeconomic factor.

⁵ Bekaert, Geert and Harvey, Campbell R., “Emerging equity market volatility”, *Journal of Financial Economics*, (No. 43, 1997, pp.29-77), pp.68-72

⁶ For the purposes of this study only three Visegrad Group countries will be used: The Czech Republic, Hungary and Poland. The Slovak Republic is excluded for data reasons.

⁷ World Bank, The, “Transition: The First Ten Years”, The International Bank for Reconstruction and Development / The World Bank, (2002), pp. xiii-xxxi, provided through: <http://siteresources.worldbank.org/ECAEXT/Resources/complete.pdf>, accessed January 28 2010

⁸ Hanousek, Jan and Filer, Randall K., “The relationship between economic factors and equity markets in Central Europe”, *Economics of Transition*, (Vol. 8, Issue 3, 2000, pp.623-638), 635

In view of the theory related to stock market integration and the liberalisation process undertaken in the region, it is important to assess the specific links between global and local sources of macroeconomic risk and financial markets. For finance purposes, the pricing of systemic risk has been the main challenge when determining cost of capital and required rates of return. From the standpoint of an investor, stock prices are the present value of expected *future* cash flows that are in many ways subjected to macroeconomic pressures.

Within the context of rational stock markets the expected return is determined by the underlying risk, be it macroeconomic or otherwise. This dynamic is at the core of modern financial theory, and has resulted in much effort being expended to price risk within the framework described. It has also resulted in the empirical testing of whether predictions made by asset-pricing models are supported by realised equity returns.

Therefore, the primary goal of this paper is to investigate whether two fundamental macroeconomic factors - foreign exchange rates and industrial production - are priced into the stock returns of the Visegrad-3. It will also assess whether changes in the total value of exports to Germany from the region have any additional effect on stock returns. The factors have been selected on an *a priori* basis from the empirical literature that suggests idiosyncratic changes to all three factors should affect the region's stock markets in different ways.

In the case of the export led Visegrad markets, they at one time had or continue to have loose ties to the European Exchange Rate Mechanism II (ERM II), which can effectively be referred to as a quasi-fixed exchange rate regime. Nevertheless, in an attempt to reduce the level of uncertainty that individual investors and firms face when making investment decisions, governments have effectively been obliged to pursue policies oriented toward exchange rate stability. This in part led to the influx of foreign capital to region of around US\$51 billion throughout the 1990's, which enabled the transition economies to re-orient its trade relations with the west⁹.

The expectation is that an appreciating national currency against either the United States dollar (USD) or the euro will affect stock returns to the downside, and is the result of decreased exports demand. This dynamic fundamentally alters the very cash flows that

⁹ World Bank, The, "Transition: The First Ten Years" (2002), 7

drive stock prices as mentioned above. On the other hand, a depreciating national currency will have the opposite affect on stock returns (to the upside) as a result of cheaper exports. Similarly, positive changes in industrial production should affect stock returns to the upside and vice versa. An increase in the production of goods as a result of demand for goods is generally linked to positive cash flows that result in increased stock prices.

A cornerstone of the region's trade relationship with the EU is bi-lateral trade with Germany. Its size and proximity to the region has made Germany an important destination for labour-intensive goods from the CEE region; this includes manufacturing output, industrial metals and primary goods. Exports to the EU from the CEE account for around 50-60% of total exports, while Germany accounts for around 40% of all EU-15 exports to the region¹⁰. On the whole, it is expected that there will be a positive relationship between changes in the dollar value of exports from the Visegrad-3 to Germany and stock returns.

This paper will utilise a macroeconomic factor version of the Arbitrage Pricing Theory (APT) to determine whether the selected macroeconomic factors are priced into stock returns, as well as the extent to which they affect stock returns. The APT is a popular multi-factor asset-pricing model that assumes stock returns can be explained as a linear function of a set of macroeconomic factors. The sample data covers a span of 12 years from 1998-2009, and was obtained from both the International Monetary Fund's (IMF) International Financial Statistics (IFS) database and Direction of Trade (DOT) database.

By specifically examining the stock returns of a sub-set of emerging markets, several limitations are to be expected. The sample size is affected by the data available for each factor being considered, and has consequently reduced the time frame to its current length of 12 years. The dataset is also affected to some extent by Hungarian share index data being available from only 2000 onwards from the IMF¹¹, as well as the effect possible outliers from each of the stock markets may have on the regression outcomes.

¹⁰ Baldwin, Richard E., et al, "The Costs and Benefits of Eastern Enlargement: The Impact on the EU and Central Europe", *Economy Policy*, (Vol. 12, No. 24, Apr. 1997, pp. 125-176), 131

¹¹ This year represents a change in legal status of the Budapest Stock Exchange in Hungary, for which the IMF's IFS has used as the official stock exchange. See: http://www.bse.hu/topmenu/about_us/history, accessed May 1 2010.

Further, because this paper has specifically chosen a set of factors to explain the stock returns in the Visegrad-3, it can be expected that there will be a certain degree of omitted variable bias.

Overall, the results obtained within the framework of the APT suggest that returns of national currencies against either the USD or euro have had a negative effect on stock returns in the Visegrad-3. However, the performance of the currencies on an individual basis leaves the results open to further investigation. On the other hand, the results indicate that industrial production has a positive, but lagged, effect on stock market returns. Finally, exports to Germany are found to have a positive influence on stock returns, confirming the importance of the region's bi-lateral trade relationship with Germany.

This dissertation is organised as follows: Section 2 presents theoretical and empirical reviews; Section 3 explains the methodology (model parameters and specification); Section 4 presents the quantitative results; and Section 5 gives a summary and conclusion.

2. Theoretical and Empirical Review

2.1. The Fisher Separation Theorem and Net Present Value

According to Sabal (2002), valuation projections are “merely estimates from which there could be *both* positive and negative deviations [from normalcy].” In other words, the use of preceding market information to estimate financial risk directly impacts both present and future expectations of value. Since financial risk is the probability of conditions that are unfavourable over time, whereby expected (assumed) returns exceed actual (real) returns, a risky investment requires a risk-return trade-off in the form of higher expected returns.

The separation principle expounded by Fisher (1930) defines parameters for decisions related to consumption, savings and investments¹². Projects with returns greater than the market interest rate have to be accepted. This is captured by the Net Present Value (NPV) formula and is defined as the difference between present value and the cash flow at time-zero. In other words, NPV (and PV) is related to the present day value of a series of future cash flows¹³. In an equivalent manner this can also equate to the present value of a stock.

Cash flows equate to a sum of money within intervals of time and can be either positive or negative (i.e. money in and money out). These are discounted using an interest rate to arrive at present value. Simply put, cash flows discounted by a higher interest rate amounts to lower NPV. The total initial investment “is maximised at the point at which the market interest rate equals the return of the marginal project.”¹⁴ Hence, maximising NPV infers the maximisation of an investor’s wealth over time. NPV is given by the following formula - see Table 1:

¹² Fisher, Irving, *The Theory of Interest*, (New York, USA, The Macmillan Co.), 1930, provided via the Library of Economics and Liberty:

<http://www.econlib.org/library/YPDBooks/Fisher/fshToICover.html>, accessed January 13 2010

¹³ Benninga, Simon, *Financial Modeling*, (Cambridge, Massachusetts, USA, The MIT Press), 2008, 4

¹⁴ Sabal, Jaime, *Financial Decisions in Emerging Markets*, (New York, USA, Oxford University Press), 2002, 19

Table 1: Net Present Value (NPV) formula

$NPV = \sum (C_t / (1+r)^t)$	
C =	Cash flow at <i>n</i> period
n =	Periods or time
r =	Interest rate, or Discount rate

The derivation of the interest rate in the NPV formula above is straight forward in its approach. In fact, NPV and hence the discount rate, should account for the uncertainties (systematic risk) that are believed to exist in the market when discounting cash flows back to present-day value. Ultimately, this led to the development of the Capital Asset Pricing Model (CAPM).

2.2. Asset Pricing: Single Factor Model

2.2.1. The Capital Asset Pricing Model (CAPM)

Asset (and stock) pricing has concerned financial practitioners and academics alike for at least 50 years. Sharpe (1964) and Lintner (1965) introduced the widely accepted pricing theory commonly known as the CAPM¹⁵. Built upon Markowitz’s (1952 & 1959) mean variance portfolio¹⁶, this seminal model uses the stock market index as a variable to explain common stock returns. It pertains to the calculation of *risk-adjusted* expected rates of return, which should exceed the risk-free rate of return – see Tables 2 and 3¹⁷. This also equates to an appropriate “hurdle rate” or discount rate that can be applied to calculate NPV¹⁸.

¹⁵ Sharpe, William F., “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk”, *The Journal of Finance*, (Vol. 19, No. 3, September 1964, pp.425-442)

Lintner, John, “The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets”, *The Review of Economics and Statistics*, (Vol. 47, No. 1, February 1965, pp.13-37)

¹⁶ Markowitz, Harry, “Portfolio Selection”, *The Journal of Finance*, (Vol. 7, No. 1, March 1952, pp.77-91)
 Markowitz, Harry M., *Portfolio Selection: Efficient Diversification of Investments*, (New York, USA, John Wiley & Sons, Inc.), 1959, provided via Cowles Foundation for Research in Economics (Yale University): <http://cowles.econ.yale.edu/P/cm/m16/index.htm>, accessed January 10 2010

¹⁷ Sabal (2002), 99

¹⁸ Shapiro, Alex, “The Capital Asset Pricing Model (CAPM)”, *Foundations of Finance*, New York University Stern School of Business, provided via: <http://pages.stern.nyu.edu/~ashapiro/>, accessed January 9 2010

The CAPM states that a single asset's risk should reflect its contribution to the overall risk of a portfolio, and should be measured as the sensitivity of the asset's returns on the returns of the overall market. The classical CAPM model uses the variance given by a stock market as part of the beta (β) function measure of risk. When i is a *risk-free asset* in the beta calculation, its covariance (correlation) with the market portfolio is zero and thus also its beta. However when i is the *total market portfolio*, or another equivalent risky asset, the quotient changes to equal 1 in the latter case, and either between 0 and 1 or above 1 in the former.

In other words, the expected returns calculated by CAPM are dependent on the calculation of beta that measures unknown systematic risk in the market. The higher the covariance of an asset is with a market portfolio the higher the beta; this implies greater covariance than the variance of the market portfolio¹⁹.

Table 2: The Capital Asset Pricing Model (CAPM):

$E(R_i) = R_f + \beta_i [E(R_m) - R_f]$	
$E(R_i) =$	An asset or portfolio's expected return
$R_f =$	Risk-free rate
$R_m =$	Expected return of the market portfolio
$\beta_i =$	Beta, or measure of risk for an asset or portfolio

Table 3: The CAPM beta function derivation:

$\beta_i = \text{Cov}(R_i, R_m) / \text{Var}(R_m)$	
$\beta_i =$	Beta, or measure of risk for an asset or portfolio
$\text{Cov}(R_i, R_m) =$	Covariance of asset _{i} and market portfolio
$\text{Var}(R_m) =$	Variance of market portfolio

As a consequence of using just one factor - i.e. the market - the CAPM faces restrictive and critically broad assumptions. The CAPM as presented above can be deduced from the one-factor model only if several assumptions hold in a "CAPM world".

¹⁹ Sabal (2002), 99-111

These assumptions include²⁰:

1. Risk aversion, rational and at the same time utility maximising.
2. Returns are normally distributed.
3. All securities or financial assets are marketable can be bought and sold on a market.
4. No transaction costs.
5. An investor is not able to influence the price of a security when buying and selling.
6. Homogeneity of expectations; *all* investors agree to the distribution of expected returns.
7. Unlimited borrowing and lending at the same risk-free rate.

Early empirical testing of the CAPM by Black, Jensen and Scholes (1972), as well as Fama and Macbeth (1973), confirm the validity of the CAPM up to the 1960's and 1970's²¹. However, further empirical analysis has shown there to be inconsistencies between average stock returns and the CAPM, leading to the conclusion that the CAPM has poor explanatory power - i.e. Fama and French (1992)²².

The empirical analyses specifically show there to be a degree of cross-sectional variation in the expected return of assets that is not captured by the beta function. By using the CAPM market beta as the sole factor of risk to predict asset returns, returns to low-beta stocks tend to be underestimated while the opposite holds for high-beta stocks. The model confines itself to using the stock market as the sole arbiter of variance in financial markets whilst other forces were possibly significant in their influence.

²⁰ Sabal (2002), 91-99

²¹ Black, Fischer, Jensen Michael C., and Scholes, Myron, "The Capital Asset Pricing Model: Some Empirical Tests", ed. Michael C. Jensen, *Studies in the Theory of Capital Markets*, (New York: Praeger, pp.79-121), 1972

Fama, Eugene F., Macbeth, James D., "Risk, Return, and Equilibrium: Empirical Tests", *The Journal of Political Economy*, (Vol. 81, No. 3, May-June 1973, pp.607-636)

²² Fama, Eugene F., and French, Kenneth R., "The Cross-Section of Expected Stock Returns", *The Journal of Finance*, (Vol. 47, No. 2, June 1992, pp. 427-465)

Moreover, the model is shown to underestimate market risk premiums and overestimate the risk-free rate²³.

As a result of the simplified assumptions above, enhancements were made to the original CAPM model. While this paper will perform an analysis of the classical CAPM, and not any of the enhanced versions, the following examples lay out the importance of the theoretical foundations of the CAPM in the pricing of assets.

Estrada (2007), for example, presents modern yield-based CAPM modifications by Lessard (1996), Godfrey and Espinosa (1996), Goldman Sachs (1999) and SalomonSmithBarney (2002)²⁴. Such adjustments to the model imply an inherent capacity to account for risks associated with financing a project, and in particular the impact those risks will have on a project's cash flows and ultimately its expected returns²⁵.

More critically, additions to the CAPM that account for perceived risks are developed on an ad-hoc basis and are affected by subjective means²⁶, ultimately drawing one further from the original theoretical boundaries. Each model causes expected return, and thus the cost of capital, to be distorted causing firms to potentially miss valuable investment opportunities. Still, these models attempted to quantify the effects of other factors and trade-offs between other (systematic) risks and expected returns²⁷. Estrada (2007) notes that the CAPM remains a popular asset-pricing model among financial practitioners.

²³ Groenewold, Nicolaas and Fraser, Patricia, "Share Prices and Macroeconomic Factors", *Journal of Business Finance & Accounting*, (24, No. 9 & 10, October & December, 1997, pp.1367-83), 1367

²⁴ As seen in: Estrada, Javier, "Discount Rates in Emerging Markets", *Journal of Applied Corporate Finance*, (Vol. 19, No. 2, Spring 2007, pp.71-78), 76

²⁵ Estrada (2007), 72

²⁶ Estrada (2007), 72 and Sabal (2002), 5

²⁷ Note: Equivalent to the cost of capital and discount rate, or "hurdle rate".

2.3. Asset Pricing: Multi-factor Models

Developments in financial theory led to the formulation of multi-factor models by King (1966) and Merton (1973)²⁸. Merton, for example, developed what became known as an inter-temporal CAPM, or consumption model. This model was extended to include a state factor such as labour income; it assumed that investor wealth was the result of state variables. Merton suggested that the issue most critical to investors was the expected return expressed as the correlation (covariance) of the asset to state variables that were included in the analysis²⁹.

Multi-factor models utilise multiple factors to explain abnormal market movements and equilibrium asset prices, thus allowing for risk to be priced adequately. Essentially, an individual asset or portfolio's returns are correlated with other factors of risk other than the market, unlike the classical CAPM. Even so, the market remained the most significant pricing variable in these models. Consequently, the Fama-French three-factor model and the Arbitrage Pricing Theory (APT) are often put forth as the most significant examples of the development of multi-factor pricing models.

2.3.1. The Fama-French Model

In light of the CAPM's shortcomings, other variables such as firm specific factors were reckoned to have significant effects on stock returns. For example, a study by Basu (1977) finds a positive significance of earnings-to-price (E/P) ratios³⁰. Alternatively, Fama and French (1992) find that firm size and book-to-market equity ratios (BE/ME) are significant in explaining cross-sectional variation in stock returns³¹. In doing so, Fama

²⁸ King, Benjamin F., "Market and Industry Factors in Stock Price Behavior", *The Journal of Business*, (Vol. 39, No. 1, Part 2: Supplement on Security Prices, January 1966, pp.139-190)

Merton, Robert C., "An Intertemporal Capital Asset Pricing Model", *Econometrica*, (Vol. 41, No. 5, September 1973, pp.867-887)

²⁹ Merton (1973), 868 - 870

³⁰ Basu, S., "Investment Performance of Common Stocks in Relations to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis", *Journal of Finance*, (Vol. 32, No. 3, June 1977, pp.663-682), 663

³¹ Fama and French (1992), 428

and French find that the CAPM alone becomes insignificant, reinforcing Black, Jensen and Scholes (1972).

The rationale behind what became the Fama-French asset-pricing model was based on firm specific measures that are correlated with underlying risk factors, i.e. risks associated with the firm itself. A common conclusion is that companies with low market value of equity, as well as companies with large differences between market and book value of equity, are more often than not financially unstable. The greater returns generated by such firms represent an intuitive basis for compensation required by investors for assuming higher risks associated with discrepancies in BE/ME ratios³².

In reference to this paper, a study conducted by Borys (2007) of four asset-pricing models concludes that the Fama-French model is impractical when analyzing the stock markets of the Visegrad Group³³. Specifically, the limited number of stocks listed on the stock exchanges in the region is cited to be the primary reason why the Fama-French factors could not be constructed³⁴. It is also acknowledged - much like Harvey (1995) - that the standard one-factor CAPM model does not hold in emerging markets.

Instead, by citing Bekaert and Harvey (1995)³⁵, Borys explains that given the dynamic process under which emerging markets have integrated into the global economy, the cost of capital should be allowed to vary over time³⁶. Borys ultimately concludes that the use of a multi-factor model, based primarily on the findings by Chen, Roll and Ross (1986), provides the best solution to estimate cost of capital in Visegrad-3 markets.

³² Novak, Jiri and Petr, Dalibor, "Empirical Risk Factors in Realized Stock Returns", Institute of Economic Studies (IES) Working Paper, Charles University, 29/2009, (2009), pp.1-2

³³ Borys, Magdalena Morgese, *Testing Multi-Factor Asset Pricing Models in the Visegrad Countries*, Charles University, Center for Economic Research and Graduate Education, Economics Institute, Working Paper Series 323, (2007), pp.8-9

³⁴ Borys (2007), 35

³⁵ Bekaert, G., and C. Harvey, "Time-Varying World Market Integration", *Journal of Finance*, (50, 1995, pp.403-444)

³⁶ Borys (2007), 7

2.3.2. The Arbitrage Pricing Theory (APT) and Macroeconomic Factor Model

Developed by Ross (1976), the APT permits the inclusion of multiple factors to help explain the relationship between expected returns of an asset by an absence of arbitrage opportunities³⁷. It holds that the expected rate of return of a financial asset can be modelled by taking advantage of possible price discrepancies among assets. In other words, the APT is derived from an arbitrage argument for asset returns generated by a multi-factor model.

Unlike the one-factor CAPM, the APT predicts a relationship between the market (or a portfolio) and the returns of an asset by a linear function of a set of multiple macroeconomic factors. It does not rely on the market as the sole factor of risk. Though early empirical research related to the APT analyzed returns of individual securities, the general model can also be used within an aggregate stock market framework.

Overall, the APT has a greater degree of flexibility in its assumptions and gives it greater explanatory power over single-factor asset-pricing models such as the CAPM³⁸. From an empirical standpoint the APT is often identified as a superior, and popular, alternative to the flawed but widely used CAPM. Sinclair (1987) points out, the multi-factor feature of the APT gives it potential to overcome the weaknesses associated with the CAPM's assumptions – see Section 2.2.1³⁹.

The APT, however, does not specify what or how many macroeconomic factors are relevant to asset pricing. This makes it unable to explain variations in stock returns in terms of a limited number of identifiable and uncorrelated factors. It also renders the factors difficult to interpret⁴⁰, leading Groenewald and Fraser (1997) to claim that this causes such real-world analyses and interpretations to be moot because the factors are not easily identifiable⁴¹.

³⁷ Ross, Stephen A., “The Arbitrage Theory of Capital Asset Pricing”, *Journal of Economic Theory*, (13, 1976, pp.341-360), pp.341-343

Sabal (2002), 107

See Section 3.1 for methodology.

³⁸ Sabal (2002), 107

³⁹ Sinclair, N.A., “Multifactor asset pricing models”, *Accounting and Finance*, (Vol. 27, 1987, pp. 17-36)

⁴⁰ Sabal (2002), 107

⁴¹ Groenewald and Fraser (1997), 1367-69

Nevertheless, in a study of the Australian equity market, they obtain results confirming the superiority of the multi-factor APT over the CAPM in terms of explanatory power.

Roll and Ross (1980), in the first empirical study of the APT, confirm several shortcomings related to the APT's lack of specification. They conclude that factors derived through multi-factor analysis should in fact be fundamental macroeconomic aggregates⁴². They also suggest further analysis of what economic factors systematically affect returns⁴³ since factors used in the APT would be proxied by derived factors⁴⁴.

As the APT instigated the use of variables without the pre-specification of variables, it has become common for the factors to be derived statistically via factor analysis or principal components analysis⁴⁵. Groenewold and Fraser (1997) note that much of the empirical literature related to the use of the APT uses either of the statistical approaches to generate artificial factors.

The two-step test is the most common method used to test the APT. This involves the use of time-series data to estimate a set of factor loadings for each asset, which are then used in cross-sectional regression analysis to explain mean asset returns in a manner similar to two-step testing of the CAPM, i.e. Roll and Ross (1980) and Chen (1983).

Other empirical studies based on the APT linking macroeconomic factors and stock market returns are, assuming trend stationarity, characterised by modelling short run relationships between macroeconomic variables and stock prices in terms of first differences. These papers have generally found a significant relationship between changes in macroeconomic variables and stock returns, and include factors such as industrial production, inflation, interest rates and the yield curve.

On the other hand, instead of using artificially devised factors and their corresponding sensitivities, the factors can be selected on an *a priori* basis. This is a particular strength of the model even though problems can be exacerbated by the general lack of consensus regarding the relationship between specific macroeconomic risk factors and the stock market, especially in EMs,

To reiterate, Humpe and Macmillan (2007) state that in the APT changes in a given macroeconomic variable can be reflected in changes to an underlying systemic risk

⁴² Roll, Richard and Ross, Stephen A., "An Empirical Investigation of the Arbitrage Pricing Theory", *The Journal of Finance*, (Vol. 35, No. 5, December 1980, pp.1073-1103), 1077

⁴³ Roll and Ross (1980), 1077

⁴⁴ Roll and Ross (1980), 1100

⁴⁵ Kandir, Serkan Yilmaz, "Macroeconomic Variables, Firm Characteristics and Stock Returns: Evidence from Turkey", *International Research Journal of Finance and Economics*, (Issue 16, 2008, pp.35-45), 36

factor that influences future market returns⁴⁶. Given this assertion, the selection of macroeconomic factors is based on the idea that three classes of factors influence stock returns: real domestic activity, nominal domestic influences and foreign factors⁴⁷. As such, this method has been chosen for this paper since it could provide the best explanation for a particular set of sample data in question.

In light of the development of the APT, Chen, Roll and Ross (1986) propose a macroeconomic factor model in an attempt to use local macroeconomic factors as proxies for risk to explain variations in stock returns⁴⁸. It was acknowledged that stock returns could be explained by the systemic relationship between economic fundamentals and financial markets⁴⁹. In other words, equity returns could be expressed as a function of changes to specific macroeconomic variables.

The model specifies the use of pre-determined macroeconomic factors as proxies for undefined variables in the APT. In contrast, the model put forth by Chen, Roll and Ross (1986) allows for macroeconomic factors to be realised and interpreted. Their analysis yielded a set of macroeconomic variables that could be used and are related to the three classes of factors that affect stock returns as stated above⁵⁰.

Chen, Roll and Ross (1986) rationalise that macroeconomic forces influence expected cash flows and/or stock dividends⁵¹. This ultimately affects the expected rate of return, or discount rate. Here, the appropriate discount rate is affected by risk factors such as interest rates and is therefore “risk-adjusted”. In view of the literature related to financial theory (i.e. NPV), changes in the macroeconomic variables would inherently alter investors’ perceptions of future cash flows thereby affecting the prices of present equity/share values – see Section 2.1.

⁴⁶ Humpe, Andreas and Macmillan, Peter, “Can macroeconomic variables explain long term stock market movements? A comparison of the US and Japan”, Centre for Dynamic Macroeconomic Analysis, University of St Andrews, Working Paper Series, CDMA07/20, (October 2007), 2

⁴⁷ Groenewold and Fraser (1997), 1377

⁴⁸ Chen, Nai-Fu, Roll, Richard, Ross, Stephen A., “Economic Forces and the Stock Market”, *The Journal of Business*, (Vol. 59, No. 3, July 1986, pp.383-403), 402

⁴⁹ Chen, Roll and Ross (1986), 384

⁵⁰ These include: Inflation, GNP, shifts in yield curve and corporate default premiums. According to Groenewold and Fraser (1997) the test performed by Chen, Roll and Ross (1986) was similar to the CAPM two-step tests.

⁵¹ The macroeconomic factors include: consumption (industrial or otherwise), energy prices, real production, employment, currency exchange and inflation.

Overall, within the realm of either the APT or the macroeconomic factor model, there exists no theoretical framework for choosing a set of macroeconomic variables. There is also a lack of consensus as to what factors are best able to explain cross-sectional variations in stock returns. Moreover, the two-step procedure utilised by Chen, Roll and Ross (1986) also suffers from the same weaknesses associated with the two-step CAPM test - it is subject to errors-in-variables issues given the use of linear regression methods⁵².

In general, the literature either picks variables based on intuitive assumptions or are based on previous studies related to the correlation of the macro-economy and financial markets⁵³. This particularly applies when examining emerging markets, although recent literature identifies specific macroeconomic variables as outlined in the literature review below.

2.4. Stock Market Integration

Early studies exploring the relationship between EMs and developed markets suggest that EMs are segmented from global capital markets. Errunza (1977) concludes that EMs remain segmented because emerging market returns are weakly correlated with developed markets. This may result in market inefficiencies and mispriced securities. In other words, if emerging markets are indeed segmented, certain arbitrage opportunities exist since future returns are determined entirely by information that is not contained – or not priced – into the stock market. An international investor can profit by enhancing mean-variance efficiency in an investment portfolio by trading on information and local factors of risk⁵⁴.

Harvey (1995) concludes that segmentation increases the importance of local market information⁵⁵, which can be used to profit. He finds that out of 12 emerging

⁵² Groenewold and Fraser (1997), 1370

⁵³ Chen, Roll and Ross (1986), 402

⁵⁴ Errunza (1977), 96

⁵⁵ Harvey, Campbell R., “Predictable Risk and Returns in Emerging Markets”, *The Review of Financial Studies*, (Vol. 8, No. 3, 1995, pp.773-816), 800-801

Harvey obtains results from regressions on local information variables, which include foreign exchange rates against the U.S. dollar, the dividend yield and local short-term “unregulated” interest rates, i.e. deposit rates, money market rates, bank rates and U.S. Treasury bill rates.

markets examined 10 exhibit significant regressions. Moreover, Korajczyk (1996) and Shackman (2006) observe that EM segmentation tends to be larger and suggest that local risk factors are critical in the pricing of risk⁵⁶. This infers that a consequence of being segmented from the world market portfolio entails a higher cost of capital, which inherently deters capital investment and handicaps future economic growth⁵⁷.

As a result of investor diversification over time, however, capital flows from external markets are considered to be a contributing factor to improving capital liquidity in EMs. This aids the development process by making capital available for investment purposes. This ultimately spurs economic growth and gradual co-integration⁵⁸. Errunza (1983), Claessens, Dasgupta and Glen (1995) and Harvey (1995) point out that while returns and risks are higher in EMs, they do exhibit varying degrees of segmentation relative to developed capital markets over time⁵⁹.

In fact, Bekaert and Harvey (1995) argue that emerging market integration is dynamic, rather than static. Put differently, various emerging markets exhibit time-varying integration whilst others remain segmented and are at first uncorrelated to developed markets⁶⁰. Most significantly, Bekaert and Harvey (1995) point out that the cost of capital should be allowed to vary as markets develop⁶¹.

As a follow up, Bekaert and Harvey (1997) find that liberalisation processes undertaken in emerging markets instead *increases* correlation with world markets after

⁵⁶ Korajczyk, Robert A., "A Measure of Stock Market Integration for Developed and Emerging Markets", *The World Bank Economic Review*, (Vol. 10, No. 2: A Symposium Issue on Stock Markets and Economic Development, 1996, pp.267-289), 267

Shackman, Joshua D., "The equity premium and market integration: Evidence from international data", *Journal of International Financial Markets, Institutions and Money*, (No. 16, 2006, pp.155-179), 176

⁵⁷ King, M.R., and Segal D., "Market segmentation and equity valuation: Comparing Canada and the United States", *Journal of International Financial Markets, Institutions and Money*, (Vol. 18, 2008, pp. 245-258), 246

Interestingly, King and Segal (2008) see no evidence of integration over time in examining developed North American stock markets, and suggest that even Canada may actually be at a disadvantage in terms of cost of capital.

⁵⁸ Errunza (1977), 96

⁵⁹ Errunza, Vihang R., "Emerging Markets: A New Opportunity for Improving Global Portfolio Performance", *Financial Analysts Journal*, (Vol. 39, No. 5, 1983, pp.51-58), 57

Claessens, Stijn, Dasgupta, Susmita and Glen, Jack, "The Cross-Section of Stock Returns: Evidence from Emerging Markets", The World Bank, Policy Research Department, WPS 1505, (September 1995), 15

Harvey (1995), 775

⁶⁰ Bekaert, and Harvey (1995), 434

⁶¹ Bekaert and Harvey (1995), pp.435-37

controlling for time factors⁶². They find that sources of risk in emerging markets undergo fundamental changes over time as integration - as opposed to segmentation – occurs and economies develop. This suggests that *global* sources of risk become more significant as time progresses. The resulting increase in correlation with developed markets should substantially lower the cost of capital and expected returns.

Given an increase in correlation with world markets, Bekaert and Harvey (1997) conclude that parallel increases in portfolio flows and foreign direct investment (FDI) ensue as a result of the effects of macroeconomic and financial liberalisation. Contrary to other findings, Bekaert and Harvey (1997) also find no increase in local market volatility⁶³. Their findings infer that correlation with developed markets should incidentally lower the opportunities to profit via arbitrage since markets become integrated and more efficient.

An extensive study conducted by Bekaert, et al. (1998) assesses the main determinants of emerging market growth and the quantitative distributional characteristics of emerging market returns over time⁶⁴. On one hand they conclude returns over time show non-normal distributional characteristics, and exhibit significant skewness and kurtosis, – i.e. deviations from the norm. On the other hand they confirm that the distribution of emerging market returns changes through time even though returns continue to exhibit deviations from normality (i.e. returns in developed markets).

De Jong and de Roon (2005) find that markets become more integrated after the implementation of capital market reforms⁶⁵, thus reinforcing the conclusions made by Harvey (1995) and Bekaert, et al (1998)⁶⁶. Coincidentally, Brooks and Del Negro (2002) conclude that Europe has integrated its markets to a greater degree than other regions. They reason that the development of the European Monetary Union (EMU) as a regional

⁶² Bekaert and Harvey (1997), 29

⁶³ Bekaert and Harvey (1997), 68

⁶⁴ Bekaert, Geert, Erb, Claude B., Harvey, Campbell R., and Viskanta, Tasdas E., “Distributional Characteristics of Emerging Market Returns and Asset Allocation”, *The Journal of Portfolio Management*, (Winter, 1998, pp.102-116), 114

⁶⁵ De Jong, Frank and de Roon, Frans A., “Time-varying market integration and expected returns in emerging markets”, *Journal of Financial Economics*, (Vol. 78, Iss. 3, December 2005, pp.583-613), 609

⁶⁶ Harvey (1995), pp.435-37
Bekaert et al. (1998), 107

bloc was the principle determinant, and that specific industry effects within the region have superseded country effects over time⁶⁷.

Overall, the findings above indicate that there is a dynamic and positive relationship between the steps taken to integrate financial markets and cross-border capital flows. This has important socio-economic and financial implications and confirms that the economic development process remains a fundamental driver of capital market development and financial integration⁶⁸.

2.5. The Central and East European Case

Following the collapse of communism and the command economic system, the major CEE nations faced the task of restructuring their economies into free-market economies. The main challenge during the transformational phase was increasing productivity in the wake of a severe drop in output and recession. The ultimate goal, still, was membership of the single European market⁶⁹.

In pursuance of this goal the transition economies implemented broad liberalisation schemes in an effort to throw open their economies. A major source of economic growth stemmed from the policies implemented to attract foreign capital during the process of reorienting the CEE economies toward the west.

Within the context of macroeconomic liberalisation, Janicki and Wunnava (2004) find that the key determinants of FDI in CEE markets included the size of the host economy, host country risk, labour costs and openness to trade⁷⁰. They find a positive relationship with respect to economic development and integration, and argue that continuous adjustments to economic and political agendas suiting investors have resulted in FDI inflows.

⁶⁷ Brooks, Robin and Del Negro, Marco, "International Stock Returns and Market Integration: A Regional Perspective", The International Monetary Fund, IMF Working Paper Series, WP/02/202, (November 2002), 16

⁶⁸ Bevan, Alan A., and Estrin, Saul, "The determinants of foreign direct investment into European transition economies", *Journal of Comparative Economics*, (32, 2004, pp.775-787), 776

World Bank, The, "Transition: The First Ten Years" (2002), pp.3-7

⁶⁹ World Bank, The, "Transition: The First Ten Years" (2002), 3

⁷⁰ Janicki, Hubert P., and Wunnava, Phanindra V., "Determinants of foreign direct investment: empirical evidence from EU accession candidates", *Applied Economics*, (36, 2004, pp.505-509), 506

Even so, Neck, Haber and McKibbin (2000) note that quantitative estimates of the effects transitional phase have produced a broad range of results depending on the assumptions applied and methodologies used⁷¹. Specifically, when it came to the development of the financial markets in the transition economies, both the methods and results diverged.

In terms of market development and integration there are significant differences that mark each of the Visegrad-3. Kominek (2003) explains that while the Czech Republic turned to free market principles, Poland favoured limited administrative regulation and control. In particular, this was reflected in their attitudes towards the development of their respective stock markets. The Czech Republic opted for a substantial open privatisation program, while markets in Hungary and Poland experienced relatively small market capitalisations at first⁷².

There are additional differences between the Visegrad-3 stock exchanges that affected their development. Primarily, the relative success of the Polish securities market was marked by the presence of stronger legal enforcement capabilities by regulatory authorities. There also existed enhanced disclosure standards in Poland at an earlier stage⁷³. As such, these differences combined to spur investor participation, particularly in Hungary and Poland by 1993⁷⁴.

Prompted by a relative lack of liquidity, the eventual failure, so to speak, of the Czech stock exchange resulted in an unfortunate situation where firms were unable to raise investment capital through public offerings (i.e. stock issuance). Between 1997-2000, there were no initial public offerings (I.P.O.) in the Czech Republic, compared to

⁷¹ Neck, Reinhard, Haber, Gottfried and McKibbin, Warwick J., "Macroeconomic Impacts of European Membership of Central and Eastern European Economies", *Atlantic Economic Journal*, (Vol. 28, Iss. 1, March 2000, pp.71-82), pp.72-73

⁷² Kominek, Zbigniew, "Stock markets and industry growth: an eastern European perspective", European Bank for Reconstruction and Development, Working Paper Series, Working paper No. 81, (October 2003), 2

⁷³ Kominek, (2003), 2

⁷⁴ Sokalska, Magdalena, "What Drives Equity Returns in Central and Eastern Europe", (Warsaw School of Economics, Instytut Ekonometrii, Working Paper, (September 2001), 4
According to Sokalska (2001), the average market capitalization of the Warsaw stock exchange was USD\$7 billion in 1996; this was substantially larger than in either the Czech Republic or Hungary.

the roughly USD\$1.06 billion offered through the Polish securities market in the same period⁷⁵.

In terms of market efficiency, Hanousek and Filer (2000) suggest that CEE equity markets do not exhibit semi-strong form efficiency for the years 1993-1999. They find that the stock markets are somewhat disconnected from the real economy and the developed world, particularly in the Czech Republic. Their conclusions also indicate that for the period in question there seems to be little conformity between the stock markets of the Visegrad-3 themselves.

With respect to the Czech Republic, Hanousek and Filer (2000) find that there is little to no correlation between both current and lagged economic variables and stock market returns. Moreover, the Czech equity market does not exhibit semi-strong efficiency, resulting in the rejection of their primary hypothesis. This suggests that the Czech market is inefficient in processing information and has, in fact, regressed to become entirely divorced from the real economy and the real world over time.

In Hungary and Poland, they find that a weak relationship exists between changes in values of local economic factors and changes in stock returns. However, the correlations are substantially higher when economic variables occur with lags⁷⁶.

While their findings do not wholly conform to the conclusions made by Bekaert and Harvey (1997), Hanousek and Filer (2000) nonetheless show that there is indeed a dynamic relationship between macroeconomic factors and stock returns over time. The differing approaches in the development of the three stock markets, and their governing institutions, are the central determinants behind their findings. It stands to reason, then, that ongoing market reforms should result in substantially different outcomes over time⁷⁷.

In another study Sokalska (2001) investigates the co-movement of equity prices in the Czech Republic, Hungary and Poland and finds that the stock markets in fact move together⁷⁸. Fundamental (local) macroeconomic variables are relatively unimportant, which in some ways confirms the conclusions made by Hanousek and Filer (2000).

⁷⁵ Kominek (2003), 3

⁷⁶ Hanousek and Filer (2000), pp.633 and 635-36

⁷⁷ Hanousek & Filer (2000), pp.634-5

⁷⁸ Sokalska (2001), 13

Instead, it is found that the key drivers influencing market returns seem to be exogenous, and pertain to foreign capital flows (i.e. portfolio flows)⁷⁹. According to Sokalska (2001) this speaks to the importance of FDI and foreign investment into the Visegrad markets and the control with which they are able to exert over market transactions⁸⁰.

Hanousek, Kocenda and Kutan (2007) also examine the intra-day reaction of asset prices to macroeconomic announcements in the Czech Republic, Hungary and Poland. They find that all three stock markets are impacted by the release of macroeconomic news from the EU, the U.S. and neighbouring markets.

Hungary and Poland exhibit strong spillover effects from the EU, while the Czech market is affected to a larger degree by macroeconomic news from the U.S. They conclude that this is due to foreign investors who make up a significant part of traded volumes, and indicate that as the three countries move towards joining the Euro-zone they will become more susceptible to macroeconomic shocks⁸¹.

The early studies that examine the major stock markets of the CEE have shown them to be segmented from global markets. Conversely, there is some conclusive evidence that over time the same stock markets react to sources of macroeconomic risk and have in turn exhibited nascent semi-efficiency.

⁷⁹ Sokalska (2001), pp.12-3

⁸⁰ Sokalska (2001), pp.4-5

⁸¹ Hanousek, Jan, Kocenda, Evzen and Kutan, Ali. M., “The Reaction of Asset Prices to Macroeconomic Announcements in New EU Markets: Evidence From Intraday Data”, Charles University, Center for Economic Research and Graduate Education [CERGE-EI], Working Paper Series 340, (March 2008), pp.18-9

2.6. Macroeconomic Factors and the Stock Market

2.6.1. Empirical Literature Review

It is acknowledged that before they gradually integrate over time, early stage emerging market stock returns are segmented from developed markets. As such, the literature considers economic development, and by extension macroeconomic variables, to be a factor in explaining the cross-sectional variations of returns as stock markets integrate.

There are a variety of factors that contribute to fluctuations in stock market returns. Each factor impacts the stock market to varying degrees depending on prevailing economic conditions and institutional foundations. Though this paper analyzes only two specific macroeconomic factors, the empirical literature below provides an overview of the dynamic relationship between macroeconomic factors and stock returns in developed and emerging markets.

The *first* group of studies examining the links between macroeconomic factors and stock returns were based on developed countries. Due to historical circumstances as well as the breadth and depth of developed markets this is unsurprising.

Chen, Roll and Ross (1986) test whether they can explain the variations in stock returns in the United States, Japan and Europe by using the macroeconomic factor model. They examine the relationship using seven macroeconomic factors⁸² and conclude that the consumption variable, the total market index and oil prices are not priced by the financial market. These factors are therefore divorced from observed returns. On the other hand, industrial production, changes in the market risk premium and the overall yield curve *are* significant in explaining expected stock returns⁸³.

Chen (1991) also examines stock returns in the United States and found that stock market returns, in an inter-temporal market equilibrium, could be forecast by interpreting

⁸² Chen, Roll and Ross (1986), 387

The variables include Inflation, Treasury-bill rates, Long-term government bond rates, Industrial Production, Low-grade bond rates (Baa), Consumption and Oil prices.

⁸³ Chen, Roll and Ross (1986), 402

macro-economic variables. These included: growth rate of industrial production, credit-default spreads, term-spreads, Treasury-bill rates and the dividend-to-price ratio⁸⁴.

In light of developments in financial markets and changes in consumer behaviour, Flannery and Protopapadakis (2002) re-examine the effects of macro-economic factors on US stock returns. They find balance of trade, employment, the consumer price index, the producer price index, housing starts and M1 monetary aggregate⁸⁵ to be significant in explaining stock market returns⁸⁶.

Humpe and Macmillan (2007) examine the effect of macroeconomic factors on long-term stock movements in the US and Japan within the framework of a discounted value model. Using co-integration analysis, they find that a single vector positively influences long-run returns in the US: industrial production. The consumer price index and long-term interest rate are negatively related. In Japan, they find two co-integrating vectors. Market returns are positively influenced by industrial production and negatively by money supply; however the CPI and long-term interest rates negatively influence industrial production. They link this to Japan's economic malaise in the 1990's and the resulting liquidity trap⁸⁷.

With respect to the United Kingdom Clare and Thomas (1994) investigated stock returns using the APT and 18 macro-economic factors to determine their magnitudes. They find that the retail price index, bank lending, corporate default risk and the price of oil to be significant determinants of market returns⁸⁸. Another study related to the Japanese stock market by Mukherjee and Naka (1995) used vector-error correction approach and co-integration relationships. They confirmed that the exchange rate, the inflation rate, money supply, long-term government bond rates and real economic activity to be significant determinants of stock market returns⁸⁹.

⁸⁴ Chen, Nai-Fu, "Financial Investment Opportunities and the Macroeconomy", *The Journal of Finance*, (Vol. 46, No. 2, June 1991, pp.529-554), 553

⁸⁵ A category pertaining to money supply (in circulation) and equals cash supplies held in demand deposit accounts

⁸⁶ Flannery, Mark J., and Protopapadakis, Aris A., "Macroeconomic Factors Do Influence Aggregate Stock Returns", *The Review of Financial Studies*, (Vol. 15, No. 3, Summer 2002, pp.751-782), 774

⁸⁷ Humpe and Macmillan, 14

⁸⁸ Clare, Andrew D., and Thomas, Stephen H., "Macroeconomic factors, the APT and the UK stockmarket", *Journal of Business Finance & Accounting*, (21, No. 3, April 1994, pp.309-330)

⁸⁹ Mukherjee, T.K., and Naka, A., "Dynamic relations between macroeconomic variables and the Japanese

A *second* series of studies investigating the relationship between macroeconomic factors and stock market returns were specifically related to East Asian and Latin American markets. These were considered to be developing at the time and the results differed according to the macroeconomic factors used, methodology and countries tested.

Early studies examining the relationship between macroeconomic variables and EM stock returns in Mexico and Singapore by Bailey and Chung (1995) and Mookerjee and Yu (1997) respectively yielded significant results⁹⁰. Bailey and Chung (1995) examine the effects of currency and political risk on Mexican equity market risk premiums. They find that the exchange rate against the USD, and debt spreads between the US and Mexico, are significant in explaining variations in returns⁹¹. Moreover, their results show that a degree of importance is attached to the exchange rate, complementing literature in international finance.

Bailey and Chung (1996) also test a multi-factor model in the Philippine market. Their findings could not explain stock market returns based on exchange rates and political changes on owners of Philippine equities⁹². In Singapore, Mookerjee and Yu (1997) investigate macroeconomic effects on stock returns. They find long-run equilibrium relationships between market returns and money supply (M1 & M2), as well as total foreign exchange reserves; there is no similar relationship with exchange rates⁹³.

In Korea, Kwon and Shin (1999) found that returns were co-integrated with four macro-factors: exchange rates, trade balance, industrial production and money supply⁹⁴. Ibrahim and Aziz (2003) investigate the stock returns in the Malaysian market and determine that industrial production and CPI share a long run and positive relationship.

stock market: An application of a vector error correction model”, *Journal of Financial Research*, (Vol. 18, 1995, pp.223-37)

⁹⁰ Bailey, Warren and Chung, Peter Y., “Exchange Rate Fluctuations, Political Risk, and Stock Returns: Some Evidence from an Emerging Market”, *The Journal of Financial and Quantitative Analysis*, (Vol. 30, No. 4, December 1995, pp.541-561), 558

Mookerjee, Rajen and Yu, Qiao, “Macroeconomic variables and stock prices in a small open economy: The case of Singapore”, *Pacific-Basin Finance Journal*, (No. 5, 1997, pp.377-388), 387

⁹¹ Bailey and Chung (1995), 558

⁹² Bailey, Warren and Chung, Y. Peter, “Risk and return in the Philippine equity market: A multifactor exploration”, *Pacific-Basin Finance Journal*, (4, 1996, pp.197-218), pp.216-17

⁹³ Mookerjee and Yu (1997), 387

⁹⁴ Kwon, Chung S., and Tai, S. Shin, “Cointegration and causality between macroeconomic variables and stock market returns”, *Global Finance Journal*, (Vol 10, Iss. 1, Spring-Summer 1999, pp.71-81)

Money supply and the exchange rate are deemed to have a secondary and negative relationship⁹⁵.

It can be inferred that the macroeconomic factors affecting stock market returns in most of the emerging markets examined are not entirely different than in the studies covering developed markets. Several factors correlated to the export-oriented nature of emerging market economies are identified in the aforementioned literature as having positive and significant effects on EM stock market returns. They include: foreign exchange rates, money supply (M1), consumer prices (as a proxy for inflation), foreign direct investment (FDI) and industrial production.

The *third* series of studies examined the relationship between macroeconomic factors and stock returns for groups of countries. Cheung and Ng (1998) use co-integration techniques to analyze the relationship in five developed countries: Canada, Germany, Italy, Japan and the USA. They use factors of aggregate personal consumption, M1, Gross National Product (GNP) and real oil prices to try to explain stock market returns. In all, they find each factor to have had co-integrated movement between each of the chosen macroeconomic variables and market returns⁹⁶.

Bilson, Brailsford and Hooper (2001) examine a series of selected emerging markets using a value-weighted world market index and macro-economic variables as proxies for local risk sources. Their findings show that the price of goods and real economic activity are not able to explain stock market returns. Commonality is a consistent factor when emerging markets are considered at a regional level rather than collectively. More importantly, money supply, exchange rates and world market returns are found to be significant⁹⁷.

For five Association of South East Asian Nations (ASEAN), Wongbangpo and Sharma (2002) show that over the long run, growth in output is positively related to stock market returns⁹⁸. De Jong and de Roon (2001) examine time-varying effects of

⁹⁵ Ibrahim, Mansor H., and Aziz, Hassanuddeen, "Macroeconomic variables and the Malaysian equity market", *Journal of Economics Studies*, (Vol. 30, No. 1, 2003, pp.6-27), 23-4

⁹⁶ Cheung, Yin-Wong and Ng, Lilian K., "International evidence on the stock market and aggregate economic activity" *Journal of Empirical Finance*, (Vol. 5, Iss. 3, September 1998, pp.281-96)

⁹⁷ Bilson, Chris, Brailsford, Tim and Hooper, Vince, "Selecting macroeconomic variables as explanatory factors of emerging stock market returns", *Pacific-Basin Finance Journal*, (No. 9, 2001, pp.401-426), 420

⁹⁸ Wongbangpo, P., & Sharma, S.C. "Stock Market and Macroeconomic Fundamental Dynamic

integration and expected returns in 30 emerging markets. They develop a model in which expected returns are dependent on the degree of market segmentation, which is measured by the ratio of assets in a given market that cannot be traded by foreign investors. After allowing for expected returns to vary over time given developments in segmentation, they find that market segmentation has a significant effect on expected returns. In this case increasing market integration leads to lower expected returns and thus lower cost of capital⁹⁹.

In a study not altogether unrelated to financial development and returns in stock markets, Billmaier and Massa (2008) use fixed-effect panel regression to study 17 emerging markets in the Middle East and Central Asia. Both hydrocarbon-rich and weak natural resource countries are used in their analysis. They conclude that institutional and remittance variables are both positive and significant in their impact on market capitalisation. Both variables are important, particularly in countries without major hydrocarbon resources. Moreover oil prices mainly drive stock market capitalisation in resource rich countries¹⁰⁰.

Overall, cross-examination of the literature suggests the following variables are, though not always, the most common in being able to explain stock returns. These are: foreign exchange rates, industrial production, money supply (M1), consumer prices (as a proxy for inflation), and FDI.

As explained earlier, the Visegrad-3's industrial base and their relationship with the Euro-zone should infer some significant relationship between those macroeconomic factors and stock markets over time, particularly since their accession to the EU in 2004. As a result, they have been chosen *a priori* as the factors of macroeconomic risk for the purposes of this paper following in the footsteps of Chen, Roll and Ross (1986), Clare and Thomas (1994), and Groenewold and Fraser (1997).

Interactions: ASEAN-5 Countries”, *Journal of Asian Economics*, (Vol. 13, No. 2, 2002, pp.27-51)
⁹⁹ De Jong, Frank and de Roon, Frans A., “Time-Varying Market Integration and Expected Returns in Emerging Markets”, Tinbergen Institute Discussion Paper, TI 2001-113/2, (Oct. 9 2001), pp.25-6
¹⁰⁰ Billmeier, Andreas and Massa, Isabella, “What drives stock market development in emerging markets – institutions, remittances, or natural resources?”, *Emerging Markets Review*, (10, 2009, pp.23-35), pp.25 and 33-4

2.6.2. The Role of Foreign Exchange Rates

Economic theory posits that changes in exchange rates directly affect a firm's net income through its foreign operations. The change in net income inherently alters the underlying value of a firm's stock price – see Section 2.1.

From a practical standpoint, foreign firms acquiring local businesses and assets are subject to local currency changes. The cost of acquisition, which is determined by local stock and currency volatility, effectively changes by a proportional rate to foreign exchange movements. Since local market volatility affects cost of capital, assessing whether foreign currency risk is priced in stock returns allows firms to hedge against unexpected currency movements.

Even so, Federova (2009) suggests that the relationship between foreign exchange rates and stock markets is controversial¹⁰¹, and no consensus has been reached with respect to the following three explanations.

Firstly, the flow-oriented model approach proposed by Dornbusch and Fisher (1980) suggests that foreign currency movements directly influence international competitiveness and trade balance. These factors ultimately affect real economic variables such as income and output. Such a relationship affects future cash flows and the price of publicly traded stocks since stock prices are the present value of future cash flows – see Section 2.1¹⁰².

The flow-oriented model represents a positive unidirectional relationship running from exchange rates to stock prices¹⁰³. In this case, the depreciation of a domestic currency makes local firms more competitive and exports cheaper relative to international competition. Higher exports leads to increased cash flows, ultimately pushing stock prices up. On the other hand, the appreciation of a domestic currency has the opposite effect by making firms less competitive and exports more expensive.

¹⁰¹ Federova, Elena and Vaihekoski, “Global and Local Sources of Risk in Eastern European Emerging Stock Markets”, *Czech Journal of Economics and Finance*, (No. 59, No. 1, 2009, pp.2-19), 2-3

¹⁰² Dornbusch, R. and Fisher, S., “Exchange Rates and the Currency Account”, *American Economic Review*, (Vol. 70, 1980, pp.960-971)

¹⁰³ Stavarek, Daniel, “Stock Prices and Exchange Rates in the EU and the USA: Evidence of their Mutual Interactions”, *Czech Journal of Economics and Finance*, (55, 2005, pp.141-61), 141

Secondly, an alternate argument by Dornbusch (1976) suggests taking a portfolio-balance approach. The portfolio-balance approach posits a negative relationship between stock prices and exchange rates whereby stock prices influence exchange rates. It advocates that investors should diversify holdings to eliminate firm specific risk (i.e. equities), effectively making currencies an alternative investment allocation in addition to bonds¹⁰⁴. Much like other financial instruments, the rules of supply and demand hold. As certain currencies become more valuable, firms making acquisitions will re-evaluate their investments as interest rates rise.

Thirdly, from a monetary approach, an exchange rate is the price of an asset (i.e. one unit of foreign currency) and therefore the actual exchange rate is determined by the future value of the exchange rate. As developments in stock prices and exchange rates may be affected by different factors, the asset market approach posits that there is no link between exchange rates and stock prices¹⁰⁵.

From an empirical standpoint, Aggarwal (1981) suggests a positive correlation between exchange rates and stock returns¹⁰⁶. On the other hand Soenen and Hennigar (1988) conclude that there is a negative relationship between monthly (effective) US dollar rates and the stock market index for the period 1980-96¹⁰⁷. Solnik (1987) finds that exchange rates are a non-factor in being able to explain stock prices in nine industrialised economies.

In addition, Jorion (1990) finds some degree of significance between the effective US dollar exchange rate for the period 1971-87 and stock returns of multinational firms¹⁰⁸. Interestingly, Ma and Kao (1990) find differences among countries based on the nature of their economies (i.e. export or import orientation)¹⁰⁹.

¹⁰⁴ Dornbusch, R., "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, (Vol. 84, 1976, pp.1161-76)

¹⁰⁵ Stavarek (2005), 142

¹⁰⁶ Aggarwal, R., "Exchange Rates and Stock Prices: A Study of the U.S. Capital Market under Floating Exchange Rates", *Akron Business and Economic Review*, (Vol. 12, 1981, pp.7-12)

¹⁰⁷ Soenen, L.A. and Hennigar, E.S., "An Analysis of Exchange Rates and Stock Prices: the U.S. Experience between 1980 and 1986", *Akron Business and Economic Review*, (Vol. 19, 1988, pp.7-16)

¹⁰⁸ Solnik, B., "Using Financial Prices to Test Exchange Rates Models: A Note", *Journal of Finance*, (Vol. 42, 1987, pp.141-49)

Jorion, P., "The Exchange Rate Exposure of US Multinationals", *Journal of Business*, (Vol. 63, 1990, pp.331-45), pp.331-2

¹⁰⁹ Ma, C.K. and Kao, G.W., "On Exchange Rate Changes and Stock Price Reactions", *Journal of Business*

Overall, there appears to be fundamental differences in the conclusions as to whether stock prices are affected by exchange rates. This may be due to the time period studied or external factors not considered. Also, early empirical work focused on the links between foreign exchange rates and stock returns in primarily developed economies and drew on limited econometric assumptions about insufficient stationarity in the data.

Consequently, the use of co-integration techniques and Granger Causality testing formed the empirical basis for further research. As such, Bahmani-Oskooee and Sohrabian (1992) find short-run bi-directional causality between S&P 500 index returns and the effective exchange rate of the US dollar for the period 1973-88¹¹⁰. Ajayi and Mougoue (1996) find positive relationships in eight industrialised economies from 1985-91; specifically they find that there is negative short-run dynamics and positive long-run effects with respect to the portfolio-balance approach. They also conclude that in the short-run currency depreciation influences stock returns in a negative manner¹¹¹.

After a rash of currency crises in emerging economies throughout the 1990's, subsequent studies began to focus on the role of exchange rates there. Applying a co-integration approach, Abdalla and Murinde (1997) find positive but divergent causalities between foreign exchange rates and stock returns in four Asian nations. Their results for India show the causality to run from exchange rates to stock prices, and the opposite for the Philippines. They reject any causal relationship in both Korea and Pakistan¹¹². Ajayi et al. (1998) find evidence showing uni-directional (Granger) causalities supporting the portfolio-balance approach in the USA and Korea, while no causal relationship could be found in emerging markets such as Malaysia¹¹³.

Prior to the Asian financial crisis in 1997, Granger et al. (2000) conclude that there is uni-directional causality to support the flow-oriented model in Singapore. Ramasamy and Yeung (2001) find that directional causalities between exchange rates and

Finance and Accounting, (Vol. 17, 1990, pp.441-49), 442

¹¹⁰ Bahmani-Oskooee, M., and Sohrabian, A., "Stock Prices and the Effective Exchange Rate of the Dollar", *Applied Economics*, (Vol. 24, 1992, pp.459-64), pp.459-62

¹¹¹ Ajayi, R.A. and Mougoue, M., "On the Dynamic Relation between Stock Prices and Exchange Rates", *Applied Economics*, (Vol. 24, 1992, pp.459-64), pp.459-60 and 461

¹¹² Abdalla, I.S.A. and Murinde, V., "Exchange Rate and Stock Price Interactions in Emerging Financial Markets: Evidence on India, Korea, Pakistan, and Philippines", *Applied Financial Economics*, (Vol. 7, 1997, pp.25-35)

¹¹³ Ajayi R.A., Friedman, J. and Mehdian, S.M., "On the Relationship between Stock Returns and Exchange Rates: Tests of Granger Causality", *Global Finance Journal*, (Vol. 9, 1998, pp.241-51)

stock markets in nine East Asian economies can vary according to the period studied. For the period 1997-2000, stock prices influence exchange rates in all countries except Hong Kong, which showed bi-directional causality¹¹⁴. Smyth and Nadha (2003) and Tabak (2006) find uni-directional causality from exchange rates to stock prices in India and Sri Lanka and Brazil respectively¹¹⁵.

Pertaining to CEE, Grambovas (2003) indicates that strong links between the foreign exchange rate volatility and capital markets in Hungary and Greece should be considered when assessing corporate value, and ultimately should be a cause of concern for policy makers¹¹⁶.

In light of market reforms undertaken in Hungary prior to 2004, there appears to be a long-run relationship between the Budapest stock market and the exchange rate of the Hungarian forint to the German mark. Grambovas also makes two interesting findings: first by noting the similarities in behaviour between the Greek drachma and the euro leading up to the drachma's dissolution in 2002; and secondly, that stock markets can affect exchange rates by concluding that a decrease in European equity markets was a determinant in a significant fall of the euro¹¹⁷.

In terms of the relationship between exchange rates and specific industries, Chamberlain et al. (1997) find that returns of US bank stocks were sensitive to foreign exchange rates, while the opposite was true for Japanese banks¹¹⁸. Rim and Mohidin (2002) conclude that there was long-run bi-directional causality running from foreign exchange rates to industry indices before and during the Asian financial crisis¹¹⁹; this

¹¹⁴ Ramasamy, B., and Yeung, M., "The Causality between Stock Returns and Exchange Rates: Revisited", University of Nottingham in Malaysia, Division of Business and Management Research Paper Series, No. 11, (2001), 1-3

¹¹⁵ Smyth, R. and Nadha, M., "Bivariate causality between exchange rates and stock prices in South Asia", *Applied Economics Letters*, (No. 10, 2003, pp.699-704), 699

Tabak, Benjamin, "The Dynamic Relationship between Stock Prices and Exchange Rates: Evidence for Brazil", *International Journal of Theoretical and Applied Finance*, (No. 9, 2006, 1377-96)

¹¹⁶ Grambovas, Christos A., "Exchange Rate Volatility and Equity Markets: Evidence from the Czech Republic, Greece and Hungary", *Eastern European Economics*, (Vol. 41, No. 5, September-October 2003, 24-48), pp.25 and 45

¹¹⁷ Grambovas (2003), 45

¹¹⁸ Chamberlain, S., Howe, J.S., and Popper, H., "The Exchange Rate Exposure of U.S. and Japanese Banking Institutions", *Banking and Finance*, (Vol. 21, 1997, pp.871-892), 872-3

¹¹⁹ Rim, H.K., and Mohidin, R., "Study on the Effects of Exchange Rate on Industry Indices in Malaysia", The H.R. Frehn Center for Management, Working Paper 01/2002, (2002), 2-3

shows that there continues to be divergent results as to the directionality of the relationship and its overall significance between exchange rates and stock returns.

There are a number of reasons why foreign exchange rates are likely to explain returns. The implementation of sound exchange rate policies in light of EU membership, inflation targeting and improved efficiency of stock markets are important factors in the future economic strategies of the Visegrad Group as a whole¹²⁰. Each can be considered to be a determinant in the stabilisation of the region's currencies.

In view of the references made to the financial theory in Sections 2.1 and 2.3, there should be a direct relationship between the expected cash flows and the value derived through discounting. In good economic times a steady stream of cash flows is more likely to occur than not, particularly when it comes to exports in CEE. As a result, expectations of stock prices derived via discounting are likely to be higher although they are subject to unexpected exchange rate changes. Finally, it can be inferred that so long as exchange rates are significant in explaining stock returns, it is priced as a risk factor.

Hypothesis 1: Exchange rate appreciation against the USD or euro negatively affect Visegrad-3 stock returns.

2.6.3. Industrial Production and the Stock Market

As the main industrial hub of the eastern European region, an intensive flow of foreign capital to the Visegrad-3 in the last twenty years helped reorganise the region's industrial infrastructure, particularly in manufacturing.

For foreign firms, the incentive to invest rested on several factors related to proximity and existing institutions. In addition, a study conducted by Rysava and Galeotti (2009) on the determinants of FDI in the Czech Republic finds that factors related to profit, labour costs and technical skills provided a comparative advantage over other CEE countries even though physical capital was moderately scarcer¹²¹.

¹²⁰ Grambovas (2003), 45

¹²¹ Rysava, Eva and Galeotti, Elisa, "Determinants of FDI in Czech Manufacturing Industries between 2000-2006", Institute of Economic Studies (IES) Working Paper 17/2009, IES FSV, Charles University Prague, (2009), 19

The differences in post-communist financial and industrial policy in the region have led to divergent results. Specifically it has led to inconclusive evidence regarding the directionality of the causal relationship between industrial growth and the development of the Visegrad-3 financial sectors¹²².

The growth of industry in the region has significant ramifications in terms of capital raising needs, while on the other hand the development of financial markets allows for industry to raise capital as a financially dependent sector over time. The importance of industrial production in CEE and its relationship with stock market returns extends to the stability of the industrial sector and export demands.

In studying the co-integrating relationship between stock returns and changes in production in nine EMs, Rangvid (2001) notes that consumption is related to the production capacities in the economy. On the other hand, the proportionality of stock returns and changes in real activity is due to a desire for a smoothing of consumption; in general equilibrium models, consumption will be determined by real activity¹²³.

Put another way, when industrial production is expected to be high in the future, investors save less in the expectation that higher returns can be garnered by entering the equity market. This results in the increase of share prices due to demand. Rangvid finds that a common stochastic trend drives stock returns and real activity in several countries examined¹²⁴. Overall, changes in expectations of real activity are proportional to changes in stock returns.

As it relates to the asset-pricing models, Salomons and Grootveld (2002) show the links between 24 global emerging market equity risk premiums¹²⁵ (ERP) and the global business cycle determined by G7 industrial production¹²⁶. Given that emerging market ERP's tend to be higher, they observe cyclical time varying behaviour and test whether

¹²² Kominek, Zbigniew, "Stock markets and industry growth: an eastern European perspective", European Bank for Reconstruction and Development, Working Paper Series, WP No. 81, (October 2003), 8
Torok, Adam, "Industrial Policy in the New Member Countries of the European Union: A Survey of Patterns and Initiatives Since 1990", *Journal of Industry, Competition and Trade*, (Vol. 7, Nos. 3-4, December 2007, pp.255-271), 268

¹²³ Rangvid, Jesper, "Predicting returns and changes in real activity: evidence from emerging economies", *Emerging Markets Review*, (2, 2001, pp.309-29), 310

¹²⁴ Rangvid (2001), 327

¹²⁵ Defined as the expected return on equity minus the risk-free rate of return.

¹²⁶ Salomons, Roelof, and Grootveld, Henk, "The Equity Risk Premium: Emerging versus Developed Markets", University of Groningen, SOM Working Paper No. 02E45, (August 7 2002), 2

perceived risks were reflected in larger ERP's in emerging markets. They find that investors are rewarded in a pattern dictated by global business cycles.

Furthermore, Salomons and Grootveld (2002) contend that strong industrial production, particularly in G7 nations, generally lowers the emerging market equity risk premium. In general, it can be assumed that long-run predictability of industrial production is positively associated with higher stock returns, particularly in view of the relationship established between cash flows and stock prices.

In addition, while inflation is not a primary risk factor considered in this paper, the “proxy effect” is useful in seeing the effects of industrial production on stock returns. According to Al-Khazali (2003), Fama (1981) explains that rising inflation rates reduce real economic activity, output, and demand for money, which consequently reduces the prospect of future corporate profits and thus stock prices¹²⁷. The “proxy effect” reflects the detrimental consequence of inflation on real economic activity.

Al-Khazali (2003) finds that in the short run, there exists a negative relationship between inflation and stock returns in 20 out of 21 emerging capital markets. In the long run, however, it is found that it takes a long period of time for inflation to be fully reflected in stock prices, and that emerging market stocks can be expected to be useful in hedging against inflation¹²⁸.

Hypothesis 2: There is a positive association between industrial production and stock market returns.

2.6.4. Visegrad-3 Exports to Germany

In light of the special circumstances under which the Visegrad-3 had to reorient their economies, they nevertheless benefitted from a long-standing bi-lateral trade relationship with Germany. The deterioration of the East German market as a destination for export goods from CEE was a contributor to the decline in productivity after the

¹²⁷ Al-Khazali, Osahmah M., “Stock Prices, Inflation, and Output: Evidence from the Emerging Markets”, *Journal of Emerging Market Finance*, (2, 2003, pp.287-314), 288

¹²⁸ Al-Khazali (2003), 313

collapse of communism. The West German market, and eventually a unified German market, however, replaced this paradigm by the middle of the nineties¹²⁹.

As a consequence of this shift, Germany ranks first among trading partners with CEE¹³⁰. Additionally, dynamic growth in exports and an increased share in export market share combined to help the CEE region catch up with Western Europe in relative terms. In 1994, the Visegrad-3 had a 1% share of total world exports; in contrast Germany had a 10% share. Between 1995-1999, growth in Hungary's export market share grew at a yearly average of 13.2%, compared to 7.6% and 3.8% in the Czech Republic and Poland. In comparison, the average change in export market share between 2000-2007 increased to 9.9% and 10.5% in the Czech Republic and Poland. In Hungary, this decreased to 6.7% for the same period¹³¹. Nevertheless, a significant share of exports from the Visegrad-3 went to Western Europe, and specifically to Germany. This growth in the region's export market simultaneously smoothed the path toward integration with the EU.

Even so, there are divergent results over whether foreign trade in CEE countries have reached equilibrium level. Jakab et al. (2000) conclude that of the Visegrad-3, Hungary integrated the quickest followed by the Czech Republic and Poland. Taking FDI into account, they find that Hungary is over-integrated, while the Czech Republic and Poland did not reach equilibrium until the end of the nineties¹³². This effectively left Hungary highly exposed to the cyclical demands in its main export markets very early on. Accordingly, these differences stemmed from the choices made with respect to economic liberalisation¹³³.

As integration with Western Europe evolved, the region's export structure also changed. While still high relative to international comparison, exports related to low-skill decreased sharply as a whole. Meanwhile, the region developed a specialisation in the

¹²⁹ Hardt, John Pearce and Kaufman, Richard F., eds. *East-Central European Economies in Transition*, Joint Economic Committee, Congress of the United States (New York, NY, M.E. Sharpe, 1995), 413

¹³⁰ Columbus, Frank, ed., *Central and Eastern Europe in Transition: Volume III*, (Commack, NY, Nova Science Publishers, Inc., 1999), pp.37-8

¹³¹ Munkacsi, Zsuzsa, "Export structure and export specialization in Central and Eastern European countries", Magyar Nemzeti Bank, Budapest (Hungary), MNB Occasional Papers, No. 81, (September 2009), pp.8-9

¹³² Jakab, M., Kovacs, Z., and Oszlay A, A., "How Far Has Trade Integration Advanced? An Analysis of Actual and Potential Trade of Three Central and Eastern European Countries", National Bank of Hungary, NBH Working Paper 2000/1, (2000), 30

¹³³ See Section 2.5

production of medium and high-tech products for export in addition to traditional manufactured goods.

In view of the development of the Visegrad-3's financial markets, the region's trade relationship with Germany, and the CEE's growing share of the total exports in Europe as a whole, it can be inferred that some association exists between the total value of exports and the stock returns. This is particularly relevant to the firms listed on the stock exchanges that depend on exports as a significant source of income.

Hypothesis 3: Increases in the total value of exports to Germany from the Visegrad-3 positively affect stock returns.

3. Methodology and Model Specification

3.1. Methodology: The Arbitrage Pricing Theory (APT)

In reference to the literature establishing both context and a link between macroeconomic factors and stock returns, the APT has been adopted to address the hypotheses presented above. The APT assumes that returns to the i th security, r_i , can be modelled as a linear function as generated within a multi-factor model, where changes in each factor is shown by a factor specific beta (β) coefficient¹³⁴:

Table 4: The Arbitrage Pricing Theory (APT)

$E(R_i) = b_{i0} + \beta_{i0}f_0 + \beta_{i1}f_1 + \dots + \beta_{if}f_f + e_i$	
$E(R_i) =$	Expected return on asset i
$i =$	1,2,...,N (i.e. portfolio of securities)
$f_i =$	Factors affecting expected return
$\beta_{i,j} =$	Factor loadings or sensitivities to factor i
$e_i =$	Random variable

(1)

Where the f_j are factors ($j = 1, 2, \dots, f$); the $\beta_{i,j}$ are factor loadings or sensitivities (i.e. beta) and e_i is a random variable with $E(e_i) = 0$, $E(e_i^2) = \sigma_i^2$, $E(e_i e_k) = 0$, $i \neq k$, and $\text{cov}(e_i, F_j) = 0$, for all i and j . There are N assets.

Assuming that all arbitrage opportunities are exhausted in equilibrium, the APT implies that the following relationship between the expected return to asset i , $E(R_i)$, and all other factor sensitivities included in the model be:

$$E(R_i) = R_f + (\delta_1 + R_f)\beta_{i1} + \dots + (\delta_f + R_f)\beta_{if}$$

(2)

Where the presence of a risk-free asset with return R_f has been assumed and δ_j can be interpreted as the expected return to a portfolio with unit sensitivity to factor j and zero sensitivity to all other factors:

¹³⁴ Sabal (2002), 107 and Groenewold and Fraser (1997), pp.1369-70

(3)

$$\{\delta_j = E(R_j^p), \text{ where } (R_j^p) = \beta_j^p + F_j + e_j^p, j = 1, 2, \dots, F\}$$

Where R_j^p is the return to the j th unit – sensitivity portfolio, β_j^p is a constant and e_j^p is a random error term with zero mean and constant variance. In the CAPM's case, Groenewold and Fraser (1997) state that $F = 1$, and $F_1 = R_m$, or the return to the market portfolio.

Within the framework of the APT, this paper will utilise observed stock market returns as the dependent variable. The German 10-year bund (bond) will be used as a benchmark risk-free rate. Observed changes in foreign exchange rates and industrial production - selected based on the theoretical and empirical literature - will be independent (predictor) variables. The national currency exchange rates relative to both the USD and the euro will be used to form two separate analyses regarding the effect of exchange rates on stock returns. Also, the total value of exports to Germany will be factored as part of the secondary analysis.

3.2. Data and Summary Statistics

3.2.1. Stock Index Data

Given their relative size and liquidity, the Visegrad-3 represents the cornerstone of the developing financial markets of Central and Eastern Europe. However, the exchanges have relatively few number of stocks listed when compared to the major stock exchanges around the world – see Table 5.

Table 5: Listed firms (equity) on selected stock exchanges, as of December 2009¹³⁵

Stock Exchange (Country)	Listed Firms (#)
Prague Stock Exchange (Czech Republic)	25
Budapest Stock Exchange (Hungary)	47
Warsaw Stock Exchange (Poland)	378
NYSE & NASDAQ (USA), ex. Euronext	6239
London Stock Exchange (UK)	2749
Frankfurt Stock Exchange (Germany)	350
Tokyo Stock Exchange (Japan)	2328

As such, the decision was made to use the stock market indices of each country as a broad representation of the market as a whole (i.e. proxies for individual assets). In essence, the Visegrad-3 stock markets will each act as part of a portfolio. The financial data was retrieved using the International Monetary Fund's (IMF) International Financial Statistics (IFS) database¹³⁶.

The monthly stock market index data are expressed in time series of national currency units and are calculated as an average for the period – see Figure 1. Returns of each country's stock markets are calculated as the proportional change in the price index month over month.

Overall, a qualitative assessment shows that the Visegrad-3 stock markets (1998-2009) seem to move in concert with one another – see Figure 1. Both the German stock market index and a standard broad index, the MSCI All-Country World Index (ACWI), have been included as benchmarks and show a similar pattern over time¹³⁷.

¹³⁵ Stock exchange data was procured from their respective websites. (See: Bibliography).

¹³⁶ International Monetary Fund (IMF), International Financial Statistics (IFS), ESDS International, University of Manchester, (Edition: February 2010)

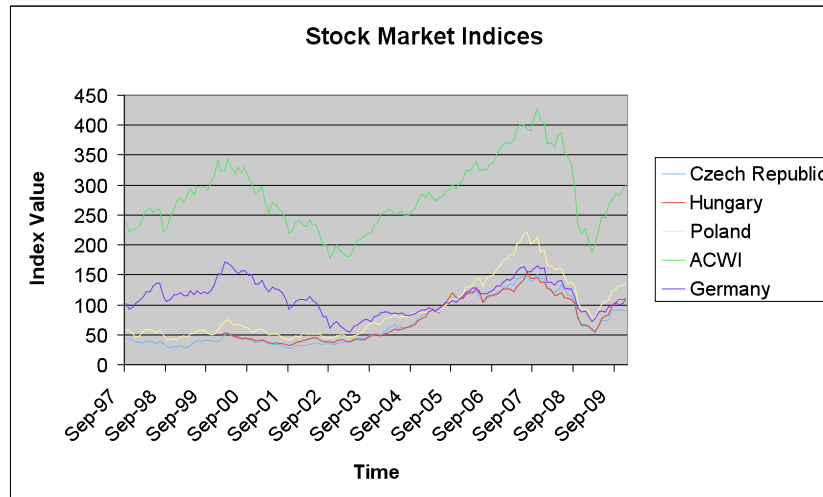
See Appendix 1: Descriptive statistics and Table 3.11: Correlation Matrix

¹³⁷ MSCI Barra, The World Index, Country Membership, provided via:

http://www.msclub.com/products/indices/tools/index_country_membership/, accessed January 14 2010

The MSCI ACWI is a comprehensive index covering 45 stock markets from developed (23) and emerging markets (22).

Figure 1: Stock market indices of the Visegrad-3, Germany and the MSCI-ACWI



Source: Author's own calculations using IMF IFS data

3.2.2. Macroeconomic Factors and Data

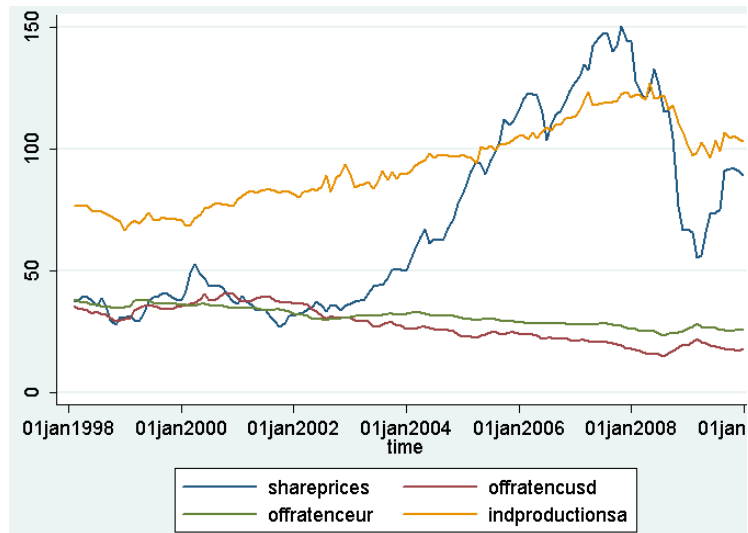
The macroeconomic data are also distilled from the IFS database and the IMF's Direction of Trade Statistics (DOTS) database¹³⁸. Foreign exchange rates are expressed in time series of national currency units per USD and euro, and are geometric averages of values within the period – see Figures 2-4. While the IFS also have end-of-period data for foreign currency, the average will be used based on results of paired t-tests.

The index for industrial production is also expressed in time series and changes are calculated as the proportional change in the index month-over-month. It is an indicator of current economic activity and is seasonally adjusted.

According to the IMF, the industrial production index is primarily comprised of mining and quarrying, manufacturing, utilities and energy activities. This is in accordance with the United Nations International Standard Industrial Classification (ISIC). However, the index is also supplemented by factors relevant to particular countries and so is taken as a proxy measurement for actual industrial production in the Visegrad-3.

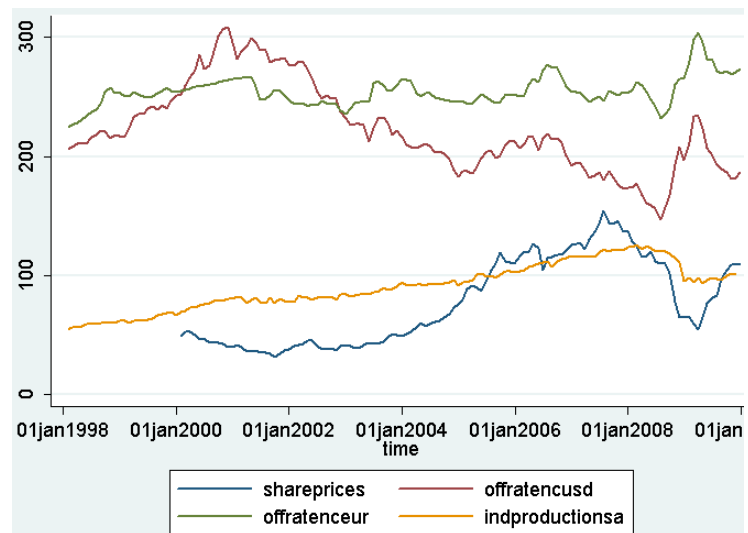
¹³⁸ International Monetary Fund (IMF), Direction of Trade Statistics (DOTS), ESDS International, University of Manchester, (Edition: March 2010)

Figure 2: Czech stock index, Official exchange rate and Industrial production



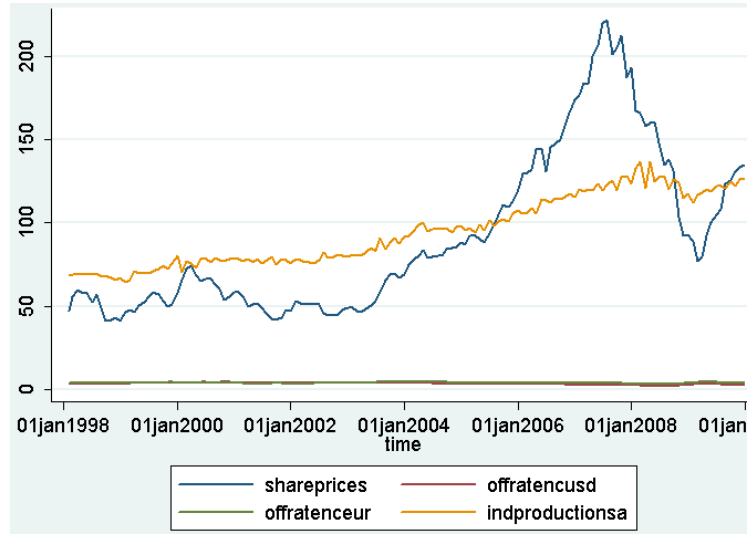
Source: Author's own calculations using IMF IFS data

Figure 3: Hungarian stock index, Official exchange rate and Industrial production



Source: Author's own calculations using IMF IFS data

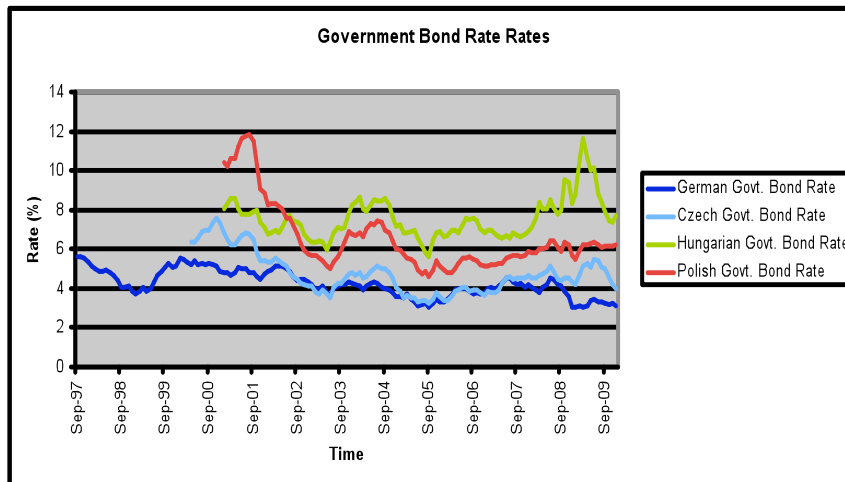
Figure 4: Polish stock index, Official exchange rate and Industrial production



Source: Author's own calculations using IMF IFS data

As the APT specifies the inclusion of a risk-free rate, it was determined that the use of the German 10-year bund (bond) as the benchmark risk-free rate would be suitable. The relative size, liquidity and stability associated with German financial markets, in addition to its proximity to CEE, suggest that German bunds are suitable as a risk-free asset. The perceived risks of investing in German bunds are low as indicated by their historic yields compared to the Visegrad-3 – see Figure 5.

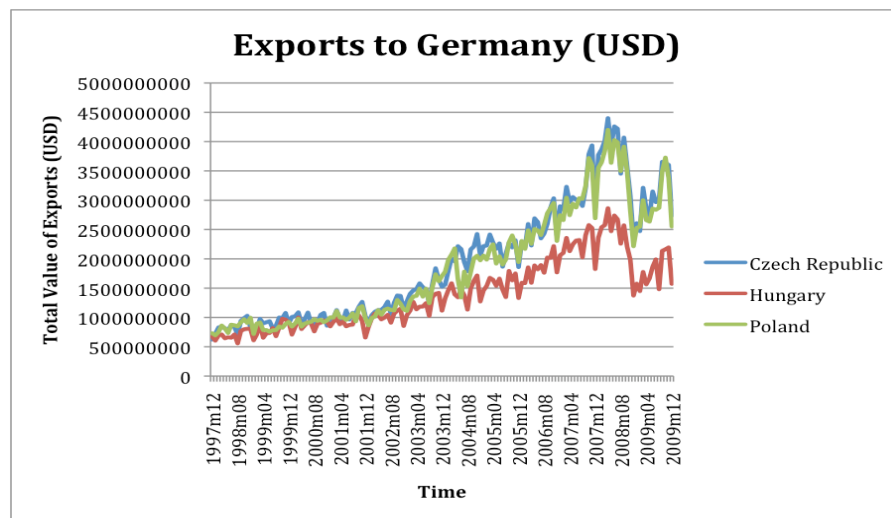
Figure 5: Visegrad-3 and German government bond rates, (%)



Source: Author's own calculations using IMF IFS data

As a measure of the impact of Germany’s impact on the region, a trade variable is included to account for the total dollar value of exports to Germany – see Figure 6. Per the DOT database, the variable is measured in monthly time-series and valued in USD. It is taken as “F.O.B.”, or free on board, in accordance with the UN International Merchandise Trade Statistics recommendations¹³⁹. Changes are transformed to calculate the proportional percentage change in the dollar value of trade month-over-month.

Figure 6: Visegrad-3 exports to Germany from Visegrad-3, (USD)



Source: Author’s own calculations using IMF DOT data

3.3. Limitations of Study

Much of the empirical literature related to developed markets in this paper have used datasets extending as far back as 20 years, if not more. In emerging markets there are, however, obstacles to obtaining complete economic and financial datasets for a lengthy period; the primary reasons being related to history and reporting requirements.

The Czech, Hungarian and Polish stock markets did not come online until the early 1990’s and faced considerable obstacles in their development. After the experience of the 1990’s, only in recent years have the efforts to boost both liquidity and

¹³⁹ International Monetary Fund (IMF), Guide to IMF International Financial Statistics, ESDS International, University of Manchester, [Edition: March 2010], provided via: http://www.esds.ac.uk/international/support/user_guides/imf/Introduction.pdf

transparency in the markets been realised, particularly in Poland¹⁴⁰. As such, every effort has been made to establish a balanced panel dataset for the years 1998-2009, though there are voids in the data for particular variables.

Other particular concerns with the model specification are the possibility of omitted variable bias and collinearity between the predictor variables. A large number of macroeconomic variables exist in most economic and financial data systems today that could be plausibly included in this analysis. These can also be correlated with each other.

Nevertheless, in light of the fact that the APT allows for factors to be selected *a priori*, the decision was made to select the macroeconomic factors above based on the economic and financial theory, as well as the empirical literature. It is hoped that through process of elimination this paper will aid in narrowing down a set of factors that affect stock market returns in the Visegrad-3 for the future analysis.

3.4. Model Specification

To ensure that the model was properly specified, tests were performed to ensure that the data was normally distributed, showed no outward signs of heteroskedasticity and behaved in a linear fashion. Because it was assumed that omitted variable bias would be a problem with the model specification, this was also tested. Finally, under the conditions of cross-sectional analysis, a specification test is conducted¹⁴¹.

3.4.1. Normality of Distribution and Residuals

The box plots indicate that with the exception of German government bond rates, the predictor variables and dependent variable show possible outliers within the dataset. There are points that are more than 1.5*(inter-quartile range) above the 75th percentile or below the 25th percentile – see Figure 7.

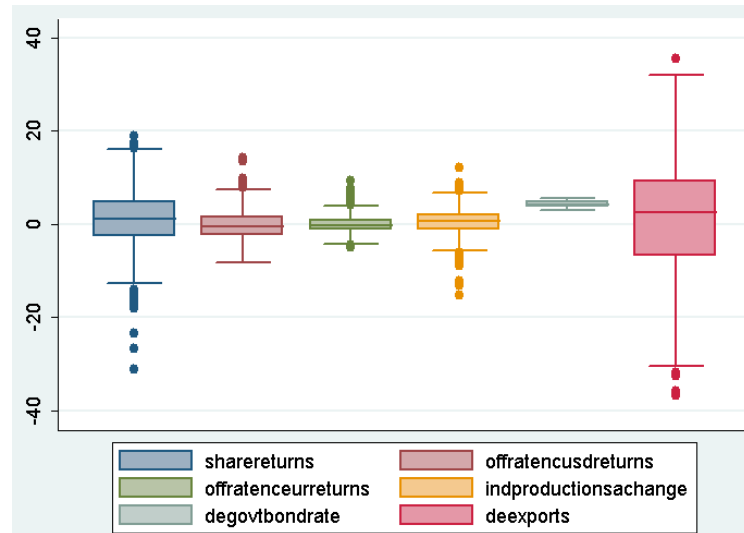
Overall, the histograms, which include normal distribution plots, indicate that the predictor variables seem to be normally distributed with no significant skewness – see

¹⁴⁰ Kominek (2003), 3

¹⁴¹ Note: STATA was used to derive all the results for the model specification and the regression outputs presented in Section 4.

Appendix 2. The slight deviations in each of the predictor variables can be attributed to possible outliers, which are also in Figure 7.

Figure 7: Box-plots diagram, Independent variables



Source: Author's own calculations using IMF data in STATA

However, when residuals were plotted against a normal distribution curve they indicate a small to insignificant deviation from normality; the deviation is assumed to be the effect of possible outliers – see Appendix 3(a). A transformation of each variable to log-normal or squared did not improve the distribution results. In fact, the individual distribution curve for stock market returns, German government bond rates and exports were skewed to a greater degree. As such, it was determined that transformed units would not be used.

To further test the assumption of normality in residuals, both the standardised normal probability (P-P) plots and the quantiles of predictors against quantiles of normal distribution were also plotted – see Appendix 3(b). The P-P plots are sensitive to non-normality in the middle of the range of data, whilst quantile plots are sensitive to non-normality near the tails¹⁴².

¹⁴² UCLA (Academic Technology Services), Stata Web Books, Regression with Stata, Chapter 2: Regression Diagnostics, Part 2.2: Checking Normality of Residuals, provided via: <http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm>, accessed February 6 2010

Accordingly, the P-P plots for residuals indicate no significant signs of non-normality. On the other hand, the quantile-plots show two plots that deviate from normality at the lower tail - this is also seen in Appendix 3(a). Again, transforming the variables to log or squared, as above, and performing the tests for normality resulted in the same predicament - i.e. the residuals were skewed to a greater degree. As such, since there appeared to be only a slight deviation from normality for both the plotted residuals against a normal distribution curve and the quantile plots, it was therefore accepted that the residuals are weak in normal distribution.

Finally, a Shapiro-Wilk W-test for normality was performed to confirm the findings above. Assuming that the distribution of residuals is normal, the test confirms that residuals are *not* normally distributed with a p-value of 0.00051 – see Appendix 3(c). This indicates that we can reject the assumption that the residuals are normally distributed given the residual plots and the W-test.

The results achieved during tests for normality were contradictory. Transforming the data did not improve the results since they were unable to smooth the residual plots against a normal distribution curve. Instead the plots were skewed to a greater degree. Therefore, it was maintained that the residuals are normally distributed based on the curve of the residual plot, the P-P plots and skewness results of predictor variables¹⁴³.

3.4.2. Correlation and Linearity

To determine simple correlation between the dependent variable and predictors, a pair-wise correlation matrix was established – see Table 6. Overall, the correlation matrix shows that there is some degree of negative correlation between stock returns and official exchange rates to the 99% level. Moreover, there appears to be no correlation between industrial production and stock returns in either the Czech Republic or Poland¹⁴⁴. Notably, while there is a positive correlation between stock returns and exports to Germany to the 99% level, this is only applicable in the case of Poland.

¹⁴³ See Appendix 1(a) and (b)

¹⁴⁴ See Appendix 4(a)-4(c) for correlation matrices by country.

Table 6: Correlation matrix, Visegrad-3¹⁴⁵

	Share Returns	German Bond Rate	NC/USD	NC/EUR	Industrial Production	Exports
Share Returns	1.0000					
German Bond Rate	-0.1415*** (0.0042)	1.0000				
NC/USD	-0.3680*** (0.0000)	0.0005 (0.9911)	1.0000			
NC/EUR	-0.4013*** (0.0000)	-0.0837* (0.0824)	0.6606*** (0.0000)	1.0000		
Industrial Production	0.0603 (0.2257)	0.0456 (0.3451)	-0.0124 (0.7980)	-0.0057 (0.9069)	1.0000	
Exports	0.1479*** (0.0030)	0.0075 (0.8773)	-0.0229 (0.6372)	0.0774 (0.1107)	-0.1276*** (0.0084)	1.0000

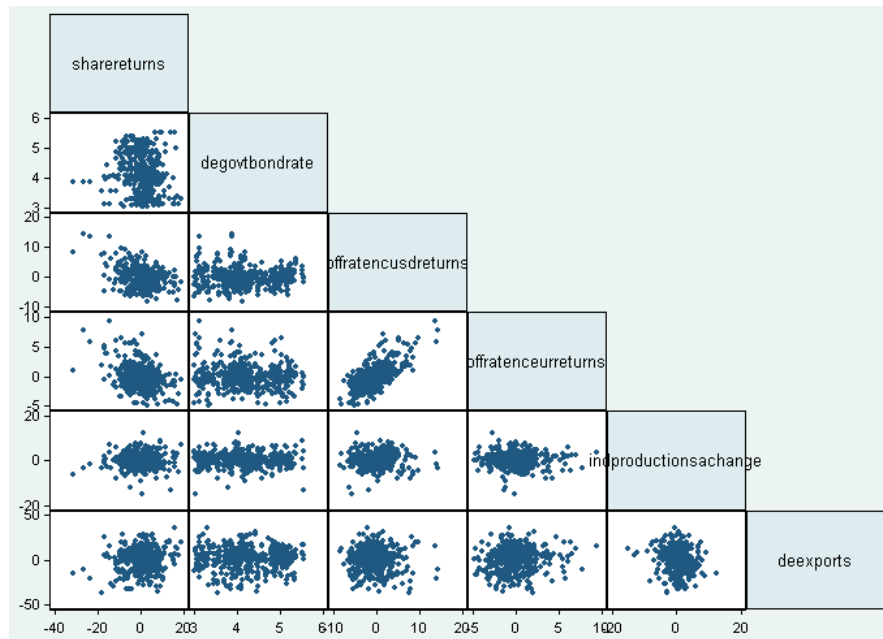
The scatter-plot matrices identify (non)-linearities and outliers in the data. Much like the correlation matrix, there appears to be a linear, and negative, relationship between stock returns and foreign exchange rates – see Figure 8. The returns generated by the Visegrad-3’s national currencies against either the USD or euro seems to have had a negative impact on share returns throughout. Also, there seems to be a subtle linear, and positive, relationship between stock returns and exports to Germany from the Visegrad-3. However, the relationship between stock returns and industrial production is less telling. There appears to be no linear relationship.

¹⁴⁵ Standard errors are given in parentheses under the coefficients.

The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level.

NC = National currency.

Figure 8: Scatter-plot matrix, Dependent and independent variables



Source: Author's own calculations using IMF IFS data

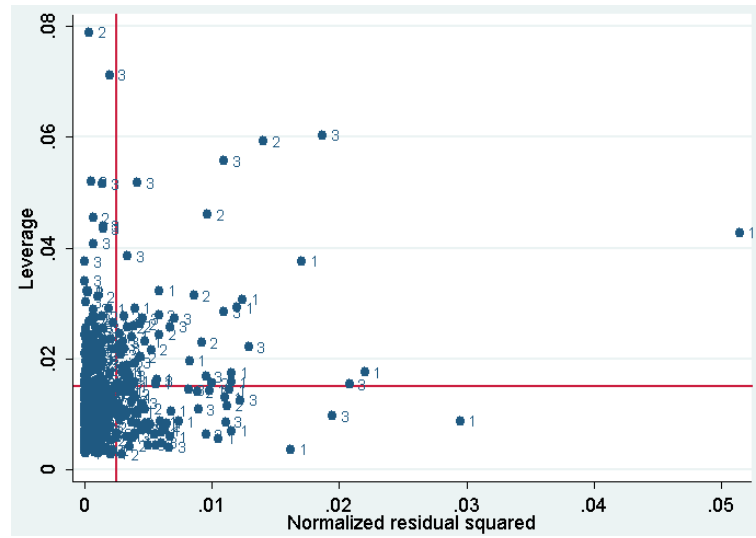
With respect to outliers, the individual scatter-plots for predictor variables against share returns point to several outliers, particularly to the downside – see Appendix 5(a)-(e). Moreover, the Czech Republic and Poland, especially, both have large residuals and large leverage. This means that specific points in the data may have potentially influential effects on the outcomes of multi-variate regressions.

By graphing normalised residual squared plots to leverage, there are specific points that stand out and may pose problems in regression analysis. Figure 9 shows the plots indicating leverage and the residual squared. Plots that are jointly high on both measures of leverage and residual may be points of concern. Several points have been identified as having potential outlier effects as they either exhibit having the largest high leverage residuals squared, or stand apart in added-variable plots – see Table 7 and Figure 10.

In addition, a DfBeta measure was also plotted to measure the impact of the outliers – see Figure 11. This was done to specifically determine the impact outliers would have on standard errors. Accordingly, the outliers plotted correspond to the ones identified in the initial analysis conducted above and may have an impact on the

regression analysis. Points lying outside of a range of 0.10 have some measurable impact on standard error results. As a result, outlier effects will be taken into consideration by way of robust regression.

Figure 9: Residual and leverage plots¹⁴⁶



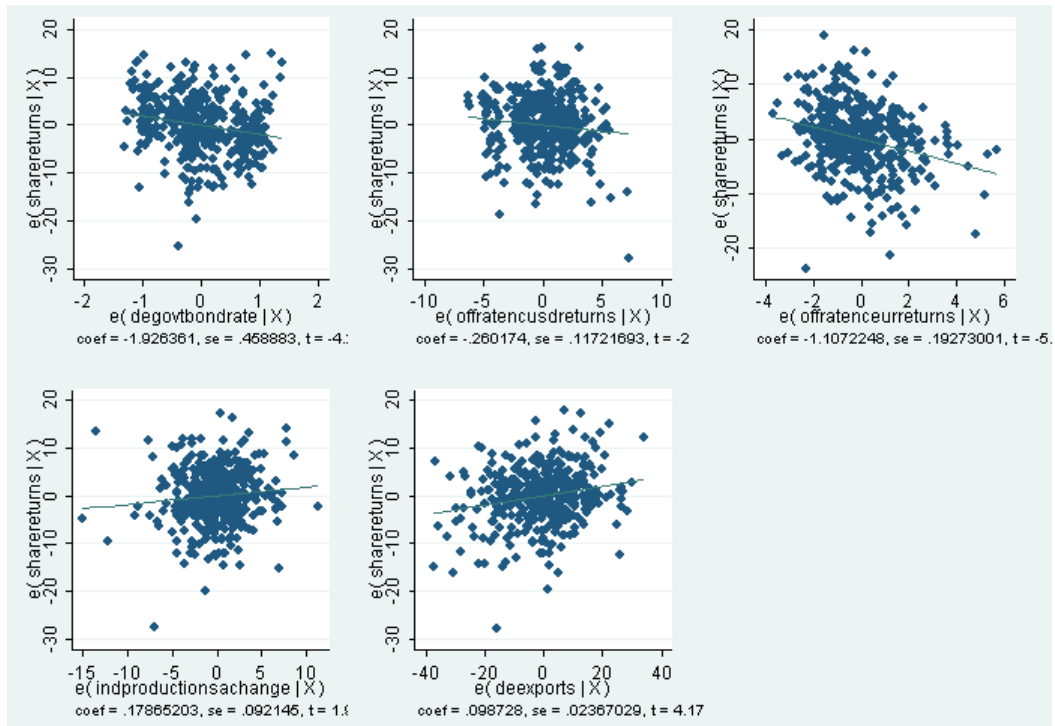
Source: Author's own calculations using IMF data

Table 7: Outlier points, (Year and month)

Country	Date
Czech Republic	1998: September, December; 2008: October; 2009: February, December
Hungary	2008: January, October, December
Poland	1998: September; 2007: November; 2008: January, October

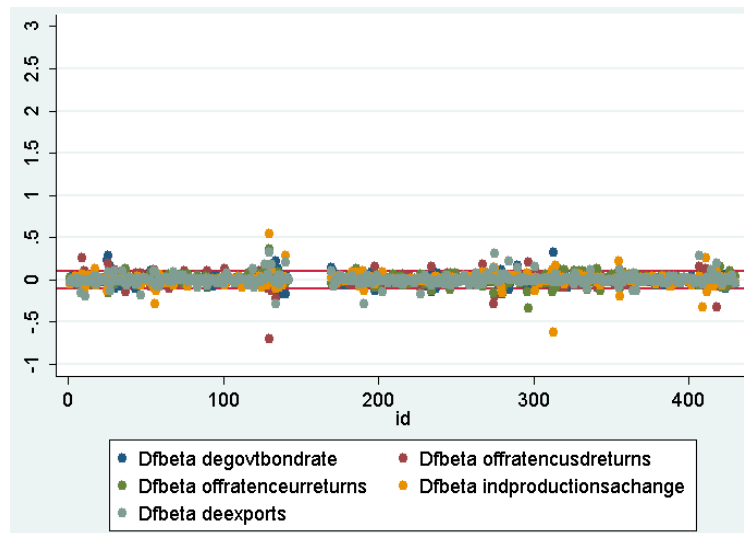
¹⁴⁶ By country: Czech Republic (1); Hungary (2); Poland (3)

Figure 10: Added-variable plots for independent variables



Source: Author's own calculations using IMF data

Figure 11: DFBETA plots



Source: Author's own calculations using IMF data

With respect to linearity, the model specification assumes that, like the APT, there is linearity between the dependent variable and predictor variables. If this assumption is violated the linear regression will try to fit a straight line to data that does not follow a straight line.

Accordingly, the linearity plots show there to be a strong degree of linearity between each of the predictors except exchange rates, which diverges – see Appendix 6(a)-(e). Again this is most likely a result of some outliers; another attempt to remedy this by creating a log of foreign exchange changes did not alleviate the problem and in fact skewed the linearity plots to a greater degree.

3.4.3. Homoskedasticity of Residuals

Ordinary Least Squares (OLS) assumes that the variance of the error term is constant, i.e. homoskedastic, or: $V(e_j) = \sigma^2$ for all j . A problem with using OLS under the conditions of heteroskedasticity is that OLS gives equal weight to all observations when observations with larger errors in variance contain less information than observations with smaller errors in variance. Under the conditions of heteroskedasticity, standard errors may be biased, which can lead to biased test-statistics and confidence intervals¹⁴⁷.

Having only assumed equal error variance (homoskedasticity), a test for heteroskedasticity was performed which tests the null hypothesis that the variance of residuals is homogenous¹⁴⁸. In this case, both the White-test and Breusch-Pagan test show that the variance of residuals is, in fact, not homogenous – see Table 8. The tests results showed significant p-values, thereby rejecting the null hypothesis that residuals are homoskedastic. Additionally, an f-test value of 0.0404 indicates some confidence that the residuals - particularly for foreign exchange rates - are heteroskedastic and not homoskedastic.

¹⁴⁷ University of California, Berkeley, Econometrics Laboratory & Software Archive (ELSA), Regression Analysis, “Assumptions for regression analysis” and “Properties of OLS estimator”, provided via: <http://elsa.berkeley.edu/sst/regression.html>, accessed February 15 2010

¹⁴⁸ UCLA (Academic Technology Services), Stata Web Books, Regression with Stata, Chapter 2: Regression Diagnostics, Part 2.3: Checking Homoscedasticity of Residuals, provided via: <http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm>, accessed February 9 2010

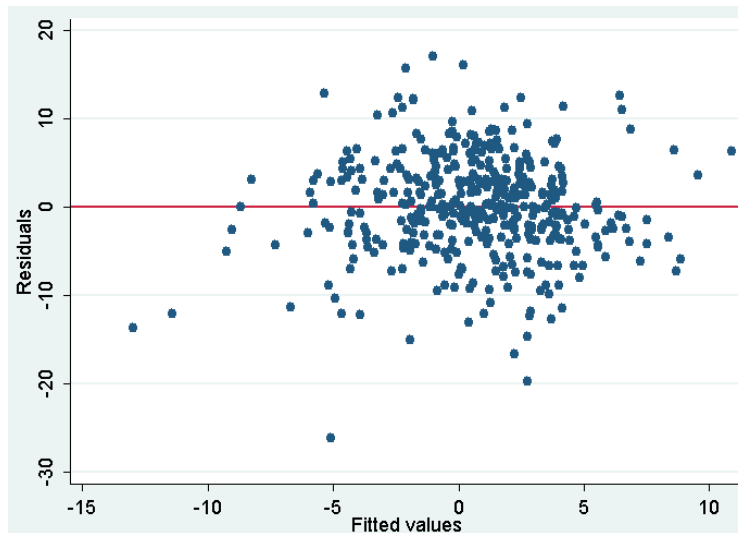
However, the White and Breusch-Pagan tests are sensitive to model assumptions that are associated with normality. As such, diagnostic plots were graphed, which showed that the severity of heteroskedasticity is not severe and most likely due to the effect of specific outliers identified above – see Table 7. Even so, it is assumed when performing regressions that the overall residuals are slightly heteroskedastic.

Table 8: White’s test and Breusch-Pagan test for heteroskedasticity

Cameron & Trivedi’s decomposition of IM-test			
Source	chi2	df	p
Heteroskedasticity	65.10	20	0.0000
Skewness	15.46	5	0.0086
Kurtosis	2.32	1	0.1279
Total	82.87	26	0.0000

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	
Ho: Constant variance	
Variables: fitted values of sharereturns	
chi2(1) =	7.46
Prob > chi2 =	0.0063

Figure 12: Residual plots for homoskedasticity



Source: Author’s own calculations using IMF data

3.4.4. Multi-collinearity of Predictors

A multi-collinearity test was performed to ensure that there was no perfect linear relationship amongst the predictor values – see Table 9. The main concern is that as degree of multi-collinearity increases, the regression model estimates of coefficients become unstable and standard errors for coefficients become inflated. The test calculates the variance inflation factor for the independent variables in the linear model. If there is perfect linearity amongst the predictors, the estimates for regression cannot be computed. In this case, the predictor values show no outward sign of multi-collinearity¹⁴⁹.

Table 9: Multi-collinearity test results¹⁵⁰

Variable	VIF	1/VIF
NC/USD	1.89	0.530059
NC/EUR	1.86	0.538572
Exports	1.04	0.963560
Industrial Production	1.02	0.979314
German Bond Rate	1.02	0.980892
Mean VIF	1.36	

3.4.5. Regression Specification

To determine whether relevant variables are left out, or redundant ones are in, a model specification test was performed. If relevant variables are omitted from the model, the common variance they share with included variables may be wrongly attributed to those variables and error term is inflated. However, since this paper only analyzes two specific variables, the model can be considered a weak one. Such a problem will have to be accommodated in the testing of the model and the interpretation of results.

¹⁴⁹ Variance inflation factor (VIF): a variable whose VIF is greater than 10 merits further investigation.

¹⁵⁰ UCLA (Academic Technology Services), Stata Web Books, Regression with Stata, Chapter 2: Regression Diagnostics, Part 2.4: Checking for Multicollinearity, provided via: <http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm>, accessed February 10 2010

Note: Tolerance (1/VIF) is used to check on degree of collinearity. A tolerance value lower than 0.1 is comparable to a VIF of 10 meaning that the variable could be considered as a linear combination of other independent variables.

The specification test (Linktest) shows that the model is specified correctly since the variable for predicted value is significant – see Table 10. However, since the squared prediction variable is also significant, the test has not failed to reject the assumption that model is specified correctly. There is a significant degree, therefore, of omitted variable bias. To ensure, an omitted variable test was performed (Ovtest), which confirms that there is a degree of specification error.

Table 10: Model specification test¹⁵¹

LINKTEST						
Share returns	Coefficient	Standard Error	t	P> t	95% Confidence Interval	
_hat	1.000519	0.06401	11.58	0.000	0.8306599	1.170379
_hatsq	-0.0522828	0.0152827	-3.42	0.001	-0.0823278	-0.0222378
_cons	0.5907166	0.3379501	1.75	0.081	-0.0736738	1.255107
OVTEST						
Ramsey RESET test using powers of the fitted values of sharereturns						
Ho: model has no omitted variables						
F(3, 392) =			8.56			
Prob > F =			0.0000			

To test the applicability of either the fixed-effects or random-effects models, the Hausman test was applied. The null hypothesis in this case assumes that the preferred model is a random effect one and that the unique errors are not correlated with the regressors. It established that a fixed-effects model was not suitable, having failed to reject the null hypothesis that a random effects model be used at a p-value of 0.9959.

In addition, a Breusch-Pagan Lagrange multiplier (LM) test was applied to detect random effects. The null hypothesis of the LM test is that variance across entities is zero, i.e. there is no significant difference across the data. The LM test concluded (p-value: 0.3423) that a random effects model is not appropriate because no significant difference in the data was found across the three Visegrad countries.

Ultimately, the results derived throughout the model specification phase, as well as the Hausman and LM tests, offers some contradictory results. This is most likely due to some degree of model misspecification as a consequence of omitted variables. This has

¹⁵¹ Princeton University, Data and Statistical Services (DSS), Statistical Packages: Stata, “Fixed/random effects (Panel data)”, provided via: <<http://dss.princeton.edu/training/Panel101.pdf>, accessed March 15 2010

been recognised as a potential problem, and as such, the specific focus of this paper will have its shortcomings.

Accordingly it was decided that a random effects model would be used in regression analysis. A random effects model assumes that the error term is not correlated with the predictors and allows for time-invariant variables to be included as explanatory variables. Moreover, a broader range of generalisations can be made to the inferences beyond the sample by using random effects. It can be expressed as:

Table 11: The random effects model

$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \dots + \beta_k X_{kit} + v_{it}$	
$Y_{it} =$	Dependent variable
$\beta_k =$	Coefficients/sensitivities of factors
$X_{kit} =$	Independent variables
$v_{it} =$	Between and within error term

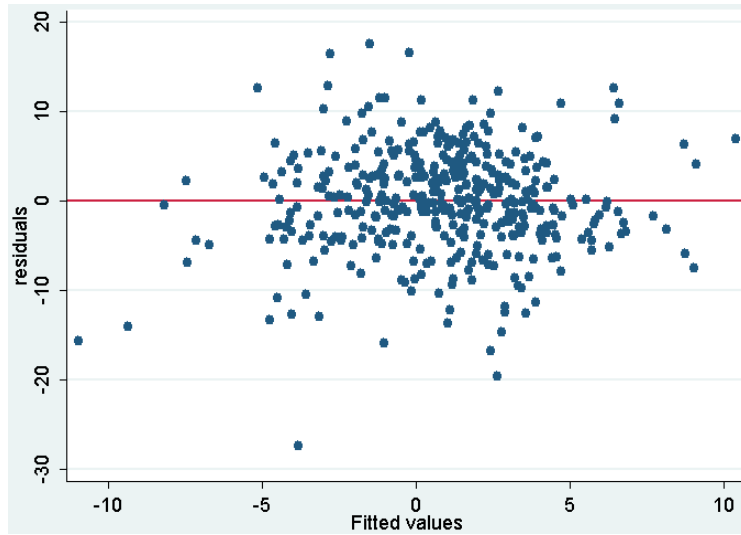
3.4.6. Robust Regression

As it was determined that heteroskedasticity and outliers could affect the overall regression results obtained via random effects, robust regression analysis will also be conducted. Robust regression takes into account the undue influence outliers might have in a regression. It uses a weighting scheme that causes outliers to have less impact on the estimates of regression coefficients¹⁵².

In general, robust regression will generally produce different statistical estimates than OLS. As Figures 13 and 14 show, the effect of plots that are jointly high on both measures of leverage and residuals is minimised, when compared to Figure 9 above.

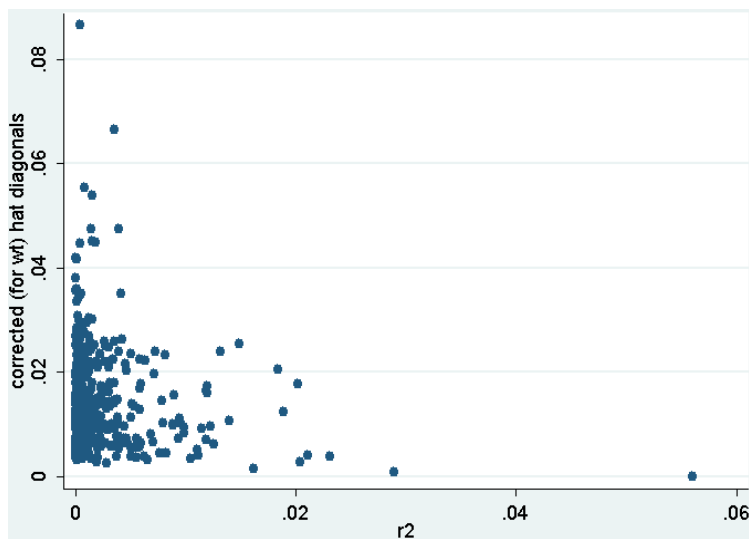
¹⁵² UCLA (Academic Technology Services), Stata Web Books, Regression with Stata, Chapter 4: Beyond OLS, Part 4.1.3: Robust Regression, provided via: <http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter4/statareg4.htm>, accessed April 15 2010

Figure 13: Residual plots for robust regression



Source: Author's own calculations using IMF data

Figure 14: Leverage plots for robust regression



Source: Author's own calculations using IMF data

4. Results

Having defined the theoretical and empirical basis for this study, as well as the model parameters, the data is presented below as follows. The regression results are presented within the framework of the APT using panel methods defined in Section 3.4.5. As such, the factor sensitivities (β_{ij} in equation (2)) are estimated by the coefficients presented below¹⁵³. This will show whether or not the predictor variables have any statistically significant effect on the stock returns of the Visegrad-3. Lagged results are also included since at least one of the predictor variables (industrial production) can be considered a lagging indicator.

Additionally, as outliers were determined to have potentially biased effects on regression outcomes, robust regression results are also included. These results will be presented in the same manner as above. Country specific results are also included¹⁵⁴.

Finally, regarding the effect of exchange rates, it should be noted that each of the regressions were performed under the theory outlined by the flow-oriented model – see Section 2.6.2. As a result, this poses potential interpretation issues since the results could be at risk of reverse causality, i.e. the portfolio-balance approach, or if there is bi-directional causality.

4.1. Random Effects Model

Overall, the regression results derived via random effects for the Visegrad-3 as a whole indicate that an appreciation in the national currency exchange rate per USD or euro has a negative, and statistically significant, effect on the stock returns. Additionally, there is no positive association between industrial production and stock returns unless exports to Germany are included in the same regression, or if lagged variables are introduced. Generally, exports to Germany have a positive and statistically significant effect on stock returns throughout the Visegrad-3.

¹⁵³ See Section 3.1 for the APT.

¹⁵⁴ Country specific results could not be derived via the random effects model as there were insufficient observations.

4.1.1. Regression Results (Random Effects Model)

Regressions (3) and (8) show that exchange rates to both the USD and euro have negative coefficients of -0.7252 and -1.3452 respectively, and are statistically significant to a 1% level – see Tables 12 and 13. By interpreting the coefficients, it can be expected that for every 1% increase in exchange rates to the USD or euro (i.e. currency appreciation) stock returns in the Visegrad-3 decrease by -0.7252% and -1.3452% respectively. This assumes that all other variables hold constant. In using exchange rates to the euro rather than the USD, the coefficients are larger, which suggests an altogether higher sensitivity of stock returns in the region to the euro.

Although the coefficients are positive, industrial production does not prove to be a statistically significant factor in either of the regressions. This suggests that it is not a priced factor under normal test (regression) conditions.

The R^2 results obtained in regressions (3) and (8) can explain only 16.03% and 19.82% of the variance in stock returns of the Visegrad-3. In other words, the degree to which cross-sectional variations in returns that can be explained by the specified model is quite low. This occurred for all regressions and was expected due to the high probability of omitted variable bias.

Table 12: Regression results, (NC/USD exchange rates)¹⁵⁵

Regressor	(1)	(2)	(3)	(4)	(5)
German Bond Rate (Risk-free)	-1.4892*** (-3.19)	-1.4783*** (-2.93)	-1.5063*** (3.21)	-2.8469*** (-4.59)	-0.85521 (-0.81)
NC/USD Change	-0.7263*** (-8.09)	-	-0.7252*** (-8.07)	-0.7165*** (-8.06)	-0.6940*** (-7.87)
Industrial Production SA	-	0.1356 (1.32)	0.1256 (1.32)	0.1226 (1.30)	-0.0107 (-0.12)
Time Effects	-	-	-	-	Yes
EU Accession	-	-	-	-2.6142*** (-3.25)	3.6715* (1.76)
R^2 : Within	0.1572	0.0244	0.1608	0.1823	0.2766
R^2 : Overall	0.1567	0.0244	0.1603	0.1819	0.2761

¹⁵⁵ The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level. Z-values (standard score) are given in parentheses under the coefficients.

Table 13: Regression results, (NC/EUR exchange rates)¹⁵⁶

Regressor	(6)	(7)	(8)	(9)	(10)
German Bond Rate (Risk-free)	-1.8773*** (-4.09)	-1.4783*** (-2.93)	-1.9031*** (-4.14)	-3.6292*** (-6.00)	-1.8648* (-1.81)
NC/EUR Change	-1.3472*** (-9.35)	-	-1.3452*** (-9.34)	-1.3872*** (-9.81)	-1.3483*** (-9.78)
Industrial Production SA	-	0.1356 (1.32)	0.1279 (1.37)	0.1237 (1.36)	-0.0095 (-0.11)
Time Effects	-	-	-	-	Yes
EU Accession	-	-	-	-3.3393*** (-4.28)	-1.4258 (-0.73)
R ² : Within	0.1957	0.0244	0.1994	0.2349	0.3279
R ² : Overall	0.1944	0.0244	0.1982	0.2333	0.3264

4.1.2. Factoring Exports to Germany from the Visegrad-3

On the whole, there is positive association between exports to Germany from the Visegrad-3 and stock returns. By including the export factor, the regression results indicate that exports to Germany from the Visegrad-3 have a positive association with stock returns. This suggests that firms listed on the three Visegrad stock exchanges have economic and financial ties to Germany.

While small, the coefficients for exports to Germany are positive and statistically significant to 1%. Taking into account the exchange rate used, it can be expected that a 1% increase in the value of exports to Germany from the region adds 0.0750% 0.0987% to stock returns – see regressions (11) and (17)¹⁵⁷.

Regarding the exchange rate factor, regressions (14) and (20) produce similar results as those in Section 4.1.1. Exchange rates to both the USD and euro remain significant at 1% and have negative coefficients of -0.7174 and -1.3977 respectively. Likewise, the larger coefficients achieved by factoring exchange rates to the euro rather than the USD again suggests a higher degree of sensitivity of the Visegrad-3's stock markets to the euro.

Industrial production seems to have a significant, and positive, association with stock returns only when exports to Germany are included in the same regression – see

¹⁵⁶ The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level. Z-values (standard score) are given in parentheses under the coefficients.

¹⁵⁷ See Tables 14 and 15

regressions (14) and (20). The coefficients indicate that for every 1% increase in industrial production, stock returns increase by 0.1683% and 0.1835% respectively. This also presumably indicates a degree of correlation between industrial production and exports to Germany.

Compared to the R^2 results derived without factoring exports to Germany, the R^2 in regressions (14) and (20) indicate that by factoring exports the model is able to explain variances in stock returns to a higher degree - 18.34% and 23.70% respectively. The percentage differences are higher when factoring national currency exchange rates to the euro. This again suggests both the sensitivity of the region's stock markets to the euro and the positive association between exports and stock returns.

Notably, the addition of a variable that accounts for EU accession in 2004 indicates that stock returns in the Visegrad-3 have not fared well since then – see regressions (15) and (21). The coefficients are negative (-2.56 and -3.29) and statistically significant to 1%. This negative result, however, can also be said of global stock markets in general given the severe effects brought on by the credit crisis starting in 2007.

By adding a time factor that extends back to 1998 to the regression, the indication is that over the long-term, the returns associated with the Visegrad-3 are positive. When compared to regression (10) above, the inclusion of the export variable in regression (22) indicates that exports have had a substantial influence over stock returns in the long run.

Table 14: Regression results factoring exports to Germany, (NC/USD exchange rates)¹⁵⁸

Regressor	(11)	(12)	(13)	(14)	(15)	(16)
German Bond Rate (Risk-free)	-1.5454*** (-3.26)	-2.8641*** (-4.60)	-1.0559 (-1.00)	-1.5726*** (-3.33)	-2.8819*** (-4.64)	-1.086 (-1.02)
NC/USD Change	-0.7197*** (-8.02)	-0.7112*** (-8.02)	-0.6916*** (-7.85)	-0.7174*** (-8.02)	-0.7091*** (-8.01)	-0.6917*** (-7.84)
Industrial Production SA	-	-	-	0.1683* (1.76)	0.1646* (1.74)	0.0254 (0.27)
Exports to Germany	0.0750*** (3.10)	0.0737*** (3.08)	0.0565** (2.45)	0.0809*** (3.32)	0.0796*** (3.30)	0.0576** (2.46)
Time Effects	-	-	Yes	-	-	Yes
EU Accession	-	-2.5772*** (-3.22)	-1.3778 (-0.67)	-	-2.5601*** (-3.20)	3.6450* (1.72)
R^2 : Within	0.1775	0.1985	0.2897	0.1838	0.2045	0.2899
R^2 : Overall	0.1771	0.1980	0.2893	0.1834	0.2041	0.2894

¹⁵⁸ The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level. Z-values (standard score) are given in parentheses under the coefficients.

Table 15: Regression results factoring exports to Germany, (NC/EUR exchange rates)¹⁵⁹

Regressor	(17)	(18)	(19)	(20)	(21)	(22)
German Bond Rate (Risk-free)	-1.9869*** (-4.31)	-3.6916*** (-6.15)	-2.1932** (-2.15)	-2.017*** (-4.39)	-3.7711*** (-6.20)	-2.2436** (-2.19)
NC/EUR Change	-1.3964*** (-9.79)	-1.4374*** (-10.27)	-1.3941*** (-10.18)	-1.3977*** (-9.83)	-1.4384*** (-10.31)	-1.3956*** (-10.18)
Industrial Production SA	-	-	-	0.1835** (1.98)	0.1787** (1.97)	0.0412 (0.46)
Exports to Germany	0.0978*** (4.16)	0.0967*** (4.20)	0.0765*** (3.45)	0.1043*** (4.41)	0.103*** (4.45)	0.0783*** (3.48)
Time Effects	-	-	Yes	-	-	Yes
EU Accession	-	-3.3053*** (-4.30)	-1.3716 (-0.70)	-	-3.2864*** (-4.29)	0.4028 (0.16)
R ² : Within	0.2308	0.2655	0.3519	0.2382	0.2726	0.3523
R ² : Overall	0.2294	0.2638	0.3504	0.2370	0.2710	0.3508

4.1.3. Regression Results (Random Effects Model with Lagged Variables)

By lagging each of the predictor variables for up to three periods, the regressions should produce results indicating that a relationship exists between any lagging macroeconomic indicators specified in the model and stock returns.

Lagging the predictor variables for one period produced results that differed from those above. In fact, each of the predictor variables was rendered insignificant with the exception of the risk-free rate. This suggests that predictor variables lagged for one period have either factored into stock market returns or have yet to be.

When lagged for two periods, regressions (25) and (31) indicate that there is positive association between industrial production and the stock returns of the Visegrad-3 – see Tables 16 and 17. The coefficient results are statistically significant to the 5% level and indicate that for every 1% increase in industrial production a 0.2325% or 0.2336% increase in stock returns can be expected. In this case, both exchange rate predictors and exports to Germany are statistically insignificant though the addition of the export variable added to the coefficient results for industrial production.

Predictor variables lagged for three periods produced varied and unexpected results. Regression (27) indicates that all predictor variables except exchange rates to the

¹⁵⁹ The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level. Z-values (standard score) are given in parentheses under the coefficients.

USD are significant the varying degrees – see Table 16. On the other hand, regression (33) indicates that all predictor variables, including exchange rates to the euro are significant – see Table 17. This presumably indicates some residual effect from previous of the macroeconomic factors on stock returns.

Table 16: Lagged effects, (NC/USD exchange rates)¹⁶⁰

Regressor	(23)	(24)	(25)	(26)	(27)	(28)
German Bond Rate (Risk-free)	-2.3923*** (-4.48)	-4.6244*** (-7.11)	-2.4003*** (-4.83)	-4.6998*** (-7.14)	-2.7371*** (-5.57)	-5.2092*** (-8.07)
NC/USD Change	-0.0587 (-0.62)	-0.0703 (-0.77)	-0.0574 (-0.61)	-0.0692 (-0.75)	0.1193 (1.28)	0.102 (1.13)
Industrial Production SA	0.2264** (2.27)	0.2236** (2.31)	0.2325** (2.31)	0.226** (2.31)	0.169* (1.70)	0.1577* (1.65)
Exports to Germany	-	-	0.013 (0.51)	0.0086 (0.35)	0.0632** (2.50)	0.0594** (2.44)
Lags	2	2	2	2	3	3
EU Accession	-	-4.2687*** (-5.08)	-	-4.3514*** (-5.12)	-	-4.6824*** (-5.64)
R ² : Within	0.0660	0.1228	0.0666	0.1245	0.0915	0.1594
R ² : Overall	0.0660	0.1227	0.0666	0.1244	0.0915	0.1590

Table 17: Lagged effects, (NC/EUR exchange rates)

Regressor	(29)	(30)	(31)	(32)	(33)	(34)
German Bond Rate (Risk-free)	-2.4007*** (-4.83)	-4.6783*** (-7.12)	-2.4110*** (-4.83)	-4.7557*** (-7.15)	-2.5701*** (-5.28)	-4.9484*** (-7.68)
NC/EUR Change	-0.0271 (-0.17)	-0.1028 (-0.68)	-0.0335 (-0.21)	-0.1074 (-0.71)	0.5443*** (3.59)	0.4667*** (3.17)
Industrial Production SA	0.2272** (2.28)	0.2242** (2.31)	0.2336** (2.32)	0.2275** (2.33)	0.1652* (1.68)	0.1551 (1.64)
Exports to Germany	-	-	0.0138 (0.54)	0.0105 (0.42)	0.0548** (2.19)	0.0524** (2.17)
Lags	2	2	2	2	3	3
EU Accession	-	-4.3093*** (-5.10)	-	-4.3925*** (-5.15)	-	-4.4596*** (-5.40)
R ² : Within	0.0652	0.1226	0.0658	0.1244	0.1166	0.1775
R ² : Overall	0.0652	0.1224	0.0658	0.1243	0.1164	0.1771

¹⁶⁰ The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level. Z-values (standard score) are given in parentheses under the coefficients.

4.2. Robust Regression

4.2.1. Robust Regression Results

Overall, the results derived through robust regression without lags do not exhibit any considerable departure from the results achieved via the random effects model above – see Sections 4.1.1 and 4.1.2. The model generally finds that the predictors have the same influential effects on stock returns in the Visegrad-3.

Specifically, exchange rates to both the USD and the euro are statistically significant and exhibit negative coefficients. Regressions (36) and (40) show that for every 1% increase in exchange rates to the USD and euro, stock returns in the Visegrad-3 decrease by -0.5953% and -1.2085% respectively – see Tables 18 and 19. The t-statistics (-7.04 and -8.90) generally support Hypothesis 1 that states that exchange rate appreciation against either the USD or euro negatively affects stock returns.

Further, under the conditions of either of the exchange rate variables, industrial production is not statistically significant unless exports to Germany from the Visegrad-3 are included in the regression. Even so, the t-statistics generally support Hypotheses 2 and 3 that state there is positive association between both factors of industrial production and exports to Germany and stock returns.

Table 18: Robust regression results, (NC/USD exchange rates)¹⁶¹

Regressor	(35)	(36)	(37)	(38)
German Bond Rate (Risk-free)	-1.9008*** (-4.34)	-2.0885*** (-4.67)	-3.314*** (-5.63)	-2.0307** (-1.97)
NC/USD Change	-0.6024*** (-7.18)	-0.5953*** (-7.04)	-0.6112*** (-7.28)	-0.6281*** (-7.31)
Industrial Production SA	0.1216 (1.37)	0.182** (2.01)	0.1786** (1.99)	0.086 (0.95)
Exports to Germany	-	0.0664*** (2.88)	0.0703*** (-3.07)	0.0546** (2.39)
Time Effects	No	No	No	Yes
EU Accession	No	No	-2.4822*** (-3.27)	-1.7154 (-1.30)

¹⁶¹ Robust regression results did not produce R² results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

Table 19: Robust regression results, (NC/EUR exchange rates)¹⁶²

Regressor	(39)	(40)	(41)	(42)
German Bond Rate (Risk-free)	-2.2781*** (-5.31)	-2.4678*** (-5.63)	-4.0983*** (-7.17)	-2.8319*** (-2.82)
NC/EUR Change	-1.1699*** (-8.72)	-1.2085*** (-8.90)	-1.2910*** (-9.69)	-1.3317*** (-9.90)
Industrial Production SA	0.1018 (1.17)	0.1661* (1.88)	0.1747** (2.02)	0.0512 (0.58)
Exports to Germany	-	0.0749*** (3.32)	0.0818*** (3.70)	0.0664*** (3.00)
Time Effects	No	No	No	Yes
EU Accession	No	No	-3.1591*** (-4.32)	1.4901 (1.02)

Results using lagged variables, however, produced different results compared to those in Section 4.1.3. Here, lagged variables for one period are statistically significant while variables lagged for more than one period indicate that they are not. These results contrast those presented above in Section 4.1.3. This suggests that under the conditions of robust regression outlier effects are minimised, bringing those plots high on both residual and leverage closer to the data sample as a whole.

Regressions lagged for one period and indicate that foreign exchange rates to both the USD and euro are statistically significant – see Appendices 7(a) and (b). Industrial production shows a positive coefficient and is statistically significant to 10% when exchange rates to the euro are included in the regression.

The addition of the exports variable results in industrial production being significant in both currency exchange cases – see Appendices 7(a) and (b). This again suggests some sensitivity on the part of stock returns to the euro when industrial production and exports are taken into account. Given the region’s proximity to Western Europe this is not unexpected.

When lagged for two and three periods, the results diverge from those presented above in Section 4.1.3. The main predictor variables are not statistically significant when lagged for two periods, although the coefficient results continue to indicate the negative

¹⁶² Robust regression results did not produce R^2 results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

association between currency appreciation and stock returns. Industrial production and exports to Germany continue to indicate positive association.

Lagged for three periods, only exchange rates to the euro are statistically significant and represent perhaps some residual effect from previous months on stock returns. Again, the result suggests that stock returns in the three stock markets are sensitive to currency valuations against the euro. The other predictor variables indicate the same pattern of effects even though they are not significant.

4.2.2. Robust Regression Results by Country

Country specific robust regressions were conducted to judge the relationship between the selected factors and stock returns on an individual basis. Overall, the predictor variables generally appear to have the same effect on stock returns as seen in the previous sections. However, differences among the three Visegrad stock markets arise, specifically as it relates to the Czech Republic. This suggests some structural differences between the three Visegrad stock markets, which mirrors Hanousek and Filer (2000).

4.2.2.1. Robust Regression Results: The Czech Republic

Overall, the results generally indicate that without lags the selected macroeconomic factors are not priced in the Czech Republic. However, the results do show there is a lag in terms of the relationship between stock returns and factors related to exchange rates and industrial production.

Under normal conditions, regressions (44) and (48) show none of the main predictor variables to be statistically significant except for exchange rates to the euro – see Tables 20 and 21. The coefficients do, however, indicate that currency appreciation against the USD or euro affects stock returns to the downside. It is interesting to note that while statistically insignificant, the coefficient result for industrial production under normal conditions is negative.

Lagged for two periods, industrial production is statistically significant and displays the same positive association with stock returns as seen in the results above – see Appendices 8(a)-(b). Coincidentally, exports seem to have no effect under both normal and lagged conditions. This perhaps speaks to both the type and number of firms listed on the stock exchange in the Czech Republic.

Table 20: Robust Regression Results, Czech Republic, (NC/USD Rates)¹⁶³

Regressor	(43)	(44)	(45)	(46)
German Bond Rate (Risk-free)	-1.7267** (-2.26)	-2.0113** (-2.58)	-3.5469*** (-3.50)	-1.8137 (-1.07)
NC/USD Change	-0.2082 (-1.32)	-0.1969 (-1.24)	-0.2135 (-1.36)	-0.1632 (-0.99)
Industrial Production SA	-0.1266 (-0.70)	-0.1081 (-0.59)	-0.1022 (-0.57)	-0.2208 (-1.21)
Exports to Germany	-	0.0312 (0.76)	0.0359 (0.89)	0.0287 (0.70)
Time Effects	No	No	No	Yes
EU Accession	No	No	-2.9481** (-2.24)	1.4135 (0.47)

Table 21: Robust Regression Results, Czech Republic, (NC/EUR Rates)

Regressor	(47)	(48)	(49)	(50)
German Bond Rate (Risk-free)	-1.9735** (-2.57)	-2.2783*** (-2.90)	-4.0283*** (-3.93)	-2.6723 (-1.53)
NC/EUR Change	-0.5905* (-1.81)	-0.6218* (-1.83)	-0.7848** (-2.33)	-0.6874* (-1.96)
Industrial Production SA	-0.1814 (-1.00)	-0.1538 (-0.85)	-0.1455 (-0.82)	-0.2699 (-1.48)
Exports to Germany	-	0.0396 (0.94)	0.0487 (1.18)	0.0355 (0.85)
Time Effects	No	No	No	Yes
EU Accession	No	No	-3.3743** (-2.57)	0.6553 (0.22)

¹⁶³ Robust regression results did not produce R² results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

4.2.2.2. Robust Regression Results: Hungary

Without lags, regressions (52) and (56) indicate that each of the macroeconomic factors are statistically significant – see Tables 22 and 23. Compared to the results obtained for the Czech Republic, the higher t-values suggest that the factors included in the model have a greater degree of influence on stock returns in Hungary.

Also, the substantially larger coefficient results for each factor suggest that stock returns are sensitive to the factors included in the regression. This indicates some bias toward the number and type of firms listed on the Hungarian stock exchange. Notably, the t-values suggest that stock returns in Hungary are oriented toward factors of industrial production, while Poland is more reliant on exports to Germany.

When lagged for three periods, none of the predictors are statistically significant except industrial production. This, again, may be a result of the residual impact of industrial production results from previous months. Overall, it appears that the Hungarian stock market seems to have priced each of the macroeconomic factors since they are statistically significant without adding lagged effects.

Table 22: Robust Regression Results, Hungary, (NC/USD Rates)¹⁶⁴

Regressor	(51)	(52)	(53)	(54)
German Bond Rate (Risk-free)	-1.9996** (-2.56)	-1.9694** (-2.49)	-3.1518*** (-3.01)	-0.0166 (-0.01)
NC/USD Change	-0.8041*** (-5.63)	-0.8785*** (-6.12)	-0.8683*** (-6.10)	-0.8722*** (-5.72)
Industrial Production SA	0.4857*** (2.82)	0.5471*** (3.15)	0.5639*** (3.29)	0.3663* (1.89)
Exports to Germany	-	0.0620* (1.76)	0.0603* (1.73)	0.0489 (1.35)
Time Effects	No	No	No	Yes
EU Accession	No	No	-2.2776* (-1.71)	5.2782 (1.00)

¹⁶⁴ Robust regression results did not produce R² results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

Table 23: Robust Regression Results, Hungary, (NC/EUR Rates)¹⁶⁵

Regressor	(55)	(56)	(57)	(58)
German Bond Rate (Risk-free)	-2.7581*** (-3.68)	-2.7382*** (-3.58)	-4.6012*** (-4.63)	-2.8079 (-1.26)
NC/EUR Change	-1.7589*** (-7.28)	-1.8475*** (-7.55)	-1.8727*** (-7.89)	-1.9161*** (-7.62)
Industrial Production SA	0.3915** (2.38)	0.4418*** (2.65)	0.4565*** (2.82)	0.2814 (1.54)
Exports to Germany	-	0.0646* (1.91)	0.0628* (1.91)	0.0545 (1.60)
Time Effects	No	No	No	Yes
EU Accession	No	No	-3.4773*** (-2.77)	1.4094 (0.28)

4.2.2.3. Robust Regression Results: Poland

Overall it appears that, much like Hungary, the Polish stock market seems to have priced each of the macroeconomic factors since they are statistically significant without adding lagged effects.

Regressions (60) and (64) show both exchange rates to the USD and euro to be statistically significant under normal conditions – see Tables 24 and 25. Notably, industrial production seems to be only statistically significant when exports to Germany are included in the regression. The lower t-values obtained for the factor of industrial production suggests that other unobserved factors are better able to explain stock returns in Poland. Also, the performance of the Polish zloty against the USD and euro further suggest unobserved factors to be important.

¹⁶⁵ Robust regression results did not produce R^2 results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

Table 24: Robust Regression Results, Poland, (NC/USD Rates)¹⁶⁶

Regressor	(59)	(60)	(61)	(62)
German Bond Rate (Risk-free)	-1.9239*** (-2.68)	-2.1012*** (-2.84)	-3.1716*** (-3.21)	-3.373** (-2.03)
NC/USD Change	-0.8057*** (-6.01)	-0.7303*** (-5.33)	-0.7130*** (-5.15)	-0.7617*** (-5.32)
Industrial Production SA	0.0984 (0.79)	0.2011 (1.55)	0.20004 (1.53)	0.088 (0.66)
Exports to Germany	-	0.1016** (2.32)	0.1119** (2.53)	0.0788* (1.75)
Time Effects	No	No	No	Yes
EU Accession	No	No	-1.9985 (-1.56)	0.8974 (0.38)

Table 25: Robust Regression Results, Poland, (NC/EUR Rates)

Regressor	(63)	(64)	(65)	(66)
German Bond Rate (Risk-free)	-2.0747*** (-2.90)	-2.1999*** (-3.00)	-3.5645*** (-3.69)	-3.4522** (-2.11)
NC/EUR Change	-1.1595*** (-6.31)	-1.1799*** (-6.38)	-1.2064*** (-6.54)	-1.2876*** (-6.65)
Industrial Production SA	0.1204 (0.97)	0.2221* (1.73)	0.2201* (1.72)	0.1224 (0.93)
Exports to Germany	-	0.1317*** (3.07)	0.1401*** (3.28)	0.0915** (2.08)
Time Effects	No	No	No	Yes
EU Accession	No	No	-2.6355** (-2.11)	1.3195 (0.58)

¹⁶⁶ Robust regression results did not produce R² results. The t-values are given in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level or *10% level

5. Conclusion

Going back to Errunza (1977) emerging market stock returns have been studied for the better part of two decades. While there is no strong consensus as to the specific nature of convergence between EMs and developed markets, Bekaert and Harvey (1997) conclude that EMs experience time-varying market integration. This comes particularly after the introduction of market reforms and economic liberalisation.

Accordingly, the cost of capital should be allowed to vary over time as the result of the lowering of systemic risks through market development. Relative to developed markets, a main disadvantage facing EMs as a result of segmentation remains a higher cost of capital, which ultimately deters investment and future economic growth. In light of this, the economies of CEE provide a striking example of market convergence as a result of both the collapse of communism and the efforts to liberalise their economies within the structural foundations of the EU.

The purpose of this paper was to explore whether specific macroeconomic variables affect stock returns in the Visegrad-3. To do so, the theoretical framework of the APT was adopted; it states that the expected return of an asset or portfolio can be modelled as a linear function of a set of macroeconomic factors. Accordingly, the expected return is risk-adjusted to account for systemic risks brought on by multiple macroeconomic factors.

In this case, the macroeconomic factors were selected *a priori* from the theoretical and empirical literature that shows that each of them should have some influential bearing on stock prices and hence stock returns. These factors are: foreign exchange rates against the USD and the euro, industrial production and the total value of exports to Germany.

On the whole, the findings suggest that stock returns in the Visegrad-3 are influenced by the selected macroeconomic factors. The pooled results indicate that the appreciation of national currencies against the USD and euro have a negative effect on stock returns. On the other hand, industrial production has a positive influence on stock returns, but is a lagged factor. Finally, exports to Germany from the region have a positive and statistically significant effect on the region's stock returns.

Additionally, the results obtained by using robust methods further confirm the findings that were derived above. However, on a country level basis there appears to be differences amongst the Visegrad-3. Both the Hungarian and Polish markets appear to exhibit some degree of semi-efficiency; the macroeconomic factors are generally shown to influence stock returns and are statistically significant without the need for lags. Conversely, none of the variables seem to have any effect on stock returns in the Czech stock market unless they are lagged.

It can be presumed that the results presented in this paper also support and perhaps add to the findings made by Hanousek and Filer (2000) regarding CEE stock market efficiency. They stated then that reforms introduced throughout the nineties in the Visegrad-3 should eventually lead to markets exhibiting greater degrees of semi-efficiency as they integrate with global markets. The caveat is that Hungary and Poland experienced a steadier and more controlled market liberalisation process than did the Czech Republic. The country specific results show there to be a clear delineation between the three countries.

Given the results achieved in this paper, it can be inferred that with time each of the Visegrad-3 markets has undergone fundamental changes as market reforms took hold. It can also be presumed that to the extent the Visegrad-3 markets have developed and converged with global markets, the cost of capital has simultaneously lowered throughout the region. This is, however, another topic for future research.

The results obtained also speak to the influence that the Hungarian and Polish markets have on overall stock returns in the region. Given the size of their markets in comparison to the Czech Republic's this was not wholly unexpected. Finally, the main shortcomings of this paper are related to unobserved variables and the assumption of the flow-oriented model that shows a uni-directional relationship between exchange rates and stock returns. Since each of the exchange rates to the USD and the euro diverged amongst the three countries the regression outcomes suggest there to be some risk of reverse causality or bi-directional causality that is not considered.

In sum, the results indicate that the macroeconomic factors selected for this paper are able to explain cross-sectional returns to varying degrees. In general, the results also suggest that the Visegrad-3 stock markets have undergone a process of dynamic change.

While the extent of their integration can be the subject of future research, the stock markets have nevertheless exhibited that the selected macroeconomic variables are factored into stock returns.

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7. Appendices

7.1. Appendix 1(a): Descriptive Statistics, Visegrad-3

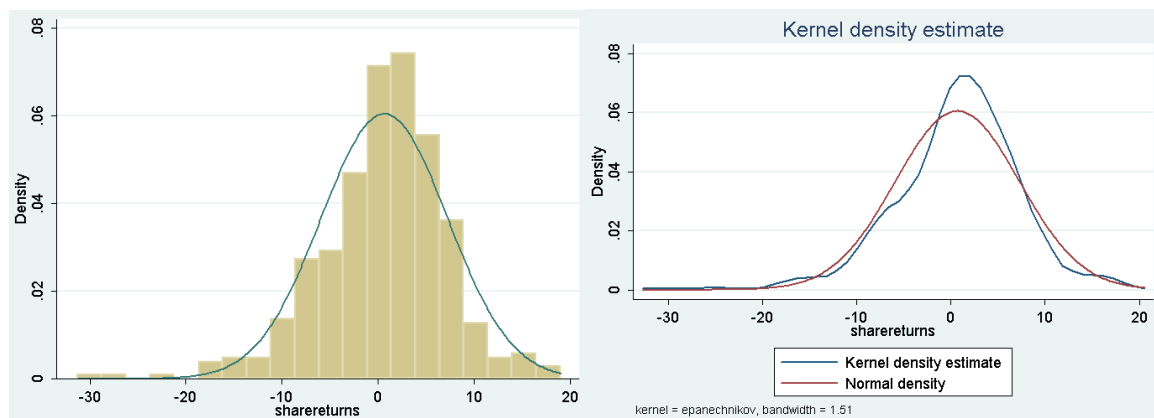
Czech Republic	Share Prices	Share Returns	NC/USD	NC/EUR	Industrial Production SA	DE Govt. Bond	Exports to DE
Mean	69.82901	0.5911356	-0.4626306	-0.2717761	0.2558132	-	1.1219759
SEMean	3.16605	0.5579053	0.2627055	0.1280826	0.2292582	-	1.02465
Median	53.52495	0.6085669	-0.6099955	-0.4600302	0.3352947	-	2.158554
Standard Deviation	37.9926	6.694864	3.152466	1.536991	2.751098	-	12.21012
Variance	1443.438	44.8212	9.93804	2.362341	7.568543	-	149.087
Skewness	0.6551663	-0.7616523	0.5302657	0.5695693	-0.0532642	-	-0.2820741
Kurtosis	1.963285	6.154253	3.425589	5.090443	3.643903	-	2.659573
Count	144	144	144	144	144	-	142
Range	123.2588	50.27553	16.49542	10.29582	15.30949	-	60.27674
Minimum	26.8522	-31.24371	-7.334581	-4.694762	-7.92032	-	-31.77655
Maximum	150.111	19.03182	9.160837	5.601061	7.389172	-	28.50019
Hungary							
Mean	77.35086	0.6750124	-0.0526501	0.1378361	0.4235237	-	0.891598
SEMean	3.321461	0.5930169	0.2710137	0.1556357	0.2319207	-	1.229159
Median	64.72275	0.8658934	-0.0449693	0.1838237	0.6700193	-	2.606315
Standard Deviation	36.38478	6.469051	3.252165	1.867629	2.773368	-	14.64712
Variance	1323.852	41.84862	10.57657	3.488037	7.69157	-	214.5381
Skewness	0.3902863	-0.6379204	0.7232041	0.7398284	-1.360498	-	-0.414694
Kurtosis	1.642315	5.436061	5.159101	5.929548	9.168492	-	2.952048
Count	120	119	144	144	143	-	142
Range	122.9803	44.19283	22.2934	12.39879	21.99912	-	72.20205
Minimum	31.7537	-26.62919	-7.961812	-4.619751	-15.15991	-	-36.72433
Maximum	154.734	17.56363	14.33158	7.779014	6.839209	-	35.47772
Poland							
Mean	91.24996	0.7385821	-0.1513459	0.038724	0.4237674	-	1.113465
SEMean	4.022256	0.5539781	0.2887895	0.210111	0.3110247	-	0.9388098
Median	74.6714	1.551667	-0.6478568	-0.5013232	0.6591039	-	2.524467
Standard Deviation	48.26707	6.647737	3.465474	2.521332	3.732297	-	11.18721
Variance	2329.71	44.19241	12.00951	6.357113	13.93004	-	125.1537
Skewness	1.027778	-0.5941312	0.9669824	0.8581736	-0.3565727	-	-0.4544902
Kurtosis	2.987347	3.960473	5.467496	3.907337	4.811888	-	3.393843
Count	144	144	144	144	144	-	142
Range	180.5131	39.77632	22.05977	14.20969	25.39187	-	60.91912
Minimum	40.9369	-23.47833	-8.237461	-4.814158	-13.14512	-	-32.63099
Maximum	221.45	16.29799	13.82231	9.39553	12.24674	-	28.28814

Appendix 1(b): Descriptive Statistics, Visegrad-3 (Total)

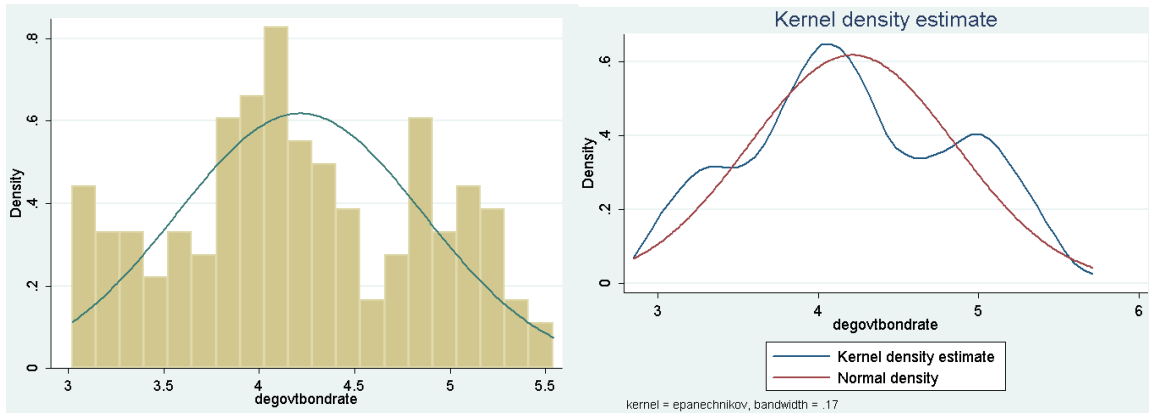
Total	Share Prices	Share Returns	NC/USD	NC/EUR	Industrial Production SA	DE Govt. Bond	Exports to DE
Mean	79.60165	0.6678276	-0.2222089	-0.0317387	0.3675719	4.212778	1.045795
SEMean	2.098122	0.3269953	0.1582724	0.097192	0.149987	0.0310621	0.6169954
Median	65.4477	1.091873	-0.4265509	-0.2057533	0.5872008	4.15	2.45357
Standard Deviation	42.37998	6.596883	3.28963	2.020098	3.113811	0.6456146	12.73464
Variance	1796.063	43.51886	10.82166	4.080798	9.695817	0.41688183	162.1711
Skewness	0.9190015	-0.6679682	0.767046	0.8856439	-0.5205762	0.0657148	-0.3986973
Kurtosis	3.179222	5.176867	4.856156	5.260374	5.886883	2.101912	3.121717
Count	408	407	432	432	431	432	426
Range	194.5978	50.27553	22.56905	14.20969	27.40665	2.52	72.20205
Minimum	26.8522	-31.24371	-8.237461	-4.814158	-15.15991	3.02	-36.72433
Maximum	221.45	19.03182	14.33158	9.39553	12.24674	5.54	35.47772

7.2. Appendix 2: Histograms and Normality of Distribution

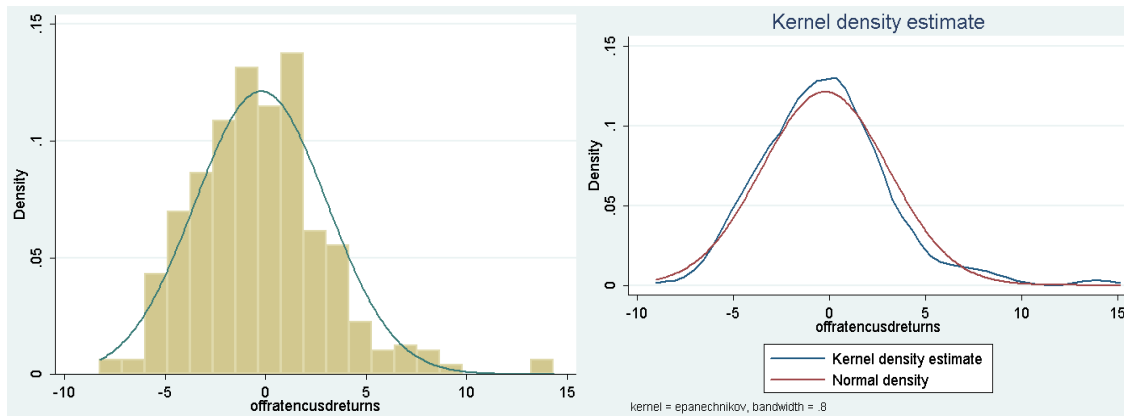
Appendix 2.1. Stock Market Returns



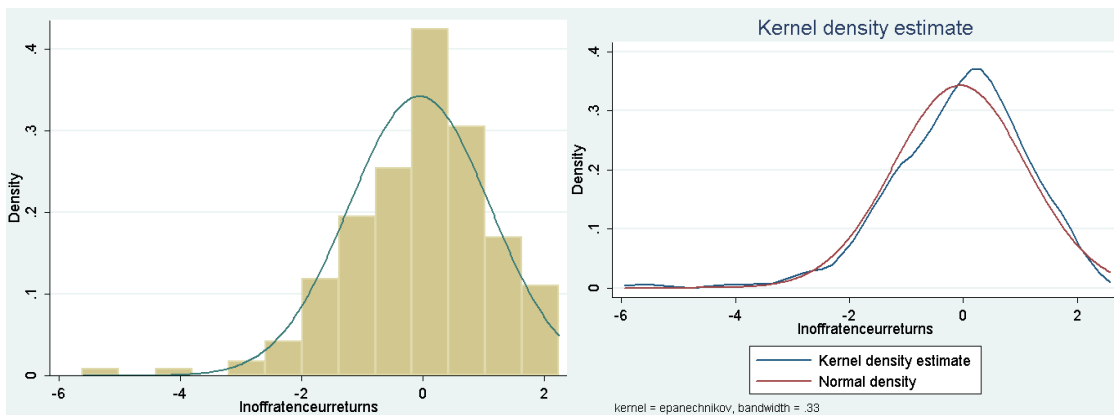
Appendix 2.2. German Government Bond Rates (Risk-free Rate)



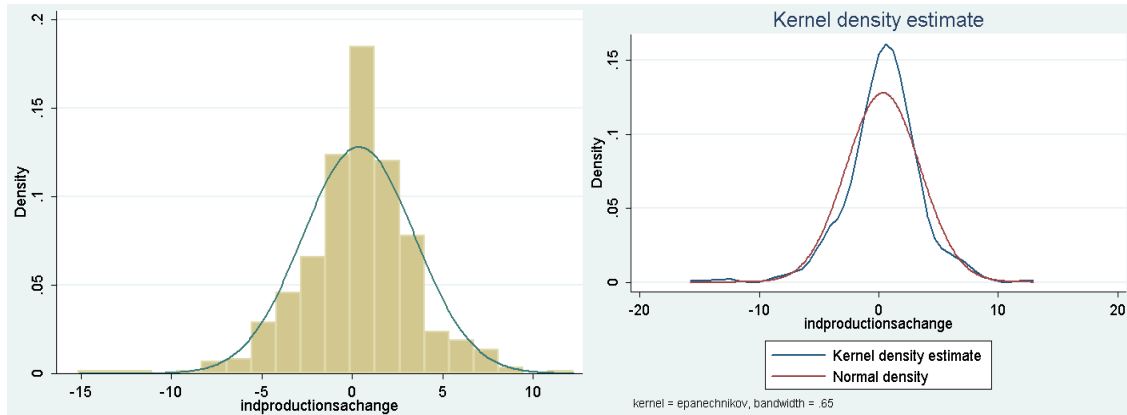
Appendix 2.3. Official Exchange Rate (National Currency) to US Dollar, (% change)



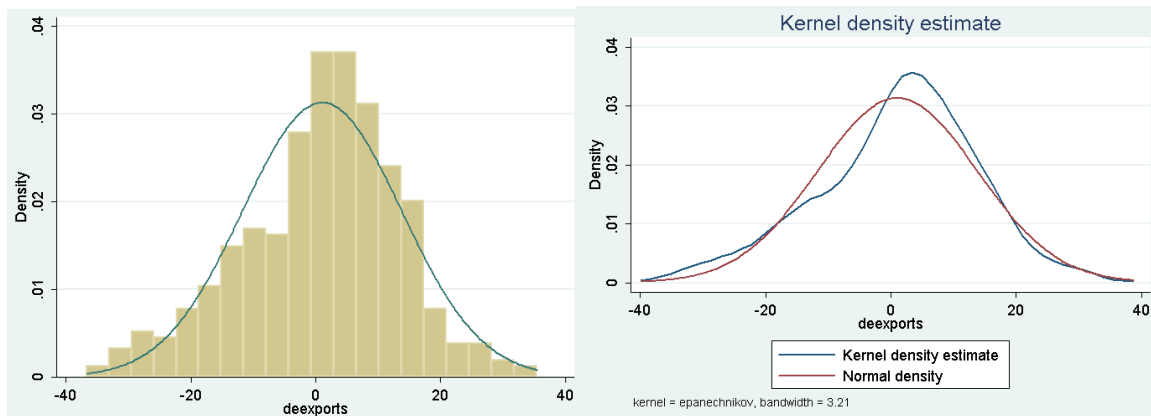
Appendix 2.4. Official Exchange Rate (National Currency) to Euro, (% change)



Appendix 2.5. Industrial Production Index, Seasonally Adjusted, (% change)

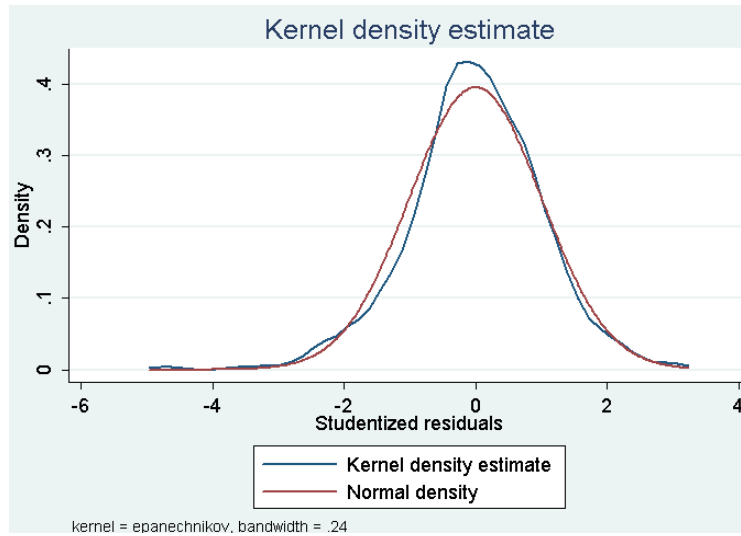


Appendix 2.6. Total Value of Exports (F.O.B.) to Germany, (% change)

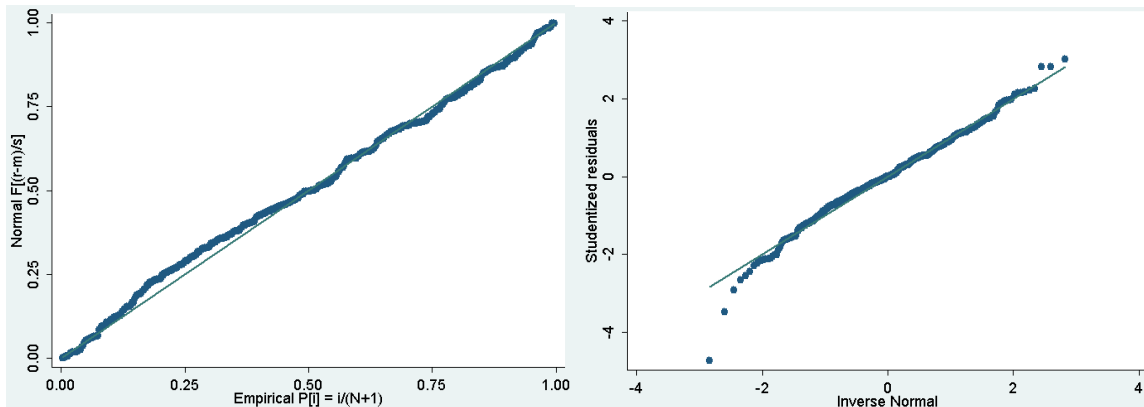


7.3. Appendix 3: Normality of Distribution

Appendix 3(a): Normality of Residuals



Appendix 3(b): Standardised Normal Probability (P-P) Plots and Quantile-Plots



Appendix 3(c): Shapiro-Wilk W-test for Normality

Shapiro-Wilk Test for Normal Data					
Variable	Obs	W	V	Z	Prob>z
r	401	0.98559	3.977	3.285	0.00051

7.4. Appendix 4: Correlation Matrices

Appendix 4(a): Correlation Matrix, Czech Republic

	Share Returns	German Bond Rate	NC/USD	NC/EUR	Industrial Production	Exports
Share Returns	1.0000					
German Bond Rate	-0.1150 (0.1669)	1.0000				
NC/USD	-0.1990** (0.0168)	-0.0210 (0.8032)	1.0000			
NC/EUR	-0.1647** (0.0486)	-0.1582* (0.0583)	0.6464*** (0.0000)	1.0000		
Industrial Production	0.0637 (0.4481)	0.0590 (0.4823)	-0.1063 (0.2048)	-0.1650** (0.0481)	1.0000	
Exports	0.0848 (0.3156)	0.0030 (0.9716)	0.0956 (0.2576)	0.2623*** (0.0016)	-0.0920 (0.2763)	1.0000

Appendix 4(b): Correlation Matrix, Hungary

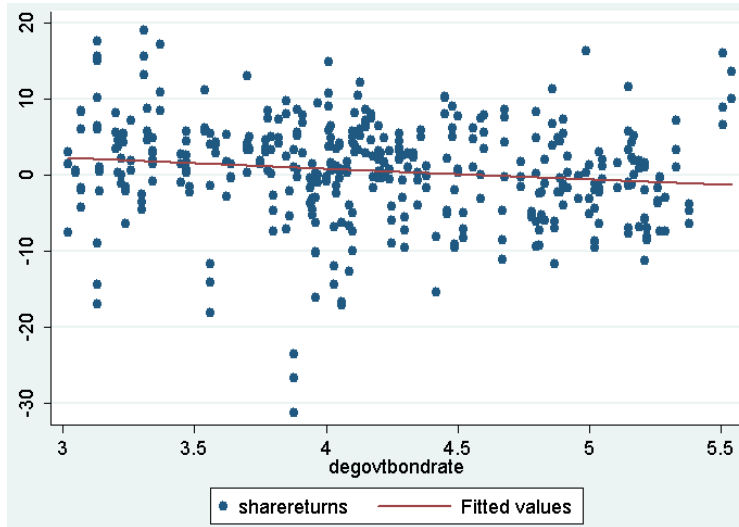
	Share Returns	German Bond Rate	NC/USD	NC/EUR	Industrial Production	Exports
Share Returns	1.0000					
German Bond Rate	-0.1819** (0.0477)	1.0000				
NC/USD	-0.4878*** (0.0000)	0.0194 (0.8177)	1.0000			
NC/EUR	-0.5531*** (0.0000)	-0.0606 (0.4708)	0.6640*** (0.0000)	1.0000		
Industrial Production	0.1549* (0.0939)	0.1361 (0.1050)	0.0260 (0.7579)	0.0399 (0.6360)	1.0000	
Exports	0.1322 (0.1555)	-0.0029 (0.9728)	-0.0400 (0.6364)	0.0410 (0.6282)	-0.0632 (0.4549)	1.0000

Appendix 4(c): Correlation Matrix, Poland

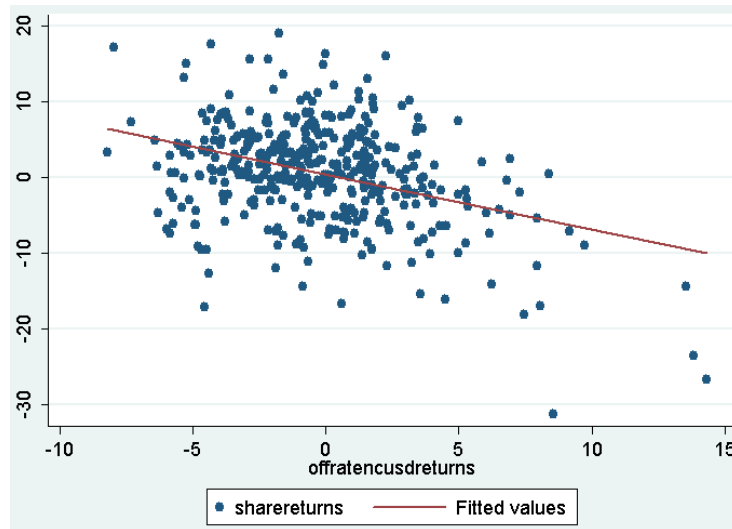
	Share Returns	German Bond Rate	NC/USD	NC/EUR	Industrial Production	Exports
Share Returns	1.0000					
German Bond Rate	-0.1364 (0.1030)	1.0000				
NC/USD	-0.4296*** (0.0000)	0.0024 (0.9771)	1.0000			
NC/EUR	-0.4746*** (0.0000)	-0.0602 (0.4733)	0.6838*** (0.0000)	1.0000		
Industrial Production	-0.0003 (0.9968)	-0.0296 (0.7247)	0.0208 (0.8050)	0.0366 (0.6630)	1.0000	
Exports	0.2364*** (0.0046)	0.0262 (0.7573)	-0.1191 (0.1581)	0.0001 (0.9989)	-0.2291*** (0.0061)	1.0000

7.5. Appendix 5: Correlation and Linearity

Appendix 5(a): Scatter Plot, Stock Returns and German Government Bond Rates



Appendix 5(b): Scatter Plot, Stock Returns and NC/USD Exchange Rates



Appendix 5(c): Scatter Plot: Stock Returns and NC/EUR Exchange Rates

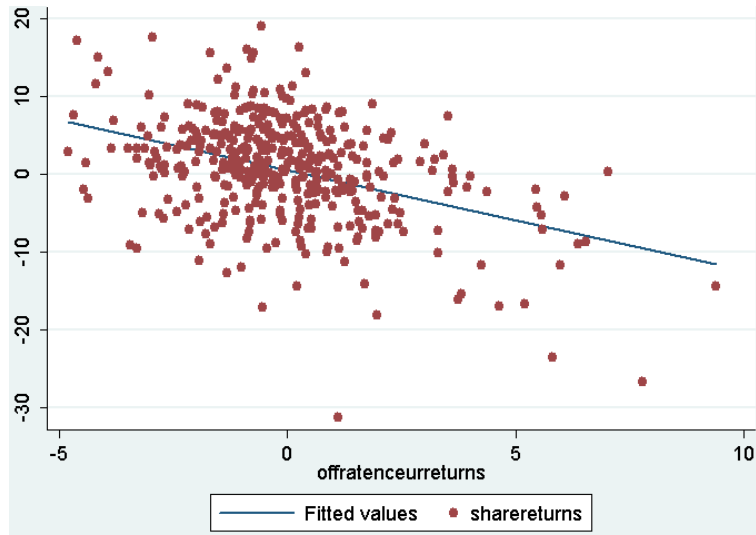


Table 5(d): Scatter Plot: Stock Returns and Industrial Production (Seasonally Adj.)

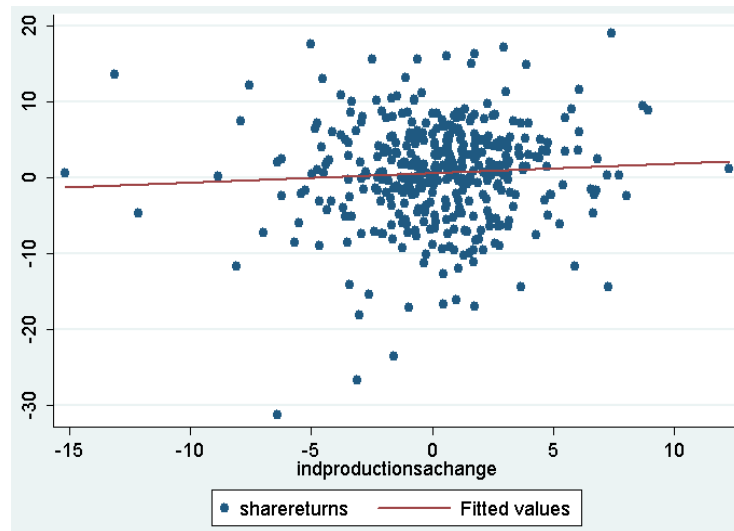
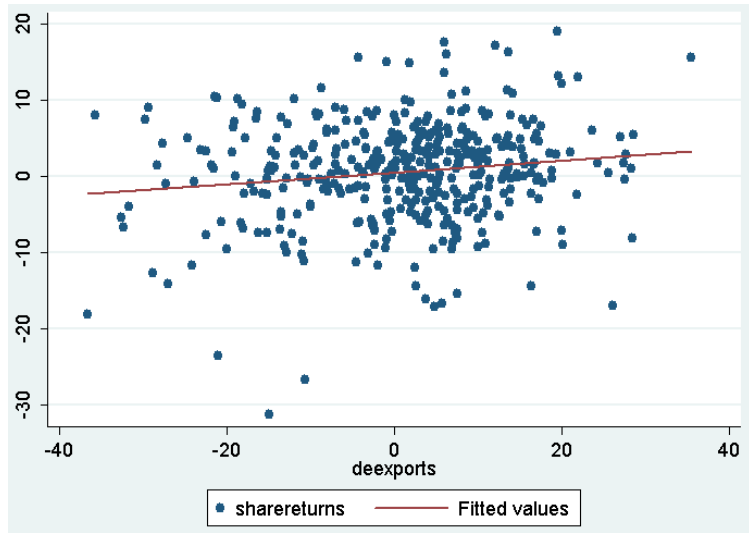
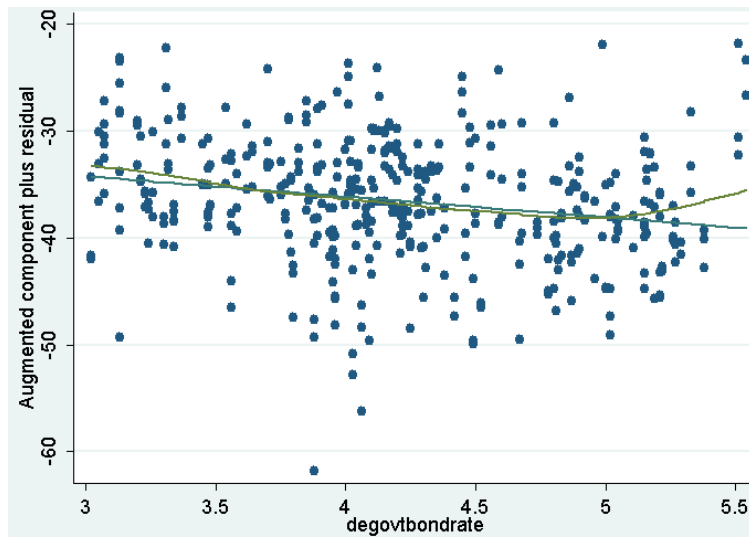


Table 5(e): Scatter Plot, Stock Returns and Exports to Germany



Appendix 7.6. Appendix 6: Linearity

Appendix 6(a): Plots for Linearity with Stock Returns, German Govt. Bond Rates



Appendix 6(b): Plots for Linearity with Stock Returns, NC/USD Exchange Rate

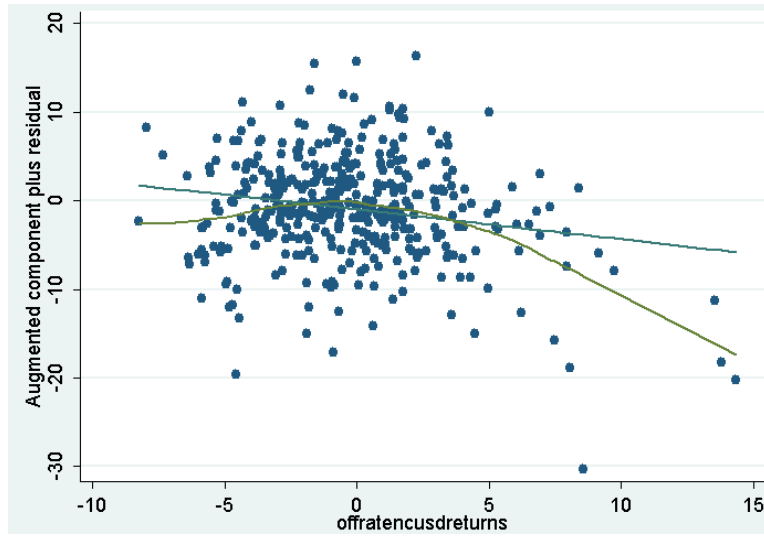
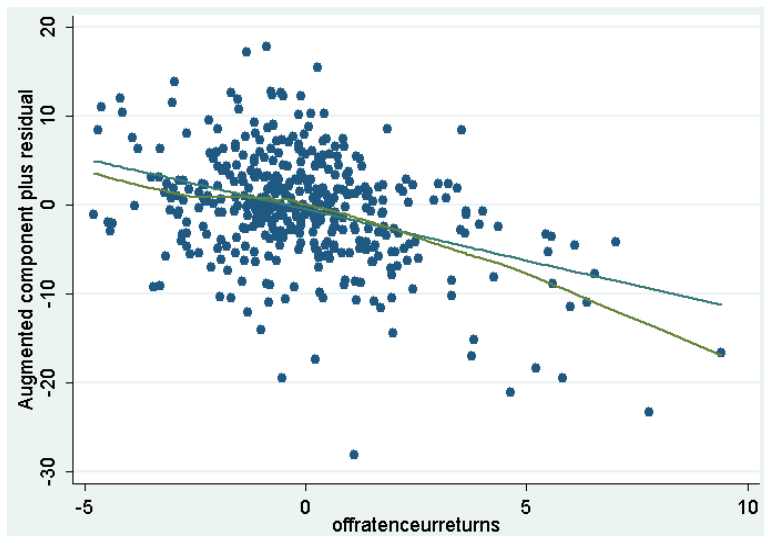
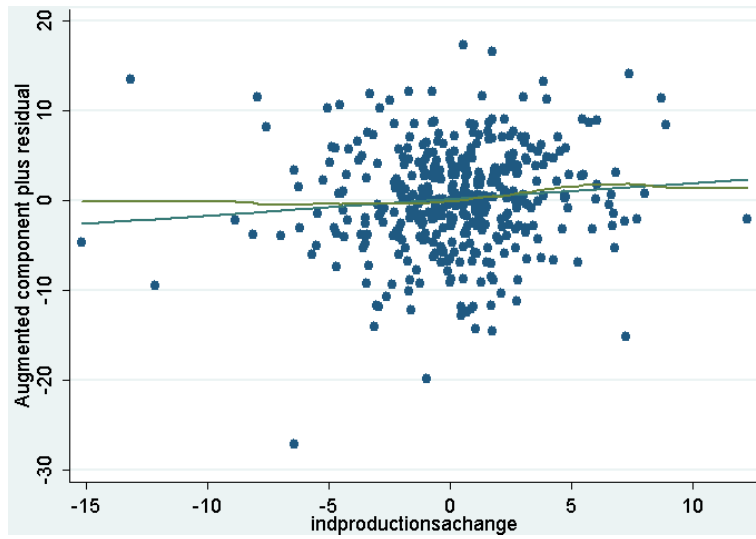


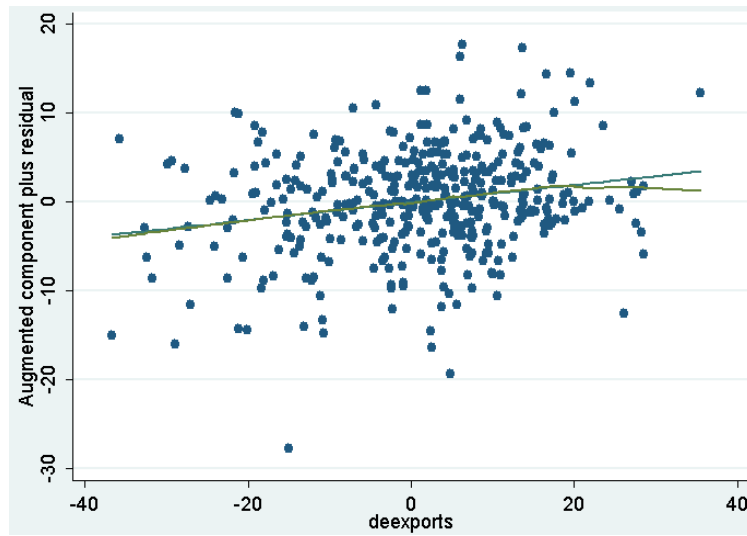
Table 6(c): Plots for Linearity with Stock Returns, NC/EUR Exchange Rate



Appendix 6(d): Plots for Linearity with Stock Returns, Ind. Production (Seas. Adj.)



Appendix 6(e): Plots for Linearity with Stock Returns, Exports to Germany



7.7. Appendix 7: Robust Regression Results

Appendix 7(a): Robust Regression Results, Lagged, Using NC/USD Exchange Rates

Regressor	(67)	(68)	(69)	(70)	(71)	(72)
German Bond Rate (Risk-free)	-2.3090*** (-5.32)	-2.4922*** (-5.47)	-4.1697*** (-6.91)	-2.7017*** (-6.09)	-2.7378*** (-6.13)	-4.5322*** (-7.59)
NC/USD Change	-0.2058** (-2.39)	-0.2021** (-2.33)	-0.2096** (-2.47)	0.0881 (1.04)	0.0962 (1.13)	0.0707 (0.85)
Industrial Production SA	0.1737 (1.91)	0.1687* (1.82)	0.1672* (1.84)	0.1367 (1.53)	0.1419 (1.56)	0.1360 (1.53)
Exports to Germany	-	-0.0107 (-0.45)	-0.0101 (-0.44)	-	0.0199 (0.86)	0.0167 (0.74)
Lags	1	1	1	2	2	2
EU Accession	-	-	-3.1264*** (-4.02)	-	-	-3.3535*** (-4.35)

Regressor	(73)	(74)	(75)
German Bond Rate (Risk-free)	-2.8228*** (-6.34)	-2.7493*** (-6.17)	-4.5105*** (-7.54)
NC/USD Change	0.1317 (1.55)	0.125 (1.48)	0.1069 (1.28)
Industrial Production SA	0.1296 (1.45)	0.151* (1.67)	0.1444 (1.63)
Exports to Germany	-	0.0279 (1.22)	0.0277 (1.23)
Lags	3	3	3
EU Accession	-	-	-3.3696*** (-4.37)

Appendix 7(b): Robust Regression Results, Lagged, Using NC/EUR Exchange Rates

Regressor	(76)	(77)	(78)	(79)	(80)	(81)
German Bond Rate (Risk-free)	-2.5229*** (-5.63)	-2.6103*** (-5.75)	-4.4723*** (-7.45)	-2.7125*** (-6.10)	-2.7384*** (-6.11)	-4.5074*** (-7.48)
NC/EUR Change	-0.5375*** (-3.83)	-0.5414*** (-3.83)	-0.6239*** (-4.51)	0.1872 (1.35)	0.1915 (1.37)	0.1014 (0.74)
Industrial Production SA	0.1734* (1.92)	0.1731* (1.89)	0.1749* (1.95)	0.1319 (1.48)	0.1366 (1.51)	0.1323 (1.49)
Exports to Germany	-	-0.0013 (-0.05)	0.0005 (0.02)	-	0.0183 (0.80)	0.0153 (0.68)
Lags	1	1	1	2	2	2
EU Accession	-	-	-3.4719*** (-4.51)	-	-	-3.3071*** (-4.27)

Regressor	(82)	(83)	(84)
German Bond Rate (Risk-free)	-2.7403*** (-6.32)	-2.6823*** (-6.17)	-4.2928*** (-7.30)
NC/EUR Change	0.6118*** (4.53)	0.5949*** (4.40)	0.5333*** (3.97)
Industrial Production SA	0.0955 (1.10)	0.1085 (1.24)	0.1108 (1.28)
Exports to Germany	-	0.0132 (0.59)	0.0152 (0.69)
Lags	3	3	3
EU Accession	-	-	-3.0772*** (-4.08)

7.8. Appendix 8: Robust Regression Results (Country Specific)

Appendix 8(a): Robust Regression Results with Lags, Czech Republic, (NC/USD)

Regressor	(85)	(86)	(87)	(88)	(89)	(90)
German Bond Rate (Risk-free)	-2.155*** (-2.79)	-2.2635*** (-2.89)	-4.394*** (-4.33)	-2.5612*** (-3.34)	-2.5603*** (-3.31)	-4.614*** (-4.53)
NC/USD Change	-0.2710* (-1.71)	-0.2759* (-1.73)	-0.2887* (-1.87)	0.0164 (0.10)	0.0172 (0.11)	-0.0161 (-0.10)
Industrial Production SA	0.1834 (1.01)	0.1747 (0.96)	0.2083 (1.18)	0.3642** (2.04)	0.3670** (2.03)	0.3515** (2.00)
Exports to Germany	-	0.0090 (0.22)	0.0131 (0.33)	-	0.0099 (0.24)	0.0048 (0.12)
Lags	1	1	1	2	2	2
EU Accession	-	-	-3.8123*** (-2.90)	-	-	-3.6754*** (-2.79)

Regressor	(91)	(92)	(93)
German Bond Rate (Risk-free)	-2.5547*** (-3.27)	-2.543*** (-3.24)	-4.5559*** (-4.37)
NC/USD Change	0.2063 (1.31)	0.1564 (0.98)	0.1187 (0.76)
Industrial Production SA	-0.1148 (-0.64)	-0.0886 (-0.49)	-0.0777 (-0.44)
Exports to Germany	-	0.0469 (1.14)	0.0489 (1.22)
Lags	3	3	3
EU Accession	-	-	-3.8097*** (-2.85)

Appendix 8(b): Robust Regression Results with Lags, Czech Republic, (NC/EUR)

Regressor	(94)	(95)	(96)	(97)	(98)	(99)
German Bond Rate (Risk-free)	-2.4124*** (-3.09)	-2.569*** (-3.25)	-4.9967*** (-4.85)	-2.5745*** (-3.32)	-2.5986*** (-3.32)	-4.5993*** (-4.40)
NC/EUR Change	-0.6043* (-1.83)	-0.6683* (-1.95)	-0.8962*** (-2.69)	0.2687 (0.83)	0.2638 (0.78)	0.0445 (0.13)
Industrial Production SA	0.1412 (0.77)	0.1279 (0.70)	0.1664 (0.95)	0.3785** (2.11)	0.3787** (2.09)	0.3556** (2.02)
Exports to Germany	-	0.0246 (0.58)	0.0366 (0.90)	-	0.0051 (0.12)	0.0042 (0.10)
Lags	1	1	1	2	2	2
EU Accession	-	-	-4.3412*** (-3.30)	-	-	-3.6348*** (-2.73)

Regressor	(100)	(101)	(102)
German Bond Rate (Risk-free)	-2.2994*** (-3.18)	-2.3006*** (-3.16)	-3.8588*** (-3.90)
NC/EUR Change	1.3317*** (4.39)	1.3343*** (4.22)	1.1383*** (3.59)
Industrial Production SA	-0.0544 (-0.33)	-0.054 (-0.32)	-0.0610 (-0.37)
Exports to Germany	-	-0.0007 (-0.02)	0.0071 (0.19)
Lags	3	3	3
EU Accession	-	-	-2.9471** (-2.34)

Appendix 8(c): Robust Regression Results with Lags, Hungary, (NC/USD)

Regressor	(103)	(104)	(105)	(106)	(107)	(108)
German Bond Rate (Risk-free)	-2.2511*** (-2.69)	-2.3210*** (-2.71)	-3.9038*** (-3.40)	-2.7436*** (-3.38)	-2.7496*** (-3.36)	-4.7531*** (-4.31)
NC/USD Change	-0.2678* (-1.72)	-0.2602 (-1.65)	-0.2573 (-1.66)	0.0956 (0.63)	0.0961 (0.63)	0.0993 (0.67)
Industrial Production SA	0.1427 (0.77)	0.1370 (0.72)	0.129 (0.69)	0.0389 (0.22)	0.0406 (0.22)	0.0347 (0.20)
Exports to Germany	-	-0.0043 (-0.11)	-0.0013 (-0.04)	-	0.0109 (0.30)	0.0060 (0.17)
Lags	1	1	1	2	2	2
EU Accession	-	-	-2.9843** (-2.02)	-	-	-3.7436*** (-2.62)

Regressor	(109)	(110)	(111)
German Bond Rate (Risk-free)	-2.8435*** (-3.57)	-2.8399*** (-3.54)	-4.9207*** (-4.48)
NC/USD Change	0.0404 (0.27)	0.0433 (0.29)	0.0589 (0.41)
Industrial Production SA	0.3939** (2.24)	0.3936** (2.22)	0.4055** (2.36)
Exports to Germany	-	0.0054 (0.15)	-0.0006 (-0.02)
Lags	3	3	3
EU Accession	-	-	-3.8293*** (-2.70)

Appendix 8(d): Robust Regression Results with Lags, Hungary, (NC/EUR)

Regressor	(112)	(113)	(114)	(115)	(116)	(117)
German Bond Rate (Risk-free)	-2.5909*** (-3.19)	-2.6261*** (-3.16)	-4.4804*** (-4.07)	-2.7176*** (-3.33)	-2.7284*** (-3.32)	-4.6967*** (-4.24)
NC/EUR Change	-0.9016*** (-3.39)	-0.9011*** (-3.33)	-0.9659*** (-3.67)	0.1741 (0.65)	0.1768 (0.65)	0.1146 (0.44)
Industrial Production SA	0.1512 (0.84)	0.1515 (0.83)	0.1432 (0.80)	0.0297 (0.17)	0.0227 (0.13)	0.0271 (0.15)
Exports to Germany	-	0.0064 (0.17)	0.0096 (0.27)	-	0.0099 (0.27)	0.0053 (0.15)
Lags	1	1	1	2	2	2
EU Accession	-	-	-3.4972** (-2.48)	-	-	-3.6989** (-2.59)

Regressor	(118)	(119)	(120)
German Bond Rate (Risk-free)	-2.7988*** (-3.51)	-2.7963*** (-3.48)	-4.8246*** (-4.38)
NC/EUR Change	0.3333 (0.206)	0.3368 (1.27)	0.3247 (1.26)
Industrial Production SA	0.3751** (2.14)	0.3764** (2.13)	0.3892** (2.27)
Exports to Germany	-	0.0026 (0.07)	-0.0044 (-0.13)
Lags	3	3	3
EU Accession	-	-	-3.7519*** (-2.66)

Appendix 8(e): Robust Regression Results with Lags, Poland, (NC/USD)

Regressor	(121)	(122)	(123)	(124)	(125)	(126)
German Bond Rate (Risk-free)	-2.8543*** (-3.69)	-2.8851*** (-3.65)	-4.2744*** (-4.04)	-2.98*** (-3.98)	-3.0637*** (-4.00)	-4.4488*** (-4.27)
NC/USD Change	-0.0926 (-0.65)	-0.0959 (-0.66)	-0.0997 (-0.68)	0.1701 (1.23)	0.2053 (1.45)	0.1634 (1.15)
Industrial Production SA	0.1854 (1.40)	0.1753 (1.27)	0.1549 (1.12)	0.0394 (0.31)	0.0576 (0.43)	0.0628 (0.47)
Exports to Germany	-	-0.0423 (-0.91)	-0.0473 (-1.01)	-	0.0449 (0.99)	0.0457 (1.00)
Lags	1	1	1	2	2	2
EU Accession	-	-	-2.6238* (-1.92)	-	-	-2.5694* (-1.91)

Regressor	(127)	(128)	(129)
German Bond Rate (Risk-free)	-3.1106*** (-4.10)	-2.9307*** (-3.88)	-4.0842*** (-4.00)
NC/USD Change	0.1403 (1.00)	0.1334 (0.96)	0.0989 (0.70)
Industrial Production SA	0.1214 (0.93)	0.1623 (1.22)	0.1594 (1.18)
Exports to Germany	-	0.028 (0.62)	0.0296 (0.65)
Lags	3	3	3
EU Accession	-	-	-2.2938* (-1.74)

Appendix 8(f): Robust Regression Results with Lags, Poland, (NC/EUR)

Regressor	(130)	(131)	(132)	(133)	(134)	(135)
German Bond Rate (Risk-free)	-2.8168*** (-3.66)	-2.7903*** (-3.54)	-4.3159*** (-4.08)	-2.9837*** (-3.98)	-3.0595*** (-3.99)	-4.4351*** (-4.22)
NC/EUR Change	-0.3386* (-1.73)	-0.3724* (-1.87)	-0.3960** (-1.99)	0.2318 (1.22)	0.2555 (1.32)	0.1785 (0.91)
Industrial Production SA	0.2064 (1.56)	0.1997 (1.45)	0.1826 (1.33)	0.0298 (0.23)	0.0444 (0.33)	0.0552 (0.41)
Exports to Germany	-	-0.0357 (-0.77)	-0.0405 (-0.88)	-	0.0370 (0.82)	0.0411 (0.91)
Lags	1	1	1	2	2	2
EU Accession	-	-	-2.7975** (-2.05)	-	-	-2.6318* (-1.95)

Regressor	(136)	(137)	(138)
German Bond Rate (Risk-free)	-3.1261*** (-4.27)	-2.9812*** (-4.07)	-3.9566*** (-3.99)
NC/EUR Change	0.4731** (2.54)	0.455** (2.46)	0.4240** (2.25)
Industrial Production SA	0.0680 (0.54)	0.0905 (0.70)	0.0911 (0.70)
Exports to Germany	-	0.0094 (0.22)	0.0129 (0.30)
Lags	3	3	3
EU Accession	-	-	-1.9262 (-1.51)