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An Empirical Examination of the Arbitrage Pricing Theory: Evidence from Jordan

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Abstract

Investors in the stock market need a valid and accurate model to predict the expected rate of return on their portfolios which necessitate testing many pricing models and determining which model is the most accurate. The problem is that both single-factor and multi-factor capital asset pricing models (CAPM) are not valid for predicting the expected rate of return. The purpose of this quantitative study was to test the validity of the arbitrage pricing theory (APT) in the Jordanian stock market as an alternative to the CAPM. The study was theoretically based on the arbitrage pricing theory introduced by Stephen Ross. The main focus of the research questions was on examining the relationship between stocks' rate of return calculated using the price index of Amman stock exchange (ASE) and a set of macroeconomic variables. The website of ASE, central bank of Jordan, and department of statistics were used to collect data about ASE price index and the independent macroeconomic variables of unemployment rate, gross domestic product (GDP), industrial producers' price index (IPPI), and exports for the period from 2000 to 2016. Collected data were analyzed using multiple-linear regression. Due to the detected multicollinearity between GDP and exports, GDP was excluded from the proposed model. The results revealed that among three variables tested, only IPPI had a significant negative effect on the stocks' rate of return.

Keywords: Amman stock exchange, arbitrage pricing theory, exports, gross domestic product, macroeconomic variables, unemployment rate, producers' price index

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1. Introduction

Developing an accurate and valid asset pricing model can help investors in the financial markets to increase their profits and benefit the economy in which they invest. The problem is that the single-factor and the multi-factor capital asset pricing model (CAPM) are not able to predict the expected rate of return accurately to help investors determine which stocks to include in their portfolios to avoid buying overvalued stocks and selling undervalued ones (Alqisie & Alqurran, 2016; Elshqirat & Sharifzadeh, 2018; Wu, Imran, Feng, Zhang, & Abbas, 2017). An alternative for the CAPM is the arbitrage pricing theory (APT) which was developed by Stephen Ross (1976). The APT model contains a set of macroeconomic variables assumed to replace the systematic risk in the CAPM without specifying which factors to use (Sekreter, 2017). The main purpose of this study was to test the validity of the APT in the Jordanian stock market using different macroeconomic variables than those used before. The relationship between macroeconomic variables and stock prices was tested by many researchers in many countries including Jordan (Al-Abdallah & Aljarayesh, 2017; AL-Naif, 2017; Alshomaly & Masa'deh, 2018; Bekhet & matar, 2013; Bouri, 2015; Dayyat & Freihat, 2017), United States (El Khoury, 2015), Arabic countries (AL-Naif, 2017; Hammami, Ghenimi, & Bouri, 2015), Pakistan (Ahmed, Vveinhardt, Streimikiene, & Fayyaz, 2017; Gul & Khan, 2013; Khan, Gul, & Ali, 2017), India (Mukherji, 2015; Sultana & Reddy, 2017), Nigeria (Ayopo, Isola, & Olukayode, 2016; Okoro, 2017; Torbira & Agbam, 2017;), south Asian countries (Ullah, Islam, Alam, & Khan, 2017), and African countries (Worlu, & Oomodero, 2017).

The relationship between macroeconomic variables and stock returns in the Jordanian market were studied by many researchers. Different macroeconomic indicators were used in these studies including inflation rate (Al-Abdallah & Aljarayesh, 2017), money supply and industrial production (Bekhet & matar, 2013; Dayyat & Freihat, 2017), interest rate (Al-Abdallah & Aljarayesh, 2017; AL-Naif, 2017; Dayyat & Freihat, 2017), exchange rate (Al-Abdallah & Aljarayesh, 2017; Bekhet & matar, 2013), foreign exchange reserve and consumer price index (Dayyat & Freihat, 2017), global oil prices (Bouri, 2015), and the growth of gross domestic product(Alshomaly & Masa'deh, 2018). In this study, I followed the same approach in the literature by testing different macroeconomic variables and examine its relationship with stocks' returns. The selected macroeconomic variables in this study were the gross domestic product (GDP), exports, unemployment rate, and industrial producers' price index (IPPI). These variables were tested in many countries but not in the Jordanian stock market at least during the last five years.

To test the relationship between the selected macroeconomic variables and the returns on stocks, five hypotheses were developed. In the first four hypotheses, I tried to verify if there is a significant relationship between stocks' returns and each of GDP, exports, unemployment rate, and IPPI individually. The objective behind the last hypothesis was to evaluate the proposed APT model containing the four independent variables together. To test these hypotheses, a quantitative design was employed because it represents the best fit for the objective of the study over the qualitative and mix designs. Both qualitative and mix designs can be used for exploring or understanding a given phenomenon as

discussed by Yilmaz (2013) but not for testing research hypothesis.

2. Literature Review

2.1 Arbitrage Pricing Theory (APT)

The APT was first introduced by Stephen Ross (1976) in the article "The Arbitrage Theory of Capital Asset Pricing". The APT represents an alternative theory for the CAPM; it replaces the one factor that affects the expected rate of return with many macroeconomics factors each with its own risk factor (beta) (Geambasu, Jianu, Hertelio, & Geambasu, 2014; Yao, Mei, & Clutter, 2014). These factors may include inflation, gross domestic product, and the major commodities prices (Geambasu et al., 2014). According to the APT, the relationship between the expected rate of return for a given stock, the risk-free return, and the return of other factors with its risk is a perfect linear relationship (Yao et al., 2014). In the APT, the expected rate of return is calculated as follows (Ross, 1976):

$$E_i = \rho + \gamma_1\beta_{i1} + \ldots + \gamma_k\beta_{ik}, \quad (1)$$

Where E_i is the expected return on the i^{th} asset, ρ is the risk-free return, β_{ik} is sensitivity of i^{th} asset to the factor k, and γ_k is the risk premium of factor k.

Both CAPM and APT try to explain the variation in the asset's expected return by considering different number of factors; the CAPM considers only the market expected return and its beta while the APT considers more variables with more betas (Geambasu et al., 2014). APT model is acceptable and followed by many academics and practitioners because it can be easily understood and provides more details with less cost despite the more calculation power and the larger volume of data needed for the model compared to

the CAPM (Geambasu et al., 2014).

2.2 APT Assumptions

Regarding model assumptions, both CAPM and APT have many similar assumptions and many different ones. The common assumptions for both models are:

1. The behavior of any single investor does not affect the market prices because the market is perfectly competitive (Alshomaly & Masa'deh, 2018) with no additional transactions cost or taxes (Akpo, Hassan, & Esuike, 2015)
2. All investors can borrow and lend money at the same rate free from risk (the risk-free rate) (Akpo, Hassan, & Esuike, 2015)
3. The investor will select the combination of assets with the minimum risk at a given expected return or the combination that generate the highest expected return at a given risk (Akpo et al., 2015)

On the other hand, there are specific assumptions for the APT model. These assumptions include:

1. All investors assume the same economic variables to affect the financial assets prices (Akpo et al., 2015)
2. Riskless profit from arbitrage opportunities do not exist (Akpo et al., 2015) (this is where the name of APT came from)
3. There is a linear relationship between the expected rate of return on a stock and an N macroeconomic factors, not only one factor as in the CAPM, (Alshomaly & Masa'deh, 2018)

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2.3 Macroeconomic Variables

Since its first introduction, the APT was tested by many researchers in many countries using many different macroeconomic variables. Some of these variables had no significant effect on the expected rate of return while others had a significant effect. Variables that had a significant effect on the rate of return include foreign exchange rate (El Khoury, 2015; Gul & Khan, 2013; Hasan, 2017; Ullah et al., 2017), interest rate (Fazli, Shlan, Radsar, & Radsar, 2014 ; Kisman & Shintabelle Restiyanita, 2015; Sultana & Reddy, 2017; Ullah et al., 2017), money supply (Mazuruse, 2014; Ouma & Muriu, 2014; Zaighum, 2014), inflation rate (Laichena & Obwogi, 2015; Sevil & Polat, 2015; Worlu & Oomodero, 2017), GDP (Kisman & Shintabelle Restiyanita, 2015; Laichena & Obwogi, 2015; Nijam, Ismail, & Musthafa, 2018), unemployment rate and exports (El Khoury, 2015). In Jordan, however, macroeconomic variables tested by researchers include inflation rate (Al-Abdallah & Aljarayesh, 2017), money supply & industrial production (Bekhet & matar, 2013; Dayyat & Freihat, 2017), interest rate (Al-Abdallah & Aljarayesh, 2017; AL-Naif, 2017; Dayyat & Freihat, 2017), exchange rate (Al-Abdallah & Aljarayesh, 2017; Bekhet & matar, 2013), foreign exchange reserve and consumer price index (Dayyat & Freihat, 2017), global oil prices (Bouri, 2015), and the growth of gross domestic product (Alshomaly & Masa'deh, 2018). The macroeconomic variables tested in this study were the GDP, unemployment rate, exports, and industrial producers' price index (IPPI); this set of variables was not tested before in the Jordanian stock market.

When GDP increases, it's assumed that profits of companies in some industries will

increase and thus, its stock prices increase and the same happened when the economy suffers from recession (Laichena & Obwogi, 2015). This effect results from the impact of the economic growth on the profits of the companies which in turn cause dividends to increase and finally increase stocks' prices (Yeap & Gan 2017). The same positive relationship may exist between stock market and exports because like the increase in GDP, increase in exports may represent a good indicator for the economic growth and thus, affect stock prices positively. Another indicator for the economic status is the unemployment rate. When the economy is booming, many jobs may become available causing the unemployment rate to decrease and stock prices may increase in the same manner when the GDP increases. This negative relationship between stock market and unemployment rate was found by a number of researchers including El Khoury (2015) and Farmer (2015). Industrial producers' price index (IPPI) measures the average prices received by the producers for their locally produced goods and services. Increase in this index may reflect a good demand for goods manufactured locally and thus, indicates a good economic status which in turn may result in increasing companies' profits and stocks prices. Based on this argument, the effect of IPPI on stock prices can be assumed to be positive.

2.4 Hypotheses

To test the proposed APT model, I developed five hypotheses: the first four hypotheses were to test the relationship between each macroeconomic variable individually and the stock price index while the last hypothesis was developed to test the validity of the

proposed model in explaining the variation of stock returns. The research hypotheses were as follows:

H1: GDP is predictor of rate of return on stocks.

H2: Exports is predictor of rate of return on stocks.

H3: unemployment rate is predictor of rate of return on stocks.

H4: IPPI is predictor of rate of return on stocks.

H5: The stock's expected rate of return is linearly dependent on the factors of: GDP, exports, unemployment rate, and IPPI.

3. Method

3.1 Research Data

Study population included stocks of all listed companies in Amman stock exchange (ASE). These stocks were considered to be represented by the ASE price index. ASE free float index was used to measure the rate of return on stocks because it contains a sample of 100 listed companies out of 228 selected from different industries and with different market capitalization; the index sample companies are updated periodically depending on how active is the stock in the market. Data analyzed in this study included quarterly closing prices of the ASE free float index, rate of return on treasury bonds, GDP, exports, unemployment rate, and IPPI for the period from 2000-2016. These data were obtained from the ASE website, Jordanian department of statistics, and the central bank of Jordan. Collected data were analyzed using multiple-linear regression

3.2 Research Design

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This study is a quantitative study designed to test the possible causes of the variation in the dependent variable. The dependent variable in the study is the expected rate of return on the stocks of the listed companies on the Jordanian stock market represented by the market index returns. The independent variables included GDP, exports, unemployment rate, and IPPI

3.3 Variables Definitions

Change in exports: is the change in the exports of the current quarter from that of the previous one. This variable was measured using the following equation:

$$\Delta EXPR = (EXPR_t - EXPR_{t-1}) * 100 / EXPR_{t-1} \quad (2)$$

Where $EXPR_t$ is the exports at quarter *t* and $EXPR_{t-1}$ is the exports at quarter *t-1*.

Change in gross domestic product (GDP): is the change in the GDP of the current quarter from that of the previous one. This variable was measured using the following equation:

$$\Delta GDP = (GDP_t - GDP_{t-1}) * 100 / GDP_{t-1} \quad (3)$$

Where GDP_t is the GDP at quarter *t* and GDP_{t-1} is the GDP at quarter *t-1*.

Industrial producers' price index (IPPI): is the quarterly IPPI published by the central bank of Jordan.

Market index excess rate of return: is the rate of return achieved in the market during the holding period of one quarter after excluding the risk-free rate for the same quarter. This return was calculated at quarter *t* using the following equation (Alqisie & Alqurran, 2016):

$$R_{mt} = (I_t - I_{t-1}) * 100 / I_{t-1} \quad (4)$$

And then the excess return is:

$$ER_{mt} = R_{mt} - R_{ft} \quad (5)$$

Where I_t is the ASE index closing price at quarter *t*, I_{t-1} is the index closing price at quarter *t-1*, and R_{ft} is the risk-free rate for quarter *t*.

Unemployment rate: is the quarterly unemployment rate among Jordanians published by the Jordanian department of statistics.

4. Results

4.1 Descriptive Statistics

The independent variables of GDP, exports, and IPPI all had an increasing trend during the period of the study from 2000-2016 while the unemployment rate was almost fixed. This trend can be noticed in Figure 1 which also indicates some seasonality in all variables except for the IPPI and unemployment rate. In addition, exports and IPPI increased abnormally during the period from March to September, 2008 followed by a sever decrease that continued until March, 2009. Unemployment rate decreased significantly during the period from March to December, 2008 and then increased until September, 2009. These trends may have been caused by the financial crisis that affected most countries during that period. Some descriptive information about the independent variables are illustrated in Table 1.

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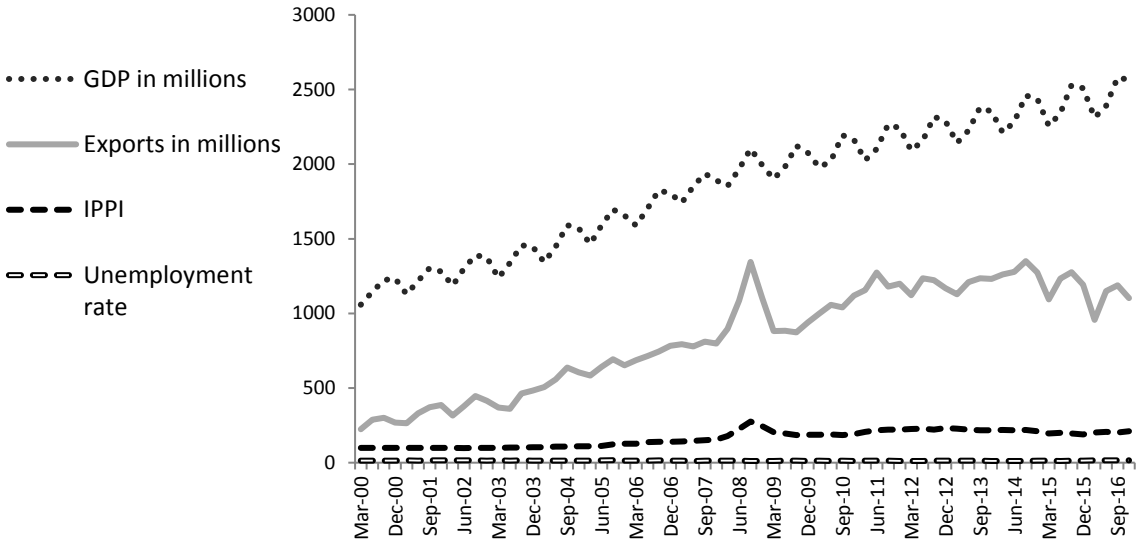

Figure 1. Trend of the selected macroeconomic variables for Jordan during the period from March, 2000 to December, 2016

Table 1. Descriptive statistics for variables of: GDP, exports, unemployment rate, and IPPI

Variable	Mean	Median	Min	Max	Standard
GDP (millions)	1	1 950.935	1 058.100	2581.000	434.683
Exports	847.057	882.962	224.010	1350.127	349.101
Unemployment	13.456	13.350	10.800	16.600	1.351
IPPI	164.659	185.367	97.633	275.433	52.353

4.2 Regression Results

To test the study hypotheses, I used the following regression model:

$$ER_{mt} = a_i + \beta_j^{\Delta GDP}(\Delta GDP) + \beta_j^{\Delta EXPR}(\Delta EXPR) + \beta_j^{UNEMP}(UNEMP) + \beta_j^{IPPI}(IPPI) + e_{jt} \quad (6)$$

After testing for the assumptions of linear regression, I found that there was

multicollinearity between GDP and exports and based on this, GDP was excluded from the model. The new model was as follows:

$$ER_{mt} = a_i + \beta_j^{\Delta EXPR}(\Delta EXPR_t) + \beta_j^{UNEMP}(UNEMP_t) + \beta_j^{IPPI}(IPPI_t) + e_{jt} \quad (7)$$

Where,

ER_{mt}: is the excess return of the market during the quarter t

a_i: is the constant term

$\Delta EXPR$: is the change in the exports of the current quarter relative to that of the previous one

$\beta_j^{\Delta EXPR}$: sensitivity of ER_{mt} to the variable of change in exports

$UNEMP$: is the unemployment rate for the quarter t

β_j^{UNEMP}: sensitivity of ER_{mt} to the variable of unemployment rate

$IPPI$; is the industrial producers' price index for the quarter t

β_j^{IPPI} : sensitivity of ER_{mt} to the variable of IPPI

e_{jt}: is the error term

The null and alternate hypotheses for the regression model can be expressed as:

H_0: a_i , $\beta_j^{\Delta EX\,R}$, β_j^{UNEMP}, $\beta_j^{IPPI} = 0$

H_1: a_i , $\beta_j^{\Delta EX\,R}$, β_j^{UNEMP}, $\beta_j^{IPPI} \neq 0$

If the APT model is true, a_i should not be different from zero and the β_j's should be different from zero. Based on the regression results summarized in Table 2 and using a significance level of 5%, the null hypothesis that $a_i = 0$ cannot be rejected which means that the value of a_i was not significantly different from zero, $t(68) = 0.417$, $p = .678$. In addition, the null

hypothesis that $\beta_j^{\Delta EXR} = 0$ cannot be rejected, $t(68) = 0.848$, $p = .400$ which means that the positive relationship between exports and stocks' return was not significant. The null hypothesis that $\beta_j^{UNEMP} = 0$ cannot be rejected $t(68) = 0.125$, $p = .901$ and thus, the relationship between the unemployment rate and stocks' return was not significant. The only significant relationship was the negative one between the stocks' return and the IPPI, $t(68) = -2.052$, $p = .044$. Based on these results, I cannot accept the last alternate hypothesis regarding the ability of the proposed APT model to explain the variation in the stocks' returns because only one variable was significant (IPPI) and because the adjusted R squared was only 6.4%.

Table 2. Results of regression analysis

Details	value	*P* value
Constant term (a_i)	7.265	.678
Beta for Change in exports (ΔEXPR)	0.092	.400
Beta for Unemployment rate	0.134	.901
Beta for IPPI	-0.057	.044
R squared	.106	
Adjusted R squared	.064	

5. Discussion

It can be seen from the study results that all the proposed macroeconomic variables were insignificant except for the industrial producers' price index which had a significant negative relationship with stocks' returns which is opposite to the hypothesized positive

relationship. Exports and unemployment rate both had the hypothesized positive relationship with stocks' returns but the relationship was insignificant. These results were concluded by some researchers including Khan, Nawaz Mir, and Jaber (2017) and Mazuruse (2014) who found that stocks' returns are not significantly related to the unemployment rate. In addition, the same insignificant relationship between exports and stocks' returns were concluded by Geambasu, Jianu, Herteliu, and Geambasu, (2014) and Romero (2017). The results indicated that the APT model with the selected variables does not explain the variation in the stocks' returns in the Jordanian market.

The study conclusions can be generalized because ASE price index that was utilized as a representative for all stocks prices is calculated using a sample of 100 listed companies updated periodically and thus, it may reflect the changes in the prices of all stocks. While the number of macroeconomic variables that affect stock returns may be unlimited, this study was limited to only four variables. In addition, what may limit studies about the effect of macroeconomic variables on stocks returns in Jordan is that information about these variables may not be available for public, may not be published online, or it may be incomplete. In future studies, more macroeconomic variables may be tested to enhance the explanatory power of the APT model. Furthermore, meta-analysis research may be conducted to survey the macroeconomic variables that had a significant effect and then test a model including all these variables for a long period of time.

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