An Analysis of the Conditional Relationship between Risk and Return in the Tehran Stock Exchange[1]

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Abstract

This paper examines the factors that affect stock returns in the Tehran Stock Exchange, the largest stock exchange in Iran. In particular, we analyze the conditional relationship between risk and return in Iran by estimating the relationship between various sources of risk -- market risk, oil price risk, exchange rate risk, gold price risk, inflation risk, skewness, and kurtosis -- and the stock return in the Tehran Stock Exchange over the period March 2005 to March 2019. The methodology used in this paper is a multi-factor model that allows the impact of the risk factors to have asymmetric effects depending on whether returns for the respective risk factor are increasing or decreasing. We analyze the risk-return relationship for four groups of industries: the top ten industries by market cap, the five largest energy consuming industries, the four major export industries, and the four major import industries. We find significant conditional relationships between risk and return for all the risk factors considered.

Keywords: risk, return, multifactor conditional model, Iran
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1. Introduction

The risk-return trade-off in the capital market and the behavior of stocks in response to risk factors have long interested economists. In the classical economic theory of portfolio selection, investors seek to maximize the expected return of their investment portfolio for a given amount of portfolio risk, or to minimize risk for a given level of expected return, which means that an investor who wants higher expected returns must accept more risk (Markowitz, 1952). In order to make good investment decisions, stock market investors should therefore identify various risk factors and evaluate the influence of these risk factors on the stock returns in the stock market. Identifying and investigating risk factors in the stock market can also be important for policy-makers who wish to improve stock market performance.

Investors in stock markets may consider many risk factors when making their investment decisions. Risk factors that affect stock returns include unsystematic risk (or diversifiable risk) and systematic risk. Unsystematic risk is specific to a portfolio and is controllable and reducible by diversification (Sharpe, 1970), while systematic risk is due to external factors and is not reducible by diversification (Ross, 1976; Turvey, Driver and Baker, 1988). Among the various systematic risk factors affecting stock returns, market risk is one of the most important. Stock returns may also be sensitive to other systematic risk factors including fluctuations in macroeconomic variables such as oil prices (Chen, Roll and Ross, 1986) and exchange rates (Ng, 2004). Thus, in addition to market risk, the economic risks faced by a country can also be considered risk factors that affect stock returns. All these risk factors affect corporate profit and can therefore influence stock returns in many ways. Moreover, if the distribution of a stock return is not normal, two additional risk factors, skewness and kurtosis of returns, can affect stock returns as well (Kraus and Litzenberger, 1976).

There are a variety of models that quantify the trade-off between risks and return, including the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Model (APT). Introduced by Treynor (1961, 1962), Sharpe (1964), and Lintner (1965), and later extended by Fama and MacBeth (1973), the Capital Asset Pricing Model (CAPM) considers only one risk factor: market risk. The CAPM has been criticized for its unrealistic assumptions (Tunali, 2010), which has led to further theoretical work on the CAPM to refine the model by adding other variables. Ross (1976) extended the CAPM by creating a multi-factor asset pricing model, the Arbitrage Pricing Theory (APT) model, as an alternative to the CAPM. This model has more flexible assumptions compared to the CAPM and models a linear relationship between an asset's expected return, market risk, and other external risk factors such as macroeconomic factors that can affect asset returns.

Pettengill, Sundaram and Mathur (1995) make a further extension to models of risk and return. They find that a positive relationship is always predicted between beta and expected returns, but this relationship is conditional on the market excess returns when realized returns are used for tests. They therefore introduce a multi-factor conditional relationship between betas and realized return which separates positive market returns from negative market returns as an alternative approach to unconditional models.

In this paper, we examine the factors that affect stock returns in the Tehran Stock Exchange (TSE), the largest stock exchange in Iran. In particular, we analyze the conditional relationship between risk and return in Iran by estimating the relationship between various sources of risk -- market risk, oil price risk, exchange rate risk, gold price risk, inflation risk, skewness, and kurtosis -- and the stock return in the Tehran Stock Exchange over the period March 2005 to March 2019.

The methodology used in this paper is a multi-factor model that allows the impact of the risk factors to have asymmetric effects depending on whether returns for the respective risk factor are increasing or decreasing. Our estimation approach involves two steps. In the first step, we run a separate regression for each industry in each year using daily data for that industry in that year to estimate the beta coefficients on each risk factor for that industry in that year. In the second step, we use the beta risk parameters estimated in the first step to estimate random effects models of the relationship between risk factors and stock returns in the Tehran Stock Exchange.

We analyze the risk-return relationship for four groups of industries: the top ten industries by market cap, the five largest energy consuming industries, the four major export industries, and the four major import industries. According to our results, there are significant conditional relationships between risk and return for all the risk factors considered.

The remainder of this paper proceeds as follows. We review the related literature in Section 2. Section 3 describes our data and methodology. Section 4 presents the results. Section 5 concludes.

2. Literature Review

The Capital Asset Pricing Model (CAPM) is a model used to verify the effect of non-diversifiable risk (also known as systematic risk or market risk) on stock market returns. The CAPM builds upon Markowitz (1952), and was introduced by Treynor (1961, 1962) and Sharpe (1964); developed further by Lintner (1965), Mossin (1966), Black (1972); and extended by Fama and MacBeth (1973). This model is a three-step portfolio approach which as a single-factor model considers only one risk factor: market risk. Market risk is a systematic risk factor in the stock market which is not specific to a portfolio and it cannot be eliminated by diversification.

Mehrara, Falahati and Zahiri (2014) investigate the relationship between systematic risk and stock returns in the Tehran Stock Exchange (TSE) by applying the CAPM to panel data for the 50 top companies of the Tehran Stock Exchange over a five-year period from 2008 to 2013. Their results show that the relationship between systematic risk and stock returns are statistically significant.

Jahan-Parvar and Mohammadi (2013) analyze market index returns in the TSE using three variants of the CAPM: the static international; the constant-parameter intertemporal; and a Markov-switching intertemporal CAPM, which allows for time-varying degree of integration with regional and international equity markets. They find that TSE returns are CAPM-efficient at monthly frequency with respect to several international market indices. Moreover, they find evidence in support of international integration of the TSE with respect to international markets.

Abbasi, Kaviani and Farbod (2017) test and evaluate the possibility of using the traditional CAPM and the Modified Capital Asset Pricing Model (MCAPM) in the TSE using monthly returns during the period 2009 to 2015. Results show that the traditional CAPM has no greater explanatory power than the MCAPM to explain stock returns of companies.

Pamane and Vikpossi (2014) test the validity of the CAPM for the BRVM space stock market using monthly stock returns from 17 companies listed on the stock exchange for the period of January 2000 to December 2008. Results offer evidence against the CAPM for all the sub-periods and even for the whole period.

Alqisie and Alqurran (2016) examine the test of validity of the CAPM in the Amman Stock Exchange (ASE) during the period 2010 to 2014, using monthly returns of 60 stocks of Jordanian companies listed in the ASE. They use the methods of Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) methods to test the CAPM in different study sub-periods. The results show that higher risk (beta) is not associated with higher levels of return, which violates the CAPM assumption.

Shinde and Mane (2019) assess the CAPM in the Indian stock market using data on the National Stock Exchange (NSE) for a period of 260 weeks from 2013 to 2018, and find that the CAPM is not applicable to the Indian stock market. Pravin and Dhananjay (2019) analyze the CAPM in the Indian stock market for the period 2011 to 2015, and find that CAPM propositions do not hold true in Indian stock market, specifically for S&P BSE Sensex Indexed stock for the specified period.

Because it was criticized for its unrealistic assumptions (Tunali, 2010), the CAPM model was further developed to include other variables. To verify that market risk is not the only component that could measure the systematic risk of stock returns, Ross (1976) extended the CAPM by creating a multi-factor asset pricing model, Arbitrage Pricing Theory (APT), as an alternative to CAPM. The APT models a linear relationship between an asset’s expected return, market risk, and other external risk factors such as macroeconomic factors that can have an effect on asset returns.

Many empirical papers have used the APT approach to analyze the unconditional relationship between risk factors and stock return. Chen, Roll and Ross (1986) use the APT model to explore a set of economic state variables such as inflation, market return and oil prices as systematic risk factors. They examine the relationship between these risk factors and the US stock return and find a strong relationship between them.

Goriaev (2004) investigates the effect of two set of risk factors, fundamental and macroeconomic (oil, currency, etc.), on the 47 most liquid stocks traded on the major Russian stock exchanges during the post-crisis period from 1999 to 2003 by using a multi-factor model.

His results show that the oil risk factor does offer a significant premium and that the dollar appears to be much more important a risk factor than the Euro.

Ng (2004) develops a dynamic international multi-factor model when expected returns are time-varying. In addition to the market risk factor, his model involves other risk factors that include covariances with exchange-rate changes of different countries, intertemporal hedging of future stock returns, and future real exchange-rate changes. The model is estimated using the data on the equity and foreign exchange returns for the United States, Japan, Germany, and the United Kingdom. Results show that while real exchange risk and intertemporal hedging of future stock return play some role, stock market risk remains the most important factor affecting the excess returns.

Tunali (2010) analyzes the relationship between macroeconomic variables (exchange rate, gold price, international crude oil prices, etc.) and stock returns in the main Turkish stock market. He investigates this relationship within the APT framework for the period from January 2002 to August 2008. The results show that there is a long-run relationship between basic macroeconomic indicators of Turkish economy and stock returns.

Izedonmi and Abdullahi (2011) use monthly data to test the performance of the APT on the Nigerian Stock Exchange (NSE) for the period 2000 to 2004. They investigate the effect of inflation, exchange rate and market capitalization on 20 sectors of the Nigerian Stock Exchange by using an ordinary least squares model. They find that there are no significant effects of those variables on the stocks' return in Nigeria. Uwubanmwen and Eghosa (2015) examine the impact of inflation rate on stock returns in the Nigerian stock market. The results show that the inflation rate has a negative but weak impact on stock return; hence, inflation is not a strong predictor of stock returns in Nigeria.

Sabetfar et al. (2011) provide weak evidence in support for the application of APT on the Iranian stock market in the Sharia is the sacred law of Islam faith based close economy. The results suggest that there are four groups of macroeconomic variables in the test period that affect stock returns for the test period, 1991 to 2008, but the significance of these factors is not consistent over time. In general the findings document a weak applicability of APT in this market.

Hussain and Khan (2014) investigate the exchange rate exposure of pharmaceutical industry of Pakistan in long run and short term using quarterly time series data for 37 quarters from 2003 to 2012. Results show that there is long run relationship between stock returns, exchange rate, and market return index.

Alshomaly and Masa'deh (2018) test the validity of CAPM and APT in the Jordanian stock market using three different firms of three main sectors -- financial, industrial, and service sector -- for the period 2000 to 2016, and find that the banking sector in Jordan faces more systematic risks than other sectors. Elshqirat (2019) tests the validity of the APT in the Jordanian stock market for the period from 2000 to 2016, and finds that among three variables tested (GDP, industrial producers' price index, and exports), only industrial producers' price index had a significant negative effect on the stocks' rate of return.

Kim and Sohel Azad (2022) investigate the relationship between macroeconomic risk and low-frequency volatility of conventional and Islamic stock markets from around the world. Using a panel of 36 countries, representing developed, emerging and Islamic countries for the period from 2000 to 2016, they find that low-frequency market volatility is lower for Islamic countries and, markets with more number of listed companies, higher market capitalization relative to GDP and larger variability in industrial production. The study also finds that low-frequency component of volatility is greater when the macroeconomic factors of GDP, unemployment, short-term interest rates, inflation, money supply and foreign exchange rates are more volatile. The empirical results are robust to various alternative specifications and split sample analyses. The findings imply that religiosity has an influence on the correction of market volatility and investors may consider the Islamic stocks to diversify their risks.

Both the CAPM (as a single-factor asset pricing model) and the APT (as a multi-factor asset pricing model) are useful and many empirical papers have used them to estimate the unconditional relationship between risk factors and stock return, but there are some limitations (Pettengill, Sundaram and Mathur, 1995; Campbell, Lo and MacKinlay, 1997; Basher and Sadorsky, 2006). While theory predicts a trade-off between risk and ex ante expected returns, most empirical papers use the ex post realized returns instead of ex ante expected returns.

Pettengill, Sundaram and Mathur (1995) find that when the realized return is used instead of the expected return to estimate the CAPM, the relationship between the risk parameters beta and the return must be conditional on the relationship between the realized market returns and the risk-free rate. They therefore introduce a conditional relationship between beta and the realized return as an alternative approach to that used by Fama and MacBeth (1973). They determine whether the direction of the market is "up" or "down" based on the relationship between the realized market returns and the risk-free rate, and separate the "up" market from the "down" market to create a conditional relationship between risk factors and the realized return.

Whether the market is up or down depends on whether the excess market return, which they define as the difference between the market return and risk-free rate, is positive or negative. If the excess market return is positive, the stock market is "up"; if excess market returns is negative, the stock market is "down". When the excess market return (or premium) is positive, the relationship between beta and the return will be positive. On the other hand, if excess market return is negative, the investor will hold the risk-free asset, which has a low beta, and the relationship between beta and return will be negative. Thus, while the relationship between expected returns and risk is always positive, the relationship between realized returns and risk can be either positive or negative depending on the market excess returns.

Pettengill, Sundaram and Mathur (1995) use this method to specify the conditional relationship between risk and return in US stock market in 1936 to 1990. They use realized returns in their estimation and separate the US stock market into up and down markets. Their results show that a positive relationship is always predicted between beta and expected returns, but this relationship is conditional on the market excess returns when realized returns are used for tests. They find that this relationship is positive in an up market and negative in a down market.

Isakov (1999) follows the approach of Pettengill, Sundaram and Mathur (1995) and investigates the effect of beta on return in the Swiss stock market. He finds that the relationship between beta and return is statistically significant and depends on the sign of market. The findings show that beta is a good measure of risk.

Fletcher (2000) examines the conditional relationship between beta and return in the stock market of 18 developed countries over the period 1970-1998, and finds a significant positive relationship between beta and return in up market months and a significant negative relationship between beta and return in down market months. Hodoshima, Garza-Gómez, and Kunimura (2000) investigate the conditional relationship in Japan’s stock market, and find that the conditional relationship between returns and beta is found to be a better fit in general when the market excess return is negative than when it is positive.

Tang and Shum (2003a) examine the risk-return conditional relationship in international stock markets and find that it is significantly positive (negative) when the market excess returns are positive (negative). Recognizing that stock returns are non-normally distributed, in Tang and Shum (2003b) they extend their study further by examining other statistical risk measures such as skewness and kurtosis. Their findings show that skewness, but not kurtosis, plays a significant role in pricing stock returns.

Basher and Sadorsky (2006) use a multi-factor model that allows for both unconditional and conditional various risk factors to investigate the relationship between risk factors and stock market returns. They examine the impact of market risk, oil price risk, exchange rate risk, skewness, and kurtosis on emerging stock market returns over the period 1992 to 2005. They consider the direction of the stock market and the oil market (up or down), and find strong evidence that market risk and oil price risk impact stock returns.

Refai (2009) investigates the unconditional and conditional risk-return relationship in Jordan and rejects the unconditional relationship. He finds a positive relationship between beta and returns for all industries in up markets, and a negative relationship for a few industries in down markets.

Theriou et al. (2010) investigate the risk-return relationship in the Athens stock exchange during 1991-2002 by using a 2-step conditional model in up and down markets. They find that there is a significant positive relationship between risk and return in the up markets and a significant negative relationship in the down markets.

Chiang and Zhang (2018) investigate the risk-return relations in Chinese equity markets Results show that stock returns are positively correlated with predictable volatility, supporting the risk-return relation in both aggregate and sectoral markets. They find a positive relation between stock return and intertemporal downside risk, while controlling for sentiment and liquidity.

Mili (2019) examines whether the intertemporal tradeoffs between risk and return explain mean reversion in sovereign credit default swap (CDS) spreads. The results show that, during the pre-crisis period, sovereign CDS spread changes were more consistent with the mean reversion hypothesis for most European countries. He also finds strong evidence that the intertemporal tradeoffs between volatility and return explain in part the mean reversion in the markets for European CDS.

Sinaee and Moradi (2010) examine the risk-return conditional relationship in the TSE during the period 2003 to 2005 in up and down markets. They also test the effects of other stock returns' characteristics such as skewness and kurtosis on the return. They did not observe any difference between these two periods, except for the explanatory power of beta during down market period. Their results also show that skewness had an important effect on returns but kurtosis did not have significant relation with returns during the three years of research period.

Our paper builds upon the previous literature, and particularly the work of Sinaee and Moradi (2010), by examining a wider variety of risk factors over a different and longer time period and by using the two-step multifactor conditional model introduced by Pettengill, Sundaram and Mathur (1995). Sinaee and Moradi (2010) analyze the period 2003 to 2005. In 2005, the value of the stock price index declined by 21% over the previous year and the bubble that had developed over the previous years in this market was destroyed. In this paper, we investigate the risk-return relationship in Tehran Stock Exchange from March 2005 until March 2019, which is a different and longer time period than that studied by Sinaee and Moradi (2010). Moreover, in addition to market risk, skewness and kurtosis, our paper also includes several risk factors which Sinaee and Moradi (2010) do not study, including oil price risk, exchange rate risk, gold price risk, and inflation risk.

3. Data and Methods

3.1. The Tehran Stock Exchange

Iran is a developing country and the Tehran Stock Exchange (TSE), an emerging or “frontier” market (“Iranian stock market”, 2010), is its largest stock exchange. A founding member of the Federation of Euro-Asian Stock Exchanges, the Tehran Stock Exchange has been one of the world’s best performing stock exchanges in the years 2002 through 2013 (Tehran Stock Exchange, 2012; Lynn, 2014).

One advantage that Iran’s stock market has in comparison with other regional markets is that there are many different and diverse industries directly involved in it, which makes it unique in the Middle East (Tehran Stock Exchange, 2012; “Iran offers incentives”, 2010). These industries include motor vehicles and auto parts, metal ores mining, real estate and construction, refined petroleum products, basic metal, and pharmaceuticals. A second advantage of Iran’s stock market is that most of Iran’s state-owned firms are being privatized under the general policies of Article 44 in the Iranian Constitution, and people are allowed to buy shares of the newly privatized firms. Despite its advantages, however, Iran’s stock market has fluctuated greatly, with different periods of recession and boom, which has affected Iran’s economy.

In this paper, we investigate the risk-return relationship in the Tehran Stock Exchange (TSE) over the period from March 21, 2005 until March 21, 2019. This period corresponds to the dates to 01/01/1384 to 29/12/1397 in the Iranian calendar. We choose to analyze this period both because it constitutes an important period in the Tehran Stock Exchange following a dramatic decline in the stock price index, and because daily data for all variables are available in this period.

Figure 1 plots the total index of the Tehran Stock Exchange (TEPIX) from March 2005 to March 2019, the time period of our analysis.

3.2. Risk Factors

There are many potential candidates for risk factors introduced in literature (Fama and French, 1992; Chan, Chen and Hsieh, 1983; Goriaev, 2004). These factors are classified into two types: fundamental factors, which are based on observed company characteristics; and systematic factors such as macroeconomic factors (Goriaev, 2004) that are not diversifiable (Turvey, Driver and Baker, 1988). The risk factors that we consider in this study are: market risk, oil price risk, exchange rate risk, gold price risk, inflation risk, skewness, and kurtosis.

Among the various systematic risk factors affecting stock returns, market risk is one of the most important and many studies have focused on it. We therefore include the excess market return, which we define as the difference between the market return and risk-free rate, as a risk factor that can affect stock returns.

A second risk factor we include is the oil price return, which we define as the percent change in the oil world price. The world oil market is a major international market. Any change in the world oil price can lead to changes in domestic markets, especially financial markets and stock markets (Papapetrou, 2001; Sadorsky, 2001; Hammoudeh and Aleisa, 2004; Hammoudeh, Dibooglu. and Aleisa, 2004; Hammoudeh and Huimin, 2005; El-Sharif et al., 2005; Huang, Hwang and Peng, 2005; Basher and Sadorsky, 2006; Boyer and Filion, 2007; Henriques and Sadorsky, 2008; Park and Ratti, 2008; Basher, Haug and Sadorsky, 2012; Tiwari et al., 2018; Davis and Hausman, 2020). The oil price is one of the systematic risk factors which influence stock market returns (Chen, Roll and Ross, 1986).

Oil price fluctuations affect industries and change their stock return. The effect of oil prices on stock returns may depend on the degree of an industry’s dependence on oil and can also change in up and down oil markets. On the one hand, when oil prices increase, the income and GDP of oil-exporting countries such as Iran increase (Kheiravar, Lin Lawell and Jaffe, 2022). With higher income and GDP, the expectations for economic development are more optimistic and the demand for industry production increase (Aghaei and Lin Lawell, 2022). Higher demand leads to higher stock price indices and greater stock return. On the other hand, however, industries need energy for their production processes (Jorgenson, 1998; Corderi and Lin, 2011; Zhang and Lin Lawell, 2017; Jorgenson, 2018; Aghaei and Lin Lawell, 2022; Kerestes, Corderi Novoa and Lin Lawell, 2022) and an increase in the oil price leads to an increase in production costs, which all else equal would put downward pressure on the industry's stock return. In Iran, the cost of energy consumption for domestic industries is determined by the government, however, so is relatively unaffected by increases in the world oil price (Kheiravar and Lin Lawell, 2022). If a domestic industry exports its production to international markets, it benefits from a lower energy cost relative to the energy cost for the same industries in other countries, which can improve its competitiveness and raise the return of its stock.

A third risk factor we include is the real exchange rate return, which we define as the percent change in the real exchange rate. Transactions between countries are conducted by an international currency and thus the exchange rate is a very important factor in a country's economy. On the one hand, an increase in the exchange rate leads to more expensive imports for domestic industries and increases their production costs. This has a negative effect on industries' profit and their dividends and thus decreases their stock return. On the other hand, an increase in the exchange rate leads to more export and also improves the competition position of domestic producers and thus has a positive effect on the stock returns. The relationship between foreign currency and stock can also be investigated from another point of view: foreign currencies (especially the U.S. dollar) are an alternative asset for stock in countries. So an increase in the exchange rate may increase the demand for foreign currency and shift some part of investor's money from the stock market to the exchange market, leading to a decrease in the stock return.

A fourth risk factor we include is the gold return, which we define as the percent change in the gold price. Economic risk is one of the most important risks that investors pay attention to, as high economic risk creates uncertainty about investments. The gold coin price in Iran has had many fluctuations in recent years and we include it as a measure of economic risk. A gold coin is an alternative asset for stock in Iranian's portfolio and its fluctuations increase risk and affect return. All these risk factors affect corporate profit and can therefore influence stock returns in many ways.

A fifth risk factor we include is the inflation rate, which we define as the percent change in the general price level. In high inflation conditions, investors keep their funds in markets such as the stock market rather than as cash. This leads to more demand for investing in the stock market and increases the stock price index and stock return. But after a while investors will realize that the intrinsic value of stock has not increased, as the increase in the return is only due to inflation. So the demand for stocks declines after a period of time and the stock return decreases to its real value.

If the distribution of a stock return is not normal, two additional risk factors, skewness and kurtosis of returns, can affect stock returns as well. We therefore include skewness and kurtosis as risk factors as well.

3.3. Industries

We estimate the conditional relationship between various risk facts and stock market returns for four groups of industries. The first group of industries consists of the ten largest sectors.

Each month, the Tehran Stock Exchange monthly bulletin publishes the top ten industries by market cap.[2] These top ten industries, which have a combined market share of approximately 90%, are the same ten industries in most of the months of our March 2005-March 2019 study period. These industries are: motor vehicles and auto parts; diversified industrial holdings; metal ores mining; real estate and construction; monetary intermediation; investment companies; cement, lime and plaster; refined petroleum products; basic metal; and chemicals and by-products.[3] We use daily data in Iranian Rial (IRR)[4] on these 10 industries from the Tehran Stock Exchange.

The second group of industries for which we estimate a conditional relationship between risk and returns consists of the largest energy consuming industries. As measured by energy intensity (energy consumption per unit of production), five of the top ten industries are the largest energy consuming industries in Iran: basic metal; chemicals and by-products; cement, lime and plaster; refined petroleum products; and metal ores mining. Since these five sectors are among the largest ten sectors in the Tehran stock market and also the largest energy consuming industries in Iran, we estimate the relationship between their stock returns and mentioned risk factors and compare the results with the results from the top ten sectors. We expect that the impact of oil price risk on returns in this group to be different from that in the first group because the relationship between oil and industries in this latter group is greater than the relationship between oil and industries in the first group.

The third and fourth group of industries we consider consist of the four major export industries (metal ores mining; cement, lime and plaster; basic metal; and chemicals and by-

[2] Market capitalization (market cap) is the total value of the issued shares of a publicly traded company; it is equal to the share price times the number of shares outstanding.
[3] The post and telecommunications sector, which was one of the top 10 sectors in the Tehran Stock Exchange since the middle of 2008, is not included in this study because it has not been active for a long enough period.
[4] The Iranian Rial (IRR) is Iran's currency. All data used in this study (except world oil price) are based on the IRR.

products) and the four major import industries (motor vehicles and auto parts; pharmaceuticals; machinery and equipment; and non-metallic mineral products) in Iran, respectively. These industries are closely related with international markets and all of their transactions are conducted by international currency and thus any fluctuations in exchange rate will affect their stock return. Considering the importance of these two groups in Iran's economy, we estimate the relationship between their stock returns and various risk factors to analyze how the risk factors, particularly exchange rate risk, affect export and import industries in Iran.

3.4. Data Sources

For the daily stock return, we use daily price index data from the Tehran Stock Exchange. The daily stock return R_{idt} of industry *i* on trading day *d* in year *t* is computed using the following formula (Theriou et al., 2010):

$$R_{idt} = \log(T_{idt} / T_{i,d-1,t}), \qquad (1)$$

where T_{idt} is the stock price index of industry *i* on trading day *d* in year *t*. Descriptive statistics for the daily stock returns of all the industries considered are reported in Table 1. The standard deviation of the stock return for each industry indicates the amount of risk. This table also reports the p-value from an augmented Dickey-Fuller (ADF) unit root test for each return, results of which show stationarity for all the returns.

As seen in Table 1, the stocks for the metal ores mining industry have the highest mean daily return and the stocks for non-metallic mineral products have the lowest mean daily return. The monetary intermediation industry has the highest standard deviation, and therefore the highest risk. This industry also has a negative mean daily return so, contrary to theory, there does not appear to be a positive relationship between risk and return for this industry. The total market return has a lower value of standard deviation, and therefore a lower risk, than the industry stock returns for any of the industries we analyze. This confirms one of the most important capital market principles: that of minimizing risk through the diversification of assets in a portfolio.

For market risk, the risk factor we use is the excess market return, which we calculate as the difference between the market return and risk-free rate. For the market return, we use the return of the Tehran Stock Exchange Dividend and Price Index (TEDPIX). Data on the TEDPIX is collected from the Tehran Stock Exchange. The risk-free rate is the interest rate of securities which do not have risk in the absence of inflation. There is no consensus measure of the risk-free rate of return. In most studies, the rate of return on bonds and the bank interest rate are used as proxies for the risk-free rate. In this study, we use data on the real one-year interest rate of Central Bank bonds in Iran as the risk-free rate. This data is from the Central Bank of the Islamic Republic of Iran (CBI).

For oil price risk, the risk factor we use is the oil return, which we calculate as the percent change in the oil world price. We use daily data on the Brent Spot Price FOB (in dollars per barrel) from the U.S. Energy Information Administration for the world oil price.

For exchange rate risk, the risk factor we use is the real exchange rate return, which we calculate as the percent change in the real exchange rate. For the nominal exchange rate, we use the average sale price in Rial of one American dollar in the Tehran free market from the Central Bank of the Islamic Republic of Iran (CBI). The real exchange rate is the nominal exchange rate times the monthly consumer price index (CPI) in US, and divided by the monthly Consumer Price Index (CPI) from the Central Bank of the Islamic Republic of Iran (CBI).

For gold price risk, the risk factor we use is the gold return, which we calculate as the percent change in the gold price. For the gold price, we use the average sale price (in thousand

Rial) of one Iranian gold coin (in particular, the Bahar Azadi coin with the new design) in the Tehran free market. This data is from the Central Bank of the Islamic Republic of Iran (CBI).

For inflation risk, the risk factor we use is the inflation rate, which we calculate as the percentage change in the general price level of price. For the general price level, we use the monthly Consumer Price Index (CPI) from the Central Bank of the Islamic Republic of Iran (CBI).

As seen in Table 1, the returns of the stocks for some industries demonstrate skewness and those for all industries show high kurtosis. We therefore include skewness and kurtosis as additional risk factors in our analysis.

Table 2 presents summary statistics of the risk factors used in this study.

3.5. Methods

We estimate the relationship between risk and return for four groups of industries in the Tehran Stock Exchange: the top ten industries by market cap, the five largest energy consumer industries, the four major export industries, and the four major import industries. Our estimation approach involves two steps, and combines the models introduced by Pettengill, Sundaram and Mathur (1995) and Basher and Sadorsky (2006).

In the first step, we estimate the coefficients β on the risk factors for each industry in each year. In particular, for each industry and for each year, we use the daily data for that industry and year to estimate the following regression model:

$$R_{idt} = c + \beta_{it}^{Mkt} Mkt_{dt} + \beta_{it}^{Oil} Oil_{dt} + \beta_{it}^{Exch} Exch_{dt} + \beta_{it}^{G} G_{dt} + \beta_{it}^{Inf} Inf_{dt} + \varepsilon_{idt} \ , \qquad (2)$$

where R_{idt} is the daily stock return of industry *i* on trading day *d* in year *t*, *c* is a constant, Mkt_{dt} is the excess market return, Oil_{dt} is the oil price return, $Exch_{dt}$ is the real exchange rate return, G_{dt}

is the gold return, Inf_{dt} is the inflation rate, and β_{it}^{X} is the reaction of industry *i*'s stock return to risk factor *X* in year *t*.

We estimate a separate first-stage regression (2) for each industry *i* and each year *t* in order to estimate a set of all the risk factor betas -- including the market beta β_{it}^{Mkt}, oil beta β_{it}^{Oil}, exchange rate beta β_{it}^{Exch}, gold beta β_{it}^{G}, and inflation rate beta β_{it}^{Inf} -- for each industry *i* and each year *t*. There are therefore 140 separate first-stage regressions (2) -- one for each of the 10 industries in each of the 14 years of our data set – and 140 sets of risk factor betas. Each risk factor β_{it}^{X} measures the reaction of industry *i*'s stock return to risk factor *X* in year *t*. By estimating a separate first-stage regression (2) for each industry *i* and each year *t*, we allow the risk factor betas to vary by both industry and year. Table 3 reports the means and standard deviations by industry of the betas β_{it}^{X} estimated for each industry and year.

In the second step, we estimate the relationship between risk factors and stock returns in the Tehran Stock Exchange using random effects models applied to an annual industry-level panel data set consisting of the annual industry stock returns R_{it} and the risk factor betas β_{it}^{X} estimated from the first step for each industry *i* and each year *t*. In this step, eight different specifications of the unconditional and conditional relationship between risk and return are estimated. The unconditional model is given by:

$$R_{it} = \gamma_0 + \gamma^{Mkt}\beta_{i,t-1}^{Mkt} + \gamma^{Oil}\beta_{i,t-1}^{Oil} + \gamma^{Exch}\beta_{i,t-1}^{Exch} + \gamma^{G}\beta_{i,t-1}^{G} + \gamma^{Inf}\beta_{i,t-1}^{Inf} + \mu_i + \varepsilon_{it} \;, \qquad (3)$$

where R_{idt} is the annual stock return of industry *i* in year *t*; the risk factor betas β_{it}^{X} are the coefficients estimated from the first step for each industry in each year; and μ_i is an industry random effect. Equation (3) is an unconditional relationship between return and risk factors.

Based on Pettengill, Sundaram and Mathur (1995) and Basher and Sadorsky (2006), the conditional model is given by:

$$
\begin{aligned}
R_{it} = \gamma_0 &+ \gamma^{Mkt>0} I\left\{Mkt_t > 0\right\} \beta_{i,t-1}^{Mkt} + \gamma^{Mkt<0} I\left\{Mkt_t < 0\right\} \beta_{i,t-1}^{Mkt} \\
&+ \gamma^{Oil>0} I\left\{Oil_t > 0\right\} \beta_{i,t-1}^{Oil} + \gamma^{Oil<0} I\left\{Oil_t < 0\right\} \beta_{i,t-1}^{Oil} \\
&+ \gamma^{Exch>0} I\left\{Exch_t > 0\right\} \beta_{i,t-1}^{Exch} + \gamma^{Exch<0} I\left\{Exch_t < 0\right\} \beta_{i,t-1}^{Exch} \\
&+ \gamma^{G>0} I\left\{G_t > 0\right\} \beta_{i,t-1}^{G} + \gamma^{G<0} I\left\{G_t < 0\right\} \beta_{i,t-1}^{G} \\
&+ \gamma^{Inf>0} I\left\{Inf_t > 0\right\} \beta_{i,t-1}^{Inf} + \gamma^{Inf<0} I\left\{Inf_t < 0\right\} \beta_{i,t-1}^{Inf} + \mu_i + \varepsilon_{it} \ , \qquad (4)
\end{aligned}
$$

where $I\left\{Mkt_t > 0\right\}$ is dummy variable which is equal to one if excess market returns are positive (up market) and $I\left\{Mkt_t < 0\right\}$ is dummy variable which is equal to one if excess market returns are negative (down market). The other dummy variables are similarly defined for each risk factor.

The summary statistics in Table 1 show that the returns of most industries demonstrate skewness and the returns of all industries show high kurtosis. We therefore also estimate unconditional and conditional models which include skewness and kurtosis as additional factors.

We test for symmetry between the up and down stock markets by testing the null hypothesis that the coefficients for the up and down markets for a given risk factor *X* are the same, and therefore that there is a symmetric relationship between risk factor *X* and stock return in up and down markets:

$$
\begin{aligned}
&H_0 : \gamma^{x>0} = \gamma^{x<0} \\
&H_1 : \gamma^{x>0} \neq \gamma^{x<0} \qquad (5)
\end{aligned}
$$

We estimate 4 unconditional models and 4 conditional models. Model 1 investigates the relationship between return and all systematic risk factors (market risk, oil price risk, exchange rate risk, gold price risk and inflation risk). Models 2 and 3 add skewness and kurtosis as additional risk factors, respectively, to Model 1. Model 4 evaluates the relationship between all risk factors and return. We estimate each of these 4 models for both the unconditional case and the conditional case. The results express the relationship between various risk factors and stock returns in the Tehran Stock Exchange.

For each model, we conduct a Hausman test to determine whether random effects or fixed effects are more appropriate. As seen in the results below, we find for each of our models that a random effects model is preferred since we do not reject the null hypothesis that the random effects and regressors are uncorrelated. Since we do not reject the null hypothesis that the random effects and regressors are uncorrelated, the random effects estimator is asymptotically efficient while the fixed effects estimator is not efficient (Hausman, 1978). We therefore use a random effects specification for all unconditional and conditional models.

4. Results

4.1. Top Ten Industries

Tables 4 and 5 show the results of these random effects regressions for the unconditional and conditional models, respectively, for the top ten industries by market cap in the Tehran Stock Exchange (group 1). The tables also present the results from a Hausman test, which show that a random effects model is appropriate since we do not reject the null hypothesis that the random effects and regressors are uncorrelated. We therefore use a random effects specification.

The results of unconditional models in Table 4 show a negative relationship between market risk and stock return that is inconsistent with the theory. It is therefore important to divide the sample period to up and down market periods to investigate the conditional risk-return relationship.

According to the results of our conditional models in Table 5, the risk-return relationship is different in up and down markets. There is a positive risk-return relationship in the up market and a negative relationship in the down market, and both of them are statistically significant at a 5% level. The result of a positive risk-return relationship in the up Tehran stock market shows that markets with higher risk receive higher return compared to markets with lower risk. This result is consistent with the theory which displays a positive (or direct) tradeoff between market risk and return in the financial field.

On the other hand, the negative market risk and return relationship in the down market in is inconsistent with the theory and shows that markets with higher risk receive lower return and that there will be more losses when markets are down. Pettengill, Sundaram and Mathur (1995), Isakov (1999), Fletcher (2000), Basher and Sadorsky (2006) and Tang and Shum (2003a,b) also find a positive relationship in the up market and a negative relationship in the down market.

Sinaee and Moradi (2010) find a positive relationship between market risk and returns in both the up and down markets during the period 2003 to 2005 and do not observe any difference between two up and down periods in the Tehran Stock Exchange in this period. The difference between our result and Sinaee and Moradi (2010)'s result can be due to the difference in the study periods. Sinaee and Moradi (2010)'s study analyzes the Tehran Stock Exchange over the years 2003 to 2005, during which the Tehran Stock Exchange was faced with a bubble. In contrast, in the first year of our study period, 2005, the value of the index was faced with a 21% reduction over the previous year and the bubble that had developed over the previous years in this market was destroyed.

The coefficient on oil price risk is positive in the unconditional models (Table 4) and for the up market in the conditional models (Table 5). This means that there is a positive relationship between oil price risk and stock returns in the up world oil market. Increasing oil prices in an up oil market increase the oil income in Iran (as an oil exporter country) and create an optimistic expectation. This condition leads to more demand for industry production. Higher demand leads to more income and benefit and higher stock price index and therefore increases the stock return. In Iran, the cost of energy consumption cost for domestic industries is determined by the government and therefore relatively unaffected by increases in the world oil price (Kheiravar and Lin Lawell, 2022). If a domestic industry exports its production to international markets, it benefits from a lower energy cost is relative to the energy cost for the same industries in other countries, which can improve its competitiveness and raise the return of its stock.

The oil price risk-return relationship in the down world oil market is significantly negative (Table 5). Iran's oil income in the down world oil market is decreasing, causing the industry's stock price index to decrease and thus the stock return to decline. Therefore we can conclude that the reaction of stock return to the oil price volatility depends on oil market condition (up or down) and the oil price risk factor is important in determining industries' stock return in the Tehran Stock Exchange in up and down world oil market.

The estimated coefficient on the exchange rate beta is positive in all unconditional models (Table 4). This coefficient also is positive in all conditional models in up markets and statistically significant at a 5% level (Table 5). But the results demonstrate a significant negative relationship between exchange rate and return in the down market (Table 5). An increase in the exchange rate can lead to more export and also improve the competition position of Iranian producers and thus can have a positive effect on stock returns. On the other hand, an increase in the exchange rate can also increase the costs to industries by increasing the costs of the inputs they import, thus decreasing their profit and stock return. Moreover, any increase in the dollar in Iran shifts some part of investors' money from the Tehran stock market to the dollar market, thus leading to a decrease in stock returns. According to our results, the positive effect of the exchange rate on stock returns outweighs its negative effect in the up market but the opposite is the case in the down market.

The results of almost all the unconditional models and conditional models in the up and down gold markets show a statistically significant negative relationship between the gold price risk and stock returns. Unanticipated fluctuations in the gold coin price, an important proxy of Iran's economic risk, imply high risk and economic instability in Iran. This decreases domestic and foreign investment in Iran and has a negative effect on the Iranian stock market. On the other hand, any volatility in the price of gold coin, which is a very important alternative asset for stock in the Iranian portfolio, can change the stock return in the Tehran stock market. When the gold coin price is increasing, many of Iran's investors turn to the gold coin market, thus decreasing the demand for stocks, diminishing the amount of stocks in their portfolio, decreasing the stock price index, and finally decreasing the stock return. According to our results, as a proxy of economic risk and a competitor for stock in Iran, the gold coin has a negative relationship with stock return in the Tehran stock return in both up and down gold market.

The estimated coefficient on the inflation rate beta is negative in all unconditional and conditional models, but not necessarily statistically significant at a 5% level. Higher inflation decreases savings and thus decreases investments – especially retail investment -- in the stock exchange, causing a negative effect on the stock return. On the other hand, inflation increases the nominal value of stock and may cause some Iranian investors to shift their money to the Tehran stock market in the short term, increasing the stock return. But after a period of time the investors realize that the intrinsic value of the stock is decreasing due to inflation and so they decrease their demand for stock, leading to an eventual decrease in the stock return in the longer term.

The relationship between skewness and return is only statistically significant in the conditional models in the up market, where it is negative. Similarly, the kurtosis-return relationship is only significant in the up market, where it is positive. So there are conditional relationships between skewness and kurtosis with stock returns only in the up stock market. In contrast, the results of Sinaee and Moradi (2010), who analyze Iran's stock market during a different and shorter period of time during which Iran was experiencing a bubble, show that skewness had an important effect on returns but kurtosis did not have significant relationship with returns during their three-year study period (2003-2005).

Table 6 displays the results of tests for symmetry between coefficients in the up and down markets for the estimated coefficients for the conditional models for the top ten industries. The null hypothesis is that the coefficients are the same in up and down markets. According to the results, the null hypothesis that the coefficients in the respective up and down markets are the same is rejected for market risk, oil risk, exchange rate risk, gold risk, and inflation risk, which means that there are asymmetrical relationships between these risk factors and stock returns in up and down markets. Nevertheless, the null hypothesis that the coefficients in the respective up and down markets are the same is not rejected for skewness and kurtosis, which means that we cannot reject a symmetric relationship between these risk factors and stock returns in up and down markets.

4.2. Five Largest Energy Consuming Industries

Tables 7 and 8 show the results of the random effects regression for all conditional and unconditional models for the five largest energy consuming industries in Iran that are active in the

Tehran Stock Exchange. The tables also present the results from a Hausman test, which show that a random effects model is appropriate since we do not reject the null hypothesis that the random effects and regressors are uncorrelated. We therefore use a random effects specification.

As the results in Tables 7 and 8 for all conditional and unconditional models for the five largest energy consuming industries show, the signs of all the estimated coefficients for the top five energy consuming industries are the same as those for the top ten industries by market cap (Tables 4 and 5), but the magnitudes of some of the coefficients are different.

Oil price risk coefficients for the top five energy consuming industries are higher in the unconditional model (Table 7) and in the up market (Table 8) than for the top ten industries by market cap (Tables 4 and 5). In Iran, the cost of energy consumption cost for domestic industries is determined by the government. This cost is approximately constant and unaffected by increases in the world oil price. If a domestic industry exports its production to international markets, it benefits from a lower energy cost is relative to the energy cost for the same industries in other countries, which can improve its competitiveness and raise the return of its stock.

4.3. Major Export Industries and Import Industries

Tables 9 and 10 show the results of the random effects regressions for the unconditional and conditional models, respectively, for the 4 major export industries in Iran. The tables also present the results from a Hausman test, which show that a random effects model is appropriate since we do not reject the null hypothesis that the random effects and regressors are uncorrelated. We therefore use a random effects specification.

As the results of Table 10 show, the relationship between the stock returns of the export industries and the exchange rate beta is significant and positive in the up exchange rate market, and negative by not necessarily significant at a 5% level in the down market. An increase in the exchange rate leads to more export and also improves the competition position of domestic producers and thus has a positive effect on the stock returns.

Tables 11 and 12 show the respective results for the 4 major import industries in Iran. The tables also present the results from a Hausman test, which show that a random effects model is appropriate since we do not reject the null hypothesis that the random effects and regressors are uncorrelated. Since we do not reject the null hypothesis that the random effects and regressors are uncorrelated, the random effects estimator is asymptotically efficient while the fixed effects estimator is not efficient (Hausman, 1978). We therefore use a random effects specification.

According to Table 12, the relationship between the stock returns of import industries and the exchange rate beta is significant and negative in the up exchange rate market, and significant and positive in the down market. An increase in the exchange rate leads to more expensive imports for domestic industries and increases their production costs. This has a negative effect on industries' profit and dividends and thus decreases their stock returns.

As the results of Tables 9-12 show, the signs of other estimated coefficients for the export and import industries are the same as they are for the top ten industries in Tables 4 and 5.

5. Conclusion

This paper analyzes the conditional relationship between risk and return in Iran by estimating the relationship between various sources of risk -- market risk, oil price risk, exchange rate risk, gold price risk, inflation risk, skewness, and kurtosis -- and the stock return in the Tehran Stock Exchange over the period March 2005 to March 2019. The methodology used in this paper is a multi-factor model that allows the impact of the risk factors to have asymmetric effects depending on whether returns for the respective risk factor are increasing or decreasing. We analyze the risk-return relationship for four groups of industries: the top ten industries by market cap, the five largest energy consuming industries, the four major export industries, and the four major import industries.

We estimate both multi-factor unconditional models and multi-factor conditional models that allow the impact of the risk factors to have asymmetric effects on stock return depending on whether returns for the respective risk factor are increasing or decreasing. Our paper improves upon previous studies of Iran's stock market by examining a wider variety of risk factors over a different and longer time period by using a two-step multifactor conditional model introduced by Pettengill, Sundaram and Mathur (1995).

In general, the results for the top ten industries show that most of risk factors have a significant conditional relationship with stock returns. Market risk has a significant positive relationship with stock returns in up market and a significant negative relationship in down market. Pettengill, Sundaram and Mathur (1995), Isakov (1999), Fletcher (2000), Basher and Sadorsky (2006) and Tang and Shum (2003a,b) also find a positive relationship between market risk and stock return in the up market and a negative relationship in the down market.

Oil price risk and exchange rate risk have a significant positive relationship with stock returns in their up markets and a significant negative relationship in their down markets. The relationship between gold price risk and stock returns is significant and negative in both up and down gold markets. The inflation risk factor has a negative relationship with return in both up and down markets, but the relationship is only significant in a few models. Skewness and kurtosis have significant effects on stock return only in the up stock market. Our results constitute strong evidence that risk factors are important in determining industries' stock return in Tehran's stock exchange.

The results for the top five energy consuming industries have estimated coefficients that are the same sign as for the top ten industries, but the magnitudes of some coefficients are different. The most important discrepancy which is noticeable between the top five energy consuming industries and the top ten industries is the relationship between oil price risk and returns. Oil price risk coefficients for the top five energy consuming industries are higher than for the top ten industries by market cap. In Iran, the cost of energy consumption cost for domestic industries is determined by the government. This cost is approximately constant and relatively unaffected by increases in the world oil price (Kheiravar and Lin Lawell, 2022). If a domestic industry exports its production to international markets, it benefits from a lower energy cost is relative to the energy cost for the same industries in other countries, which can improve its competitiveness and raise the return of its stock.

The results for the four major export industries have estimated coefficients that are the same sign as for the top ten industries, but the magnitudes of some coefficients are different. The most noticeable discrepancy between the four major export industries and the top ten industries is the relationship between exchange rate risk and returns. The relationship between the stock returns of the export industries and the exchange rate beta is significantly positive in the up exchange rate market, but is insignificant in the down market. An increase in the exchange rate leads to more export and also improves the competition position of domestic producers and thus has a positive effect on the stock returns.

For the four major import industries, the signs of all the estimated coefficients are same as they were for the other groups of industries, except for the sign on exchange rate risk. The relationship between the stock returns of import industries and the exchange rate beta is significantly negative in the up exchange rate market and significantly positive in the down market; which is the opposite of what we found with the other industry groups. An increase in the exchange rate leads to more expensive imports for domestic industries and increases their production costs. This has a negative effect on industries' profit and dividends and thus decreases their stock returns.

Splitting the sample into up markets and down markets yields significant conditional relationships between return and the betas for the risk resources. According to the results of tests for symmetry between coefficients in the up and down markets, the null hypothesis that the coefficients in the respective up and down markets are the same is rejected for market risk, oil risk, exchange rate risk, gold risk, and inflation risk, which means that there are asymmetrical relationships between these risk factors and stock returns in up and down markets. These finding are consistent with the results of most papers that investigate the conditional relationship between risk and return.

Based on our findings that many sources of risk can affect stock returns, policy-makers and financial experts should pay attention to the relationship between risk factors and stock returns in up and down markets. The conditional effect of risk factors on the stock return should be evaluated using multi-factor conditional models such as the one we use in this paper to estimate the relationship between risk and return. This can lead to more investor confidence in Iran and possibly greater economic growth. If investors are assured about the long-term performance of the stock exchange and the amount of risk is consistent with their expectations, investment in the stock exchange will increase, which may lead to economic development and economic growth in emerging economies (Demirgüç-Kunt and Levine, 1996; Carp, 2012).[5]

[5] Growth in the stock exchange does not necessarily lead to economic growth, however, especially in Iran. Iran's slow economic growth may be due in part to sanctions and government monetary policy (Bazoobandi, 2020). Salehi,

Our work suggests several possible areas of future research, including adding more industries to the analysis and adding more macroeconomic variables as risk factors in the models. We also hope in future work to develop and estimate dynamic international multi-factor conditional models that allow the volatility process to follow GARCH dynamics and that allow for Markov switching between up and down markets, building on the work of Ng (2004) and Jahan-Parvar and Mohammadi (2013).

Karimzadeh and Paydarmanesh (2017) examine the impact of Iran Central Bank sanction on Tehran Stock Exchange, and find that despite, or perhaps possibly because of, economic sanctions imposed by other countries, the Tehran Stock Exchange has been growing.

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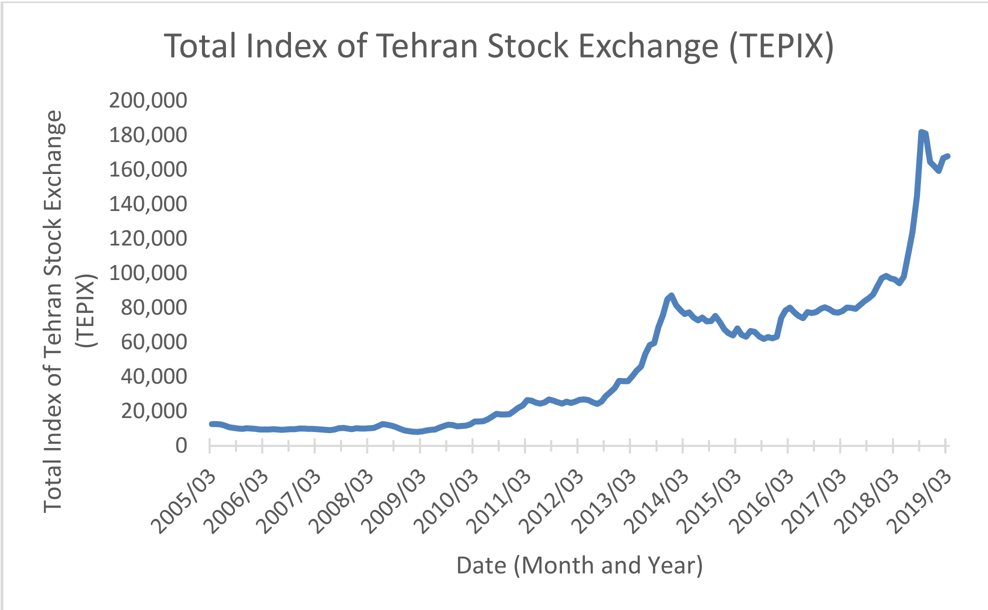
Figure 1: Total Index of Tehran Stock Exchange, March 2005 to March 2019



Data Source: Financial Information Processing of Iran (FIPIran), http://www.fipiran.com/DataService/IndexIndex

Table 1: Summary statistics of daily industry stock returns

Industry Name	Obs	Mean	Std Dev	Min	Max	Skewness	Kurtosis	ADF Unit root test p-value
Motor Vehicles and Auto Parts	1,786	0.027	0.992	-8.572	3.623	-0.768	12.151	0.000
Diversified Industrial Holdings	1,786	0.053	1.105	-14.687	6.504	-3.664	54.208	0.000
Metal Ores Mining	1,786	0.138	1.280	-15.640	7.571	-1.359	31.686	0.000
Real Estate and Construction	1,786	0.029	0.730	-7.310	5.351	-0.798	21.996	0.000
Monetary Intermediation	1,378	-0.006	1.360	-18.103	9.753	-5.064	80.448	0.000
Investment Companies	1,786	0.027	0.666	-5.311	2.941	-0.339	11.945	0.000
Cement, Lime and Plaster	1,786	-0.019	0.660	-4.313	11.392	6.455	114.203	0.000
Refined Petroleum Products	1,786	0.076	1.341	-9.444	20.843	4.954	83.873	0.000
Basic Metal	1,786	0.164	1.235	-4.651	21.714	6.159	106.986	0.000
Chemicals and By-Products	1,786	0.056	1.169	-19.059	12.211	-3.165	104.283	0.000
Pharmaceuticals	1,784	0.120	0.965	-3.893	20.463	10.930	224.943	0.000
Machinery and Equipment	1,786	0.007	1.226	-14.941	6.209	-1.705	32.341	0.000
Non-Metallic Mineral Products	1,786	-0.056	0.971	-10.805	5.732	-2.277	28.056	0.000
Total Market	1,786	0.035	0.585	-2.559	5.402	0.555	13.833	0.000

Table 2: Summary statistics of daily risk factors

Risk factor	Obs	Mean	Std Dev	Min	Max
Excess market return	1,784	-0.079	0.638	-2.912	7.980
Oil price return	1,784	0.044	2.352	-10.830	11.291
Real exchange rate return	1,782	0.049	0.801	-9.524	8.520
Gold return	1,782	0.111	1.148	-5.674	9.398
Inflation rate	1,785	0.044	0.033	-0.026	0.126

Table 3: Mean and standard deviations of first-stage betas for each industry

Industry	Market Beta	Oil Price Beta	Exchange Rate Beta	Gold Price Beta	Inflation Beta
Motor Vehicles and Auto Parts	0.625	0.027	-0.034	-0.004	0.521
	(0.578)	(0.101)	(0.202)	(0.165)	(1.852)
Diversified Industrial Holdings	1.014	-0.035	0.025	0.042	4.353
	(0.625)	(0.044)	(0.136)	(0.124)	(3.650)
Metal Ores Mining	0.851	0.066	-0.084	0.012	0.442
	(0.415)	(0.045)	(0.162)	(0.074)	(1.862)
Real Estate and Construction	0.082	-0.138	-0.074	0.022	-1.685
	(0.585)	(0.028)	(0.241)	(0.025)	(1.641)
Monetary Intermediation	1.242	0.074	0.077	-0.054	-0.935
	(1.495)	(0.038)	(0.448)	(0.251)	(4.413)
Investment Companies	0.328	-0.014	-0.048	-0.023	1.278
	(0.344)	(0.019)	(0.108)	(0.065)	(2.152)
Cement, Lime and Plaster	0.205	-0.002	-0.045	-0.074	-0.615
	(0.335)	(0.024)	(0.178)	(0.065)	(2.217)
Refined Petroleum Products	0.376	-0.024	0.064	-0.048	2.015
	(0.524)	(0.120)	(0.235)	(0.274)	(6.045)
Basic Metal	1.269	0.015	0.249	-0.036	-2.241
	(0.974)	(0.038)	(0.276)	(0.228)	(2.574)
Chemicals and By-Products	1.288	-0.039	-0.042	-0.028	3.289
	(1.542)	(0.085)	(0.291)	(0.062)	(3.213)
Pharmaceuticals	0.216	-0.042	-0.123	0.027	-3.128
	(0.174)	(0.025)	(0.236)	(0.214)	(8.759)
Machinery and Equipment	0.395	-0.044	0.016	0.085	0.367
	(0.645)	(0.102)	(0.274)	(0.039)	(5.445)
Non-Metallic Mineral Products	0.013	0.028	0.072	-0.016	0.605
	(0.258)	(0.127)	(0.143)	(0.189)	(4.058)

Notes: This table reports the means and standard deviations by industry of the risk factor betas estimated for each industry and year. For each industry in each year, a separate regression is run using daily data for that industry in that year to estimate the beta coefficients on each risk factor for that industry in that year. There are therefore 14 separate estimates of each risk factor beta for each industry, one for each of the 14 years of our data set. For each industry and each risk factor, this table reports the means and standard deviations over the 14 beta estimates for that risk factor for that industry. Standard deviations are in parentheses.

Table 4: Results of unconditional models for the top 10 industries by market cap

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta	-0.014*	-0.061*	-0.044*	-0.085*
	(0.006)	(0.030)	(0.021)	(0.032)
Oil price beta	1.32*	1.248	1.238*	1.029
	(0.65)	(0.921)	(0.530)	(0.680)
Exchange rate beta	0.120	0.192*	0.083*	0.154*
	(0.039)	(0.080)	(0.028)	(0.061)
Gold price beta	-1.700*	-1.710*	-1.644*	-1.658*
	(0.712)	(0.741)	(0.743)	(0.712)
Inflation beta	-0.0006*	-0.005	-0.006	-0.013
	(0.0002)	(0.006)	(0.013)	(0.015)
Skewness		-0.215		-0.182
		(0.1)		(0.087)
Kurtosis			0.256	0.188
			(0.131)	(0.172)
Constant	0.205*	0.255*	0.77*	0.651*
	(0.082)	(0.103)	(0.316)	(0.269)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.218	0.582	0.309	0.610
R-squared	0.153	0.171	0.150	0.371
p-value (Pr>F)	0.005**	0.004**	0.004**	0.001**
# Observations	140	140	140	140

Notes: Standard errors are in parentheses. The top 10 industries by market cap are: motor vehicles and auto parts; diversified industrial holdings; metal ores mining; real estate and construction; monetary intermediation; investment companies; cement, lime and plaster; refined petroleum products; basic metal; and chemicals and by-products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 5: Results of conditional models for the top 10 industries by market cap

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta*up market dummy	0.057*	0.017*	0.028*	0.005*
	(0.031)	(0.002)	(0.018)	(0.002)
Market beta*down market dummy	-0.420*	-0.455**	-0.246*	-0.266*
	(0.178)	(0.194)	(0.091)	(0.125)
Oil price beta*up market dummy	1.115*	1.090*	1.222**	1.148*
	(0.456)	(0.478)	(0.448)	(0.495)
Oil price beta*down market dummy	-2.397*	-2.123*	-0.639*	-1.812**
	(0.995)	(0.839)	(0.22)	(0.622)
Exchange rate beta*up market dummy	0.261*	0.286*	0.363*	0.323*
	(0.110)	(0.111)	(0.148)	(0.150)
Exchange rate beta*down market dummy	-0.086*	-0.062	-0.120*	-0.031**
	(0.036)	(0.479)	(0.052)	(0.014)
Gold price beta*up market dummy	-1.659*	-1.668*	-1.650*	-1.677*
	(0.718)	(0.712)	(0.712)	(0.715)
Gold price beta*down market dummy	-1.270*	-0.548	-0.471*	-0.089*
	(0.522)	(0.804)	(0.221)	(0.031)
Inflation beta*up prices dummy	-0.006*	-0.013	-0.014*	-0.015*
	(0.003)	(0.017)	(0.006)	(0.007)
Inflation beta*down prices dummy	-0.028	-0.004	-0.055*	-0.006
	(0.088)	(0.140)	(0.014)	(0.131)
Skewness*up market dummy		-0.275*		-0.181*
		(0.113)		(0.072)
Skewness*down market dummy		-0.277		-0.181
		(0.205)		(0.129)
Kurtosis*up market dummy			0.325*	0.166*
			(0.136)	(0.073)
Kurtosis*down market dummy			0.328	0.152
			(0.218)	(0.120)
Constant	0.251*	0.310*	0.751*	0.664*
	(0.111)	(0.18)	(0.332)	(0.226)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.368	0.850	0.684	0.959
R-squared	0.30	0.365	0.370	0.477
p-value (Pr>F)	0.000***	0.001***	0.000***	0.000***
# Observations	140	140	140	140

Notes: Standard errors are in parentheses. The top 10 industries by market cap are: motor vehicles and auto parts; diversified industrial holdings; metal ores mining; real estate and construction; monetary intermediation; investment companies; cement, lime and plaster; refined petroleum products; basic metal; and chemicals and by-products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 6: Symmetry test for estimated coefficients in conditional models for the top 10 industries by market cap

	Model 1	Model 2	Model 3	Model 4
Market beta	0.001***	0.001***	0.0312*	0.0401*
Oil price beta	0.005**	0.008**	0.045*	0.027*
Exchange rate beta	0.028*	0.052*	0.044*	0.035*
Gold price beta	0.016*	0.020*	0.005**	0.003**
Inflation beta	0.041*	0.030*	0.056*	0.015*
Skewness		0.653		0.672
Kurtosis			0.568	0.520

Notes: The table reports p-values (Prob>chi2) of symmetry test for estimated coefficients in the conditional models in Table 5. The null hypothesis is that the coefficients are the same in up and down markets. The top 10 industries by market cap are: motor vehicles and auto parts; diversified industrial holdings; metal ores mining; real estate and construction; monetary intermediation; investment companies; cement, lime and plaster; refined petroleum products; basic metal; and chemicals and by-products. Significance codes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 7: Results of unconditional models for the 5 largest energy consuming industries

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta	-0.107*	-0.108*	-0.088*	-0.125*
	(0.040)	(0.051)	(0.038)	(0.053)
Oil price beta	2.005*	1.972	2.174*	2.068
	(0.891)	(1.44)	(0.937)	(1.33)
Exchange rate beta	0.238	0.190*	0.119*	0.213*
	(0.188)	(0.091)	(0.054)	(0.096)
Gold price beta	-1.717*	-1.712*	-1.617*	-1.650*
	(0.801)	(0.810)	(0.810)	(0.712)
Inflation beta	-0.002*	-0.003	-0.005	-0.006
	(0.0001)	(0.002)	(0.007)	(0.007)
Skewness		-0.413		-0.310
		(0.336)		(0.194)
Kurtosis			0.406	0.491
			(0.240)	(0.335)
Constant	0.307*	0.307*	0.611*	0.517*
	(0.131)	(0.148)	(0.231)	(0.254)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.219	0.451	0.370	0.332
R-squared	0.438	0.488	0.510	0.602
p-value (Pr>F)	0.003**	0.004**	0.001**	0.002**
# Observations	70	70	70	70

Notes: Standard errors are in parentheses. The five largest energy consuming industries in Iran are: basic metal; chemicals and by-products; cement, lime and plaster; refined petroleum products; and metal ores mining Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 8: Results of conditional models for the 5 largest energy consuming industries

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta*up market dummy	0.051*	0.058*	0.060*	0.019*
	(0.020)	(0.021)	(0.021)	(0.007)
Market beta*down market dummy	-0.328*	-0.408**	-0.310*	-0.300*
	(0.136)	(0.133)	(0.144)	(0.119)
Oil price beta*up market dummy	2.149*	1.712*	2.071**	1.510*
	(0.982)	(0.70)	(0.787)	(0.682)
Oil price beta*down market dummy	-1.226*	-1.613*	-1.017*	-1.441**
	(0.614)	(0.718)	(0.421)	(0.522)
Exchange rate beta*up market dummy	0.291*	0.303*	0.366*	0.315*
	(0.125)	(0.128)	(0.182)	(0.144)
Exchange rate beta*down market dummy	-0.060*	-0.038	-0.093	-0.026
	(0.028)	(0.030)	(0.083)	(0.028)
Gold price beta*up market dummy	-1.640*	-1.677*	-1.638*	-1.670*
	(0.781)	(0.849)	(0.674)	(0.752)
Gold price beta*down market dummy	-1.252*	-0.566	-0.468*	-0.077*
	(0.593)	(0.421)	(0.205)	(0.036)
Inflation beta*up prices dummy	-0.004*	-0.020	-0.029*	-0.016*
	(0.002)	(0.022)	(0.006)	(0.005)
Inflation beta*down prices dummy	-0.029	-0.001	-0.047*	-0.010
	(0.020)	(0.002)	(0.027)	(0.011)
Skewness*up market dummy		-0.478*		-0.219*
		(0.190)		(0.090)
Skewness*down market dummy		-0.426		-0.187
		(0.323)		(0.122)
Kurtosis*up market dummy			0.321*	0.215*
			(0.144)	(0.085)
Kurtosis*down market dummy			0.368	0.304
			(0.332)	(0.220)
Constant	0.326*	0.291*	0.675*	0.438*
	(0.134)	(0.132)	(0.271)	(0.183)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.339	0.555	0.438	0.568
R-squared	0.530	0.529	0.573	0.646
p-value (Pr>F)	0.001***	0.000***	0.001***	0.001***
# Observations	70	70	70	70

Notes: Standard errors are in parentheses. The five largest energy consuming industries in Iran are: basic metal; chemicals and by-products; cement, lime and plaster; refined petroleum products; and metal ores mining Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 9: Results of unconditional models for the 4 major export industries

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta	-0.118*	-0.038*	-0.018*	-0.054*
	(0.050)	(0.018)	(0.007)	(0.026)
Oil price beta	1.331*	1.559	1.341*	1.250
	(0.617)	(1.277)	(0.550)	(0.861)
Exchange rate beta	0.316*	0.730*	0.428*	0.593*
	(0.155)	(0.332)	(0.176)	(0.262)
Gold price beta	-1.215*	-1.242*	-1.332*	-1.051*
	(0.581)	(0.540)	(0.614)	(0.526)
Inflation beta	-0.001*	-0.003	-0.001	-0.004
	(0.0006)	(0.0007)	(0.003)	(0.003)
Skewness		-0.166		-0.257
		(0.120)		(0.159)
Kurtosis			0.152	0.130
			(0.132)	(0.105)
Constant	0.127*	0.142*	0.232*	0.548*
	(0.058)	(0.067)	(0.111)	(0.241)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.120	0.444	0.439	0.638
R-squared	0.122	0.141	0.210	0.275
p-value (Pr>F)	0.001**	0.001**	0.000***	0.002**
# Observations	56	56	56	56

Notes: Standard errors are in parentheses. The four major export industries are: metal ores mining; cement, lime and plaster; basic metal; and chemicals and by-products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 10: Results of conditional models for the 4 major export industries

	Dependent variable is stock return			
	Model 1	Model 2	Model 3	Model 4
Market beta*up market dummy	0.019*	0.016*	0.154*	0.038*
	(0.006)	(0.007)	(0.069)	(0.015)
Market beta*down market dummy	-0.331*	-0.274**	-0.176*	-0.133*
	(0.157)	(0.087)	(0.090)	(0.061)
Oil price beta*up market dummy	1.878*	1.476*	1.967**	2.160*
	(0.792)	(0.740)	(0.752)	(0.927)
Oil price beta*down market dummy	-0.231*	-0.783*	-0.855*	-0.589**
	(0.123)	(0.412)	(0.378)	(0.275)
Exchange rate beta*up market dummy	1.181*	0.837*	1.282*	0.754*
	(0.610)	(0.395)	(0.545)	(0.370)
Exchange rate beta*down market dummy	-0.116	-0.120*	-0.286	-0.258
	(0.099)	(0.044)	(0.231)	(0.220)
Gold price beta*up market dummy	-1.260*	-1.291*	-1.320*	-1.321*
	(0.618)	(0.586)	(0.659)	(0.566)
Gold price beta*down market dummy	-1.005*	-1.390	-0.865*	-0.663*
	(0.457)	(1.148)	(0.377)	(0.278)
Inflation beta*up prices dummy	-0.002*	-0.004	-0.006*	-0.021*
	(0.001)	(0.001)	(0.005)	(0.016)
Inflation beta*down prices dummy	-0.208	-0.038	-0.011*	-0.040
	(0.171)	(0.025)	(0.004)	(0.026)
Skewness*up market dummy		-0.120*		-0.058*
		(0.062)		(0.027)
Skewness*down market dummy		-0.107		-0.089
		(0.088)		(0.065)
Kurtosis*up market dummy			0.139*	0.277*
			(0.066)	(0.140)
Kurtosis*down market dummy			0.132	0.087
			(0.095)	(0.089)
Constant	0.166*	0.210*	0.444*	0.576*
	(0.068)	(0.094)	(0.201)	(0.264)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.274	0.565	0.574	0.745
R-squared	0.333	0.341	0.393	0.458
p-value (Pr>F)	0.001***	0.000***	0.002***	0.001***
# Observations	56	56	56	56

Notes: Standard errors are in parentheses. The four major export industries are: metal ores mining; cement, lime and plaster; basic metal; and chemicals and by-products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 11: Results of unconditional models for the 4 major import industries

	Model 1	Model 2	Model 3	Model 4
Market beta	-0.144*	-0.118*	-0.218*	-0.329*
	(0.064)	(0.063)	(0.086)	(0.134)
Oil price beta	0.678*	0.555	0.226*	0.872
	(0.309)	(0.417)	(0.109)	(0.666)
Exchange rate beta	-0.228	-0.168*	-0.121*	-0.217*
	(0.148)	(0.074)	(0.051)	(0.086)
Gold price beta	-1.114*	-1.088*	-1.148*	-1.210*
	(0.488)	(0.550)	(0.484)	(0.501)
Inflation beta	-0.005*	-0.004	-0.003	-0.004
	(0.002)	(0.003)	(0.001)	(0.002)
Skewness		-0.082		-0.154
		(0.064)		(0.141)
Kurtosis			0.156	0.110
			(0.123)	(0.097)
Constant	0.121*	0.186*	0.352*	0.441*
	(0.047)	(0.088)	(0.163)	(0.187)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.318	0.352	0.372	0.525
R-squared	0.188	0.171	0.180	0.386
p-value (Pr>F)	0.003**	0.001**	0.004**	0.002**
# Observations	56	56	56	56

Notes: Standard errors are in parentheses. The four major import industries are: motor vehicles and auto parts; pharmaceuticals; machinery and equipment; and non-metallic mineral products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

Table 12: Results of conditional models for the 4 major import industries

	Model 1	Model 2	Model 3	Model 4
Market beta*up market dummy	0.138*	0.017*	0.073*	0.018*
	(0.055)	(0.009)	(0.021)	(0.008)
Market beta*down market dummy	-0.219*	-0.274**	-0.223*	-0.288*
	(0.110)	(0.088)	(0.116)	(0.120)
Oil price beta*up market dummy	0.536*	0.083*	0.230**	0.313*
	(0.268)	(0.036)	(0.123)	(0.139)
Oil price beta*down market dummy	-1.031*	-1.055*	-0.736*	-1.152**
	(0.438)	(0.532)	(0.324)	(0.418)
Exchange rate beta*up market dummy	-0.207*	-0.253*	-0.295*	-0.277*
	(0.114)	(0.122)	(0.128)	(0.115)
Exchange rate beta*down market dummy	0.122*	0.087*	0.150*	0.118**
	(0.045)	(0.040)	(0.072)	(0.040)
Gold price beta*up market dummy	-1.085*	-1.137*	-1.233*	-1.211*
	(0.524)	(0.554)	(0.610)	(0.561)
Gold price beta*down market dummy	-1.039*	-0.866	-0.341*	-0.466*
	(0.430)	(0.640)	(0.162)	(0.210)
Inflation beta*up prices dummy	-0.004	-0.017	-0.023*	-0.012
	(0.003)	(0.020)	(0.011)	(0.004)
Inflation beta*down prices dummy	-0.133	-0.021	-0.125*	-0.020
	(0.120)	(0.024)	(0.049)	(0.016)
Skewness*up market dummy		-0.082*		-0.1426*
		(0.027)		(0.049)
Skewness*down market dummy		-0.080		-0.116
		(0.064)		(0.086)
Kurtosis*up market dummy			0.177*	0.188*
			(0.086)	(0.075)
Kurtosis*down market dummy			0.229	0.212
			(0.136)	(0.151)
Constant	0.173*	0.219*	0.413*	0.446*
	(0.067)	(0.110)	(0.160)	(0.183)
p-value (Pr>chi2) from Hausman test (H0: random effects and regressors are uncorrelated)				
Hausman test p-value (Pr>chi2)	0.387	0.434	0.537	0.545
R-squared	0.236	0.212	0.276	0.453
p-value (Pr>F)	0.002***	0.001***	0.001**	0.000***
# Observations	56	56	56	56

Notes: Standard errors are in parentheses. The four major import industries are: motor vehicles and auto parts; pharmaceuticals; machinery and equipment; and non-metallic mineral products. Significance codes: * p<0.05, ** p<0.01, *** p<0.001

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