

Efficiency, Risk, and Events in the Tehran Stock Exchange

Mohammad R. Jahan-Parvar*

East Carolina University

Hassan Mohammadi†

Illinois State University‡

January 2011

Abstract

This paper analyzes market index returns in the Tehran stock exchange (TSE) within the context of three variants of the Capital Asset Pricing Model: the static international; the constant-parameter intertemporal; and a Markov-switching intertemporal CAPM, which allows for the degree of integration with regional and international equity markets to be time-varying. We find that TSE returns are CAPM-efficient at monthly frequency. Moreover, we find evidence in support of international integration of the TSE. We conduct event studies for TSE returns to examine the impact of non-market events. We find that TSE returns have become less sensitive to non-market factors over time.

Keywords: Emerging and frontier markets, Event study, GARCH, ICAPM, Iran, Markov switching, Volatility.

JEL Classification: C22; C32; G12; G15.

*Corresponding author, A-426 Brewster Building, Department of Economics, East Carolina University, Greenville, NC 27858, USA. Office Phone No: (252) 328-4770, e-mail: jahanparvarm@ecu.edu.

†Department of Economics, Campus Box 4200 Normal, IL 61790, USA. e-mail: hmohamma@ilstu.edu.

‡We thank Ai-Ru Cheng, Esfandiar Maasoumi, M. Hashem Pesaran, Hadi Salehi Esfahani, and seminar participants at 2010 Conference on Iran's Economy for their help and comments, which improved this paper. Golaleh Moshrefi provided research assistance. The remaining errors are ours.

1 Introduction

Since the mid-1990s, there has been growing interest in emerging and frontier financial markets among both financial scholars and practitioners. One of the least studied frontier markets is the Tehran Stock Exchange (TSE), the sole equity exchange in the Islamic Republic of Iran. Very little is known about the features of this market. In our study, we address some basic questions about risk and index returns behavior in this under-studied stock exchange.

A study of the TSE would naturally contribute to the literature on emerging markets finance in general, and Middle East and North Africa (MENA) financial markets in particular. While emerging markets have attracted considerable attention in the finance literature since the early 1990s, for example see Bekaert and Harvey (2003); the MENA region is relatively understudied. The most comprehensive recent study is Cheng et al. (2010). We follow Cheng et al. 's methodology very closely. In this paper, we analyze Tehran stock exchange index excess returns to test for efficiency of this market, via three variants of Sharpe (1964) and Lintner (1965) capital asset pricing theory (CAPM). We first test for the static international CAPM, following Lintner (1965). The objective is to measure the ability of this classical variant of CAPM to explain the behavior of excess returns in the TSE. We find that at the monthly frequency, TSE excess returns are CAPM-efficient.

Second, following the seminal work of Merton (1973) and the voluminous literature that it generated, we test for constant-parameter intertemporal CAPM model in TSE returns. We find that using conventional measures for risk-return trade-off, provides statistically mixed support for a positive market price of risk in TSE excess returns.

Third, based on the seminal work of Bekaert and Harvey (1995), we study the level of integration of the Tehran stock exchange with international financial markets, using a Markov-switching intertemporal CAPM which allows for a time-varying degree of integration with international equity markets. Our empirical findings, surprisingly, support a considerable degree of market integration for the Tehran stock exchange. Cheng et al. (2010) find evidence of international integration for Bahrain, Israel, and Turkey, but not other MENA markets. Thus, based on our empirical evidence, the Iranian market behaves more like the three arguably more open markets than other neighbors in the MENA region.

Finally, we conduct event studies for TSE returns data to examine the potential impact of local, regional, and international non-market events. We find evidence of significant sensitivity in TSE excess returns to economic and non-economic events. However, our empirical findings

imply that events seem to have more impact in the late 1990s and early 2000s. Since 2003, very few events seem to induce abnormal returns. We, cautiously, interpret this finding as support for gradual maturation of this market.

If investment in a frontier market such as Tehran stock exchange is an objective for investors seeking to diversify their portfolios, then some knowledge of the basic properties studied in this paper are necessary. It is important to bear in mind that this market is open to both small and large foreign investors.¹ We believe that finance research community would find some of our findings, such as the level of efficiency at monthly frequency for a market populated by investors who are far less sophisticated than their developed market counterparts and prone to insider information trading, to be pleasantly surprising. Hence, we believe that a rigorous empirical study of this virtually unknown market is interesting and informative.

Among the very few studies that look at the Iranian equity market, Foster and Kharazi (2008) examine the issues of efficiency and profitability of momentum strategies in TSE returns for the 1997-2002 period. They find evidence in support of efficiency at the weekly frequency, but not at the daily frequency. Our findings are inline with their conclusion regarding efficiency at lower frequencies. Hakim and Rashidian (2009) attempt to study the impact of events on TSE returns. Their study, however, has severe methodological shortcomings. We use the standard event study methodology to address the questions that they raised.

We also briefly review other recent studies of the MENA region's financial markets. None of these studies include the TSE in their sample. Errunza (2001) focuses on the liberalization and integration of financial markets in Egypt, Israel, Jordan, Morocco, and Turkey. Ghysels and Cherkaoui (2003) study trading costs in Morocco. Lagoarde-Segot and Lucey (2008) study information efficiency in seven MENA markets and find heterogeneous levels of efficiency. Billmeier and Massa (2009) study the role of oil reserves, remittances, and institutions besides the traditional factors, and find that they appear to play a role in the determination of market capitalization in the MENA and Central Asian financial markets. Alsubaie and Najand (2009) investigate the informational role of trading volume in predicting the direction of short-term returns for the Saudi Stock Exchange. Two recent studies, Billmeier and Massa (2008) and Jahan-Parvar and Waters (2010), study formation of financial bubbles in the MENA region.

The rest of the paper proceeds as follows. In Section 2, we briefly review the history of

¹Portfolio investment in Iranian companies is illegal in the U.S., as it violates Iran-Libya Sanctions Act (ILSA) of 1996, among other laws and acts of the Congress. But other international investors can, and in fact do, invest in the TSE.

TSE activities. We discuss the data used in this study in Section 3. In Section 4, we study the efficiency of TSE in an international CAPM and international factor model setting. Risk-return trade off and dynamics of market returns volatility are the subject of Section 5. We test whether TSE is integrated or segmented from the international financial system and report the test results in Section 6. We study the impact of several important non-market events on TSE returns in Section 7. Section 8 concludes.

2 A Brief Introduction to the Tehran Stock Exchange

The Tehran Stock Exchange (TSE) began operation in February 1967. It experienced robust growth in its first decade of operation. The number of listed companies increased from six in 1967 to 105 in 1978. Similarly, TSE's market capitalization increased from USD 885 million to USD 3.4 billion during the same time period. A number of factors contributed to the rapid growth of the TSE during this period. In particular, relative political stability, the land reform (also known as the White Revolution), a push towards the development of manufacturing sector, rapid rise in crude oil prices, and tax exemption status of listed companies are among the most important contributing factors.²

The Islamic revolution of 1978 and Iraq's invasion of 1981 reduced exchange activities significantly. By 1982, market capitalization fell to about USD 149 million. Following the cease-fire of August 20, 1988 in the Iraq-Iran war, the TSE gained prominence as a mechanism for channeling savings into investment, and fostering Iran's efforts towards economic reconstruction and development.³ As a result, the number of listed companies increased from 56 in 1982 to 306 in 2000. Since 2000, the performance of the TSE has followed two distinctive patterns; see Hakim and Rashidian (2009). The 2000-2004 period witnessed brisk performance in the TSE, with its market capitalization growing from USD 34 billion to USD 411.5 billion, and the Tehran Price Index (TEPIX) reaching an all time high of 13,882 on August 4, 2004. However, a severe market correction brought the index down 35% to 9069 on July 26, 2006. By 2007, the market capitalization rose above its level in 2004. However the number of listed companies was still below its 2004 values due to merger and acquisition activities.

The post-2000 Iranian economy has been subject to several internal and external shocks which may have influenced the TSE's performance. First, the economy has been subject to

²See TSE website: <http://www.iranbourse.com>.

³Iran and Iraq have not signed a peace treaty as of January 2011.

numerous external sanctions imposed by the United States and/or the United Nations' Security Council. We discuss these sanctions in Section 7. Hakim and Rashidian (2009) provide a detailed discussion of punitive sanctions on Iranian companies and entities.

Second, a number of other external events may have also potentially affected the performance of the TSE, including (a) the sharp rise and the subsequent fall in crude oil prices in 2000-2008 period; (b) the September 11, 2001 terrorist attacks in the U.S. and (c) the subsequent U.S. war on terror in two of Iran's neighboring countries – Iraq and Afghanistan.

Third, the Iranian economy has also been subject to a number of internal financial, policy, and political shocks with potential effects on the TSE performance. In particular, one may emphasize the following events. First, we note the imposition of stricter disclosure rules on the TSE in 2002 to improve transparency. Second, the tax law of 2003, which reduced marginal tax rates from 50% to 35%. Third, the 2004 amendment to the Article 44 of the Constitution which allowed privatization of 80% of the state assets. Of these, “Justice Shares” scheme gets 40% and the rest are planned to be publicly offered at the TSE.⁴ The government retains ownership of the remaining 20%. Under the privatization plan, 47 oil and gas companies (including PetroIran and North Drilling companies) worth an estimated USD 90 billion are to be privatized by 2014.⁵ Finally, we note the election of President Ahmadinejad in 2005 and the change in administration's attitudes towards the TSE.

3 Data

We use daily and monthly returns data from the TSE and MSCI (formerly, Morgan Stanley Capital International) in this research. The binding constraint in our study is the availability of online historical data from the TSE. We downloaded daily data from the Central Bank of Iran web site for December 27, 1998 to May 29, 2009 period. We use the TEPIX (TSE All-Share Price Index) market price index. As a proxy for the world equity market, we use the

⁴“Justice Shares” is a plan to transfer ownership of state owned industries equitably among all Iranians, especially the poor. We do not know how successful this plan is or the state of progress of the plan.

⁵See Iran Daily newspaper: <http://iran-daily.com/1387/3234/html/economy.htm>.

MSCI World index available from *Thomson Reuters Datastream*.⁶

Figure 1 shows the logarithmic values of the level of MSCI World and TEPIX indices. As the figure shows, between 2000 and 2003, the two indices move in opposite directions. However for the remainder of the sample period, they seem to move broadly in the same direction. In fact, the coefficient of correlation between the two indices is -0.5732 between May 2000 and September 2003, 0.3093 between May 2005 to May 2009, and 0.3458 for the full sample.

TSE data are expressed in Iranian Rials (IR), while the available international data are in U.S. Dollars. We transform the IR-denominated returns to USD-denominated returns, using IR-USD exchange rate data from the Central Bank of Iran. Officially, the IR-USD exchange rate was fixed at 1,750 IR per 1 USD until March 18, 2002.⁷

Since Iran follows the Persian calendar which differs substantially from the Gregorian calendar, we matched the trading day data from the TSE to MSCI index data.⁸ We constructed the monthly data by matching the corresponding TSE data to the last trading day in the Gregorian calendar. Our proxy for the risk-free rate is the daily 3-month secondary market US T-bill rate from the Federal Reserve Bank of St. Louis FRED II database.⁹

Table 1 presents the summary statistics of the data. The TSE data have substantially higher returns, similar volatility, positive skewness, and substantially larger excess kurtosis in comparison with international market index returns.¹⁰

⁶We also studied the *MSCI Emerging Markets Index*, (EM). Daily data on the EM index does not cover the pre-2004 period, hence we just use this index in our study of monthly returns. We found that there is no significant relationship between TEPIX index returns and EM returns. Hence, while these results are available upon request, they are not reported in the paper.

⁷Since March 2002, foreign exchange market has not been a “free floating” market. The Central Bank of Iran and other government entities routinely intervene in this market. While we admit that the exchange rate data we use may have some potential shortcomings, it is the only available data set that meets our criteria of length, frequency, and uniform method of collection.

⁸Working week is also different. Instead of having Saturday and Sunday as the weekend, Iranians work half day on Thursday and have Fridays off. Thus, there is a difference in the length of the working week.

⁹Iran does not have an independent central bank. Moreover, Iranian government bonds are not risk-free due to Iran’s confrontational foreign policy. Hence, we follow the long-standing tradition of using the 3-month T-Bill rate as the risk-free rate.

¹⁰We do not include the data point pertaining to the floating of the IR versus USD (March 2002) in calculation of the values in this table.

4 Static International CAPM and Factor Models

We are interested in testing market efficiency in TSE returns. The workhorse model of modern equity pricing since the 1960s has been CAPM. It comes in many flavors and our initial choice is the Sharpe (1964) and Lintner (1965) variation. This model states that the expected excess returns of an asset are linearly dependent on excess market returns. Empirically, the systematic risk of the asset is estimated by regressing its excess returns on some measure of excess returns of a broad equity market measure. To apply the model to an international setting, we regress the TSE excess returns on excess returns of an index composite of international markets.

The Sharpe (1964) and Lintner (1965) formulation of the international CAPM is given by:

$$r_t = \alpha + \beta r_t^W + \epsilon_t \quad (1)$$

where r_t is the TEPIX excess return over the 3-month T-Bill rate, r_t^W is the MSCI World excess return over the 3-month T-Bill rate, and ϵ_t is assumed to be a white noise innovation process. We use the 3-month T-Bill rate as the proxy for risk free rate for the following reasons. First, the paper is written from the point of view of the international investor seeking diversification.¹¹ Such an investor has access to the international fixed income asset markets. Second, Iran's nascent fixed income market is not deep enough. The most common fixed income traded asset is the "participation certificate", which resembles a bond. However, holding of this instrument is not widespread enough for its yield to be treated as the risk free rate. Another candidate is the interest paid on saving deposits. However, this rate does not change often enough to reflect the expectations of investors about the state of the economy and inflation. In fact, determination of this rate is often a political process which in recent years has cost two Chairpersons of the Central Bank of Iran their jobs.¹² Fourth, given the confrontational foreign policy, dependence of the government budget on the volatile crude oil prices, and general volatility of the Iranian government, it is an open question whether any Iranian fixed income asset can be viewed as

¹¹Iranian authorities actively court international investors at the time of writing of this article. The 2005 Foreign Portfolio Investment by-law, effective since April, 2010, allows for up to 20% of ownership of listed companies by foreign entities which includes voting and management rights. This is an increase from maximum of 10% of the outstanding shares. The same by-law also allows for quick repatriation of capital gains by small investors. Institutional and large investors are now allowed to repatriate their earnings within two years (down from three years).

¹²For example, see the article published on May 25, 2007 in The Guardian: <http://www.guardian.co.uk/business/2007/may/25/iran.internationalnews>

risk free.

As mentioned earlier, we use the MSCI World index returns as a proxy for world market returns and the 3-month US T-bill rate as a proxy for the global risk-free rate. The above variant of the international CAPM assumes there is no exchange-rate risk. Under certain conditions, exchange-rate risk is not priced independently from market risk; see, for example, Adler and Dumas (1983). A necessary condition for a market to be CAPM efficient is $\alpha = 0$. If $\beta = 0$, then the market is segmented from the international capital market. International CAPM results are presented in Table 2. The models were estimated by OLS and Newey-West HAC standard errors were computed; see Newey and West (1987).

The empirical results show that with monthly MSCI World returns as a predictor, in the plain vanilla international CAPM, the monthly $\hat{\alpha}$ is not significantly different from zero at conventional significance levels. On the other hand, daily $\hat{\alpha}$ is significant. While monthly results are strictly CAPM efficient; daily results, while statistically significant, are not strictly CAPM-efficient in the sense that Jensen's α is not zero. Since both daily and monthly $\hat{\beta}$ are significantly different from zero at 10% significance level or better, this implies that monthly TEPIX returns are positively correlated with broad international market indices at both daily and monthly frequencies. Sampling frequency seems to be influential on the regression results. However, these results are good enough to allow for using daily market regressions in Section 7.

One possible explanation for statistically significant Jensen's α at daily frequency could be the "delayed reaction" hypothesis of Hong and Stein (1996). That is, market participants in the TSE incorporate new information relatively slower than what we observe at the international level.¹³ We do not address the issue of reaction to availability of new information in the TSE and leave this question for future research. Another explanation is that similar to the conclusions reached by Foster and Kharazi (2008), the Tehran stock exchange may suffer from problems such as insider trading and other inefficiencies at higher sampling frequencies, but closing prices at weekly and monthly levels seem to be efficient. Notice that Foster and Kharazi (2008) found statistically insignificant daily regression results.

There are well-documented criticisms to CAPM and two remedies are often considered.¹⁴ The most common approach is to use the Fama and French (1996) methodology. We can not

¹³See Hong et al. (2007) and Fan and Jahan-Parvar (2010).

¹⁴For example, see Maasoumi and Racine (2002).

use this method since Fama-French factors are not available for the TSE. As an alternative, we use a variant of multifactor models. A classic example is Chen et al. (1986), who link stock market performance to a set of well-known macroeconomic factors. We postulate that oil prices have an impact on market performance in the 5th largest oil exporter in the world. Thus, we use the growth rate of oil prices. We also consider Hamilton (1996) net oil price increase (NOPI) over the preceding four months. Further, we allow for the possibility that there is a correlation between TSE returns and international macroeconomic factors such as changes in one of the international measures of the risk-free rate, or in case of a major commodity exporter, fluctuations in the USD exchange rate against other major international currencies. To this end, we include changes in 3-month T-Bill rates, and changes in exchange rates between the USD and the British Pound, the Japanese Yen, the Swiss Franc, and the Euro.¹⁵ These series are all available from the Federal Reserve Bank of St. Louis FRED II data bank.

In the next step, we test whether augmenting the model with the factors discussed above affects these results on asset pricing efficiency and capital market integration obtained with the simple international CAPM; exclusion of these factors can be a source of omitted variables bias. The factor model is given by:

$$r_t = \alpha + \beta r_t^W + \sum_{j=1}^J \delta_j F_{t,j} + \epsilon_t, \quad (2)$$

where the factors $F_{t,j}$ are the log differences in the daily spot oil price, the squared log differences in the spot oil price, the squared world market excess returns, Hamilton (1996) net oil price increase or “NOPI”, changes in 3-month T-Bill rates, and changes in exchange rates between the USD and British Pound, Japanese Yen, Swiss Franc, and the Euro.¹⁶

As it turns out, none of these factors help in improving the performance of the international CAPM model. In general, either their impact is not statistically significant, or their inclusion in the model is not supported based on a combination of likelihood-ratio tests, the Akaike information criteria, and the Bayesian information criteria. To save space, we do not report these results. However, they are available upon request.

¹⁵In case of the Euro, we had to trim the data set since the Euro/USD exchange rate is available only since January 1999.

¹⁶We used West Texas Intermediate spot oil prices from the US Department of Energy’s database as our oil price measure. We acknowledge the criticisms raised by Kilian (2008) about using net oil price changes as a predicting factor for both macroeconomic and financial models.

5 Constant-Parameter Intertemporal CAPM

Merton (1973) extended the static CAPM of Sharpe (1964) and Lintner (1965) to an intertemporal framework which allows for a changing set of investment opportunities. In his intertemporal CAPM (ICAPM) specification, the expected conditional excess return for market i should vary positively with its conditional variance:

$$\mathbb{E}_{t-1}[r_t^i] = \mu + \lambda \text{Var}_{t-1}[r_t^i], \quad (3)$$

where the parameter λ is the coefficient of relative risk aversion of the representative agent.¹⁷ λ is also referred to as the risk premium associated with market risk. If the intertemporal CAPM holds, then $\mu = 0$.

To investigate whether there is a risk-return trade-off of the intertemporal CAPM form in TSE, we fit two specifications of GARCH-in-Mean models to the excess returns series.¹⁸ In this case, the conditional mean for the excess returns in market is given by:

$$r_t = \mu + \lambda h_{t-1} + \varepsilon_t, \quad (4)$$

where $\varepsilon_t = \sqrt{h_t} e_t$, $e_t \sim N(0, 1)$, and h_t is the conditional variance of r_t . The workhorse model in this literature is the GARCH-in-Mean (GARCH-M) which postulates that the volatility process follows the GARCH dynamics of Bollerslev (1986). In Bollerslev (1986) GARCH(1,1) formulation for conditional volatility, h_t follows:

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (5)$$

We refer to equations (4), and (5) jointly as an GARCH-M model.

Bekaert and Harvey (1997) emphasize that equity returns in emerging markets exhibit substantial asymmetry in volatility, possibly due to a leverage effect in which firms' leverage increases with negative returns. Accordingly, we use the Exponential GARCH (EGARCH) model of Nelson (1991) to allow for such asymmetry.

$$\ln(h_t) = \omega + \alpha g(z_{t-1}) + \beta \ln(h_{t-1}) \quad (6)$$

$$g(z_t) = \theta z_t + \delta [|z_t| - \mathbb{E}|z_t|], \quad (7)$$

¹⁷This conditional single-factor formulation follows under the assumption that the variance of the change in wealth is much larger than the variance of the change in the state variable with which wealth varies; see Merton (1980).

¹⁸Sinaee and Moradi (2010) also study the risk-return trade-off in TSE returns. However, their methodology does not follow the mainstream analysis.

where $z_t = \varepsilon_t/\sqrt{h_t}$ and $\delta = 1$. We refer to equations (4), (6), and (7) jointly as an EGARCH-M model.

Estimation results for fitting TEPIX excess returns using GARCH-M and EGARCH-M formulations are reported in Table 3. As shown in Panel A, simple GARCH-M does not fit the data well, regardless of whether we use monthly or daily sampled data. This formulation characterizes the volatility dynamics of the returns well. However, estimated values for λ are problematic. At daily frequency, this parameter is statistically significant. But the estimated λ s at both daily and monthly frequencies are negative, which implies a negative correlation between risk and returns. Moreover, the estimated intercept parameters, μ , which theoretically should be zero, are statistically significant at conventional confidence levels.

On the other hand, as is seen in Panel B, the estimated EGARCH parameters, $\hat{\omega}$, $\hat{\alpha}$, $\hat{\beta}$, and $\hat{\theta}$, are generally significantly different from zero at conventional confidence levels. The statistically significant estimates of θ suggest asymmetry in the impact of “bad” vs. “good” news in TEPIX excess returns. This so-called “leverage effect” is negative for daily and positive for monthly excess TEPIX excess returns.

EGARCH estimation at monthly level delivers $\hat{\lambda}$ that is statistically significant and positive. Moreover, estimated intercept parameter μ is statistically indistinguishable from zero. Thus, at monthly frequency, EGARCH-M fitting of TEPIX excess returns delivers intertemporal CAPM efficiency. Intertemporal CAPM efficiency is lost with EGARCH-M model once we increase the sampling frequency to daily. Using daily excess returns, while estimated λ is statistically significant at 1% level, it has a negative sign. This implies that investors are willing to accept more risk for lower returns, which is counterintuitive. The bulk of risk-return trade-off literature uses monthly, not daily, excess returns for empirical investigation of intertemporal CAPM efficiency, as portfolio rebalancing generally happens at monthly frequency; as an example see Ghysels et al. (2005). Thus, we consider our monthly EGARCH-M results more interesting and encouraging.

Several new findings in the literature suggest that variations of GARCH-M models with symmetrically distributed innovations may not be the best way to model the risk-return trade-off. In particular, results of Rossi and Timmermann (2009) and Feunou et al. (2010) imply that there exists strong evidence of higher moments asymmetry in returns, which leads to mixed empirical results like those reported here.

6 Markov-Switching Intertemporal CAPM

International finance theory includes an active line of research studying market integration versus segmentation. Some examples related to our study include Bekaert and Harvey (1995), Harvey (1995), Bekaert and Harvey (1997), and more recently Bekaert et al. (2008). The thrust of this line of research is the study of country-specific versus global pricing of risk premia. As noted by Bekaert and Harvey (1995), empirical evidence suggests that expected returns of assets with the same level of exposure to risk factors are influenced by their “nationality.” Such results are consistent with incomplete equity market integration. Cheng et al. (2010) apply this methodology to Middle Eastern and North African financial markets. We follow their methodology in our study of integration vs. segmentation for TSE returns.

Bekaert and Harvey (1995) propose a conditional regime-switching model which generalizes the Sharpe (1964), Lintner (1965), and Merton (1973) asset pricing models to allow for time-varying weights on local and global pricing of an asset. We use this framework to study the extent to which the TSE degree of integration with world capital markets changes across time.

Let S_t be a latent state variable for a market which can take on two values, with $S_t = 1$ denoting that market is integrated with international equity markets in observation t and $S_t = 2$ denoting it is segmented. Define:

$$\phi_{t-1} = \text{Prob}(S_t = 1 | \mathcal{F}_{t-1}), \quad (8)$$

where \mathcal{F}_{t-1} is the observation $t - 1$ information set. As before, let r_t and r_t^W be, respectively, the excess return for the target market and the world market. Bekaert and Harvey (1995) model r_t as:

$$r_t = \phi_{t-1} \lambda^W \text{Cov}_{t-1}[r_t, r_t^W] + (1 - \phi_{t-1}) \lambda \text{Var}_{t-1}[r_t] + \varepsilon_t, \quad (9)$$

where λ^W and λ are the risk premia associated with world market systematic risk and country-specific idiosyncratic risk.¹⁹ While the above framework allows the probability of integration, ϕ_{t-1} , to vary across time, we assume that the transition probabilities $p_{1,1} = \text{Prob}(S_t = 1 | S_{t-1} = 1)$ and $p_{2,2} = \text{Prob}(S_t = 2 | S_{t-1} = 2)$ are constant. We study constant risk premia λ^W and λ :

$$\lambda^W = \exp(c_1) \quad (10)$$

$$\lambda = \exp(c_2). \quad (11)$$

¹⁹Following Bekaert and Harvey (1995), we do not include an intercept term in equation (9).

Through use of the exponential function in (10)-(11), we constrain each risk premium to be positive.

We estimate the model by maximum likelihood. Estimation is carried out in two stages. First, we compute $\text{Var}_{t-1}[r_t]$ and $\text{Cov}_{t-1}[r_t, r_t^W]$ using a rolling window estimation scheme.²⁰ Second, we form the likelihood function according to the model in equation (9) and maximize it. To avoid local optima, we perturb our starting values and re-estimate the model 50 times for each excess returns series.²¹

We are interested in the behavior over time of the estimated probabilities of integration, i.e., ϕ_{t-1} for the TSE. High values of these probabilities show that pricing of assets in the TSE is done primarily with respect to the covariance of TSE returns with the world market excess return (integration), and low probabilities imply mostly local pricing of risk (segmentation). Figure 2 shows the behavior of monthly estimated values of ϕ_t . As is seen, at monthly frequency, TSE is generally integrated with the world market (MSCI World Index). There are two episodes of dramatic departure from this behavior. The first episode roughly corresponds with the start of the Operation Iraqi Freedom. The second episode starts in June 2008, which may be interpreted as pricing on local information due to increased uncertainty about the global financial sector, leading to the deepening of the Great Recession of 2007-2009.

Estimation results for both monthly and daily frequencies are reported in Table 4. The top panel reports the descriptive statistics for filtered probabilities of international pricing, $\hat{\phi}_t$. Regardless of the frequency used, these summary statistics indicate a significant level of integration for the TSE. Using daily data, there is approximately 50% probability of integration. Once we reduce the sampling frequency to monthly, the level of estimated average integration increases to over 55%. Meanwhile, the median for estimated ϕ_t at monthly frequency is greater than 63%. These results are important once they are compared and contrasted with the results reported by Cheng et al. (2010) for several neighboring markets. Our estimated results show

²⁰We fix a sub-sample period of m days for calculating the variance of r_t and the covariance between r_t and r_t^W , and roll the sample one day forward to compute for the next pair of statistics. In order to find a sensible value for m , we look at the estimated partial autocorrelation function of the squared excess returns and include all the lags that have a significant impact on the current level.

²¹We also estimated the model with time-varying risk premia, where $\lambda_{t-1}^W = \exp(\psi_W' Z_{t-1}^W)$ and $\lambda_{t-1} = \exp(\psi' Z_{t-1})$. We used a set of global and local instrumental variables, similar to those used by Bekaert and Harvey (1995), as components of Z_t^W and Z_t , respectively. We found that including Z_t^W and Z_t does not improve the estimation results significantly. As a result, we only discuss the results obtained through estimation of the constant risk premia model.

that the Iranian stock market behaves more like markets in Bahrain, Israel, and Turkey. The estimated values of ϕ_t for the TSE are significantly larger than what is observed for Kuwait, Oman, or Saudi Arabia. We interpret these findings, along with the visual evidence presented in Figure 2, to imply a significant level of integration between TEPIX excess returns and MSCI World excess returns.

Transition probabilities are reported in the middle panel of Table 4. We find that using monthly excess returns, both states are significant and persistent. On the other hand, daily returns, while both estimated transition probabilities are statistically significant, $p_{22}^{\hat{}}$ is far less persistent.

Estimated values for risk premia are reported in the bottom panel of Table 4. Notice that following Bekaert and Harvey (1995), we restrict the value of the risk premium to be positive. That said, while statistically not significant, the magnitude of estimated values for risk premia using daily and monthly returns are comparable to those in neighboring countries, reported by Cheng et al. (2010). The risk premium associated with the world market systemic risk is statistically insignificant, but the estimated value of this parameter is very similar to those reported in Cheng et al. for Bahrain and Kuwait. Similarly, estimated value for local risk premium, $\hat{\lambda}$, is close to those reported by Cheng et al. for Bahrain, Jordan, and Morocco.

Estimation of the market price of risk is empirically difficult, as discussed in Section 5. Thus, finding very large standard errors for estimated values of λ^W and λ is not surprising. As such, this result does not automatically imply a spurious relationship between TSE and MSCI World excess returns. Figure 3 depicts the estimated conditional covariance between TEPIX and MSCI World excess returns. We believe that the pattern and the size of estimated conditional covariances reported in this figure provide evidence against a spurious relationship between TEPIX and MSCI World index returns. Based on the evidence presented here, we conclude that the TSE is more integrated in the international financial system than the political isolation of the country would lead one to believe.

7 Event Studies for TSE

Next, we study the impact of events on the excess returns. This line of research is an empirical test of the “efficient market hypothesis” (EMH) of Fama (1965). Specifically, if strong or semi-strong forms of EMH hold, then a news announcement should not have an impact on excess returns of a firm. If they do, such impact may be viewed as evidence against EMH. The

standard procedure is to break down the sample into pre-event, event, and post-event periods, and analyze excess returns across the first two periods.²²

A typical application of this method is concerned with market related news announcements, such as mergers and acquisitions, macroeconomic announcements, stock splits and buy-backs, or financial distress news, among many others. In our study, however, we consider the impact of economic and non-economic news on aggregate market index excess returns. We provide a description of these events in Section 7.1. Hakim and Rashidian (2009) conduct a study of the impact of U.S. government sanctions on the performance of TSE-listed stocks. We incorporate these sanction dates in our study. Their analysis, however, suffers from theoretical and empirical shortcomings documented by Doornik and Ooms (2008).

In the next step, we provide a brief description of events study methodology, based on the “market model”, discussed in MacKinlay (1997), among others. This method is based on the statistical analysis of residuals from regressing asset excess returns on market excess returns. We extend this method to the analysis of international markets, by treating the country-specific excess returns as an asset, and those of the world market proxy as market returns. Based on the results presented in Table 2 and discussed in Section 4, we use MSCI World index returns as the proxy for world market returns, r_t^W .

We then split the sample into three segments called estimation (pre-event), event, and post-event windows, respectively. Sample size is important, since each window needs to be large enough to allow for reliable estimation. Hence, we conduct our event studies analysis using daily data only. The alternative approach of using monthly data inevitably leads to windows with very few data points.²³

Our estimation window has 300 data points, or slightly more than one trading-year worth of data. This means that we use the 300 data points preceding the event window to establish the estimated parameters. We use an event window with 60 data points. That is, we choose an event window such that there are 29 trading days before and 30 trading days after the event date. This sample selection policy leads to roughly over two months of trading in this window. We then fit the following model using OLS and observations in the estimation window, and

²²For an excellent overview of this methodology, refer to MacKinlay (1997) and Campbell et al. (1997).

²³Results in Section 4 imply that there is a statistically significant correlation between TSE and MSCI World excess returns at the daily frequency. We base our analysis in this Section on the results reported in Table 2.

save the estimated parameters:

$$r_{i,t} = \alpha + \beta r_{i,t}^W + \epsilon_{i,t}, \quad (12)$$

where i corresponds to the estimation window and $\epsilon_{i,t} \sim (0, \sigma_{\epsilon_i}^2)$. We then form the out of sample disturbances of the market model using

$$AR_\tau = r_\tau - \hat{\alpha} - \hat{\beta} r_\tau^W, \quad (13)$$

where τ belongs to the event window. Variance of AR_τ is given in Eq. (9) in MacKinlay (1997). For the interval $[\tau_1, \tau_2]$ in the event window, following MacKinlay (1997), we define the cumulative abnormal returns as

$$CAR(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_\tau. \quad (14)$$

Similarly, variance of $CAR(\tau_1, \tau_2)$ is given by

$$\sigma_{CAR(\tau_1, \tau_2)}^2 = (\tau_2 - \tau_1 + 1)\sigma_{\epsilon_i}^2. \quad (15)$$

For a suitably chosen event window, under the null hypothesis of no abnormal returns, $CAR(\tau_1, \tau_2) \sim N(0, \sigma_{CAR(\tau_1, \tau_2)}^2)$. We set τ_1 and τ_2 to be the start and the end point of the event windows. Thus, the relevant test statistic is

$$\eta = \frac{CAR(\tau_1, \tau_2)}{\sqrt{\sigma_{CAR(\tau_1, \tau_2)}^2}}. \quad (16)$$

Under the null hypothesis of no abnormal returns, asymptotically $\eta \sim N(0, 1)$. We view the rejection of the null hypothesis as evidence in favor of the existence of abnormal returns due to the event studied.

7.1 Important Events

We now briefly discuss the important events considered for our analysis. We emphasize the fact that the list of events studied in this paper is not exhaustive. It is relatively easy to compile alternative lists including other events that we have not analyzed here. Table 5 reports these events. We include five events from Hakim and Rashidian (2009), the renewal of the Iran-Libya Act of 1996 on August 5, 2001, the U.S. Department of the Treasury's sanction against scientific exchanges with Iran on February 9, 2004, sanctions against Bank Saderat of Iran, September 8, 2006, and ratification of UN Security Council resolutions 1747 and 1803.

Attacks on the World Trade Center on September 11, 2001 had far-reaching political and economic effects across the world. We believe that the start dates of two wars in neighboring Afghanistan and Iraq, may have an impact on the Iranian economy and markets. Liberalization of IR exchange rate in March 2002 had profound effects on both TSE returns and on the Iranian economy in general. Election of president Ahmadinejad in June 2005 was as unexpected and controversial as was his re-election in June 2009. His populist and stridently fundamentalist views, at least initially, worried investors. He famously declared participation in equity markets as “gambling” and the stock market as “a tool of corruption”.²⁴ He then engaged in a very public battle against the then chairman of the TSE, and eventually forced him out of office before his term was over, using an executive order. We thus include both Mr. Ahmadinejad’s election and the inauguration of the new chairman of the TSE as important events.

The subject of Iran’s nuclear program is controversial and generates considerable political tension. In January 2006, the Iranian government ostentatiously broke the seals on the uranium enrichment centrifuges in the Natanz nuclear facility in central Iran. This facility was sealed by the IAEA as an outcome of negotiations regarding Iran’s nuclear program with the Khatami administration, leading to temporary suspension of uranium enrichment. President Ahmadinejad’s administration adopted a different and more adversarial strategy in negotiation with IAEA and western governments. Hence, we include the 2006 standoff between the Iranian government and IAEA as an interesting episode for gauging the sensitivity of the TSE to the international conduct of the Iranian government.

The last event that we study here is landslide victory of conservatives allied with president Ahmadinejad over their reformist rivals in the “Majlis” (Iranian parliament) elections in March 2008.

7.2 Impact of Events on TSE Excess Returns

As is seen in Table 6, the majority of events studied seem not to have induced abnormal, positive or negative, TSE returns. For the first four events in our study, we reject the null hypothesis of no abnormal returns. These events are the renewal of the Iran-Libya Act, the

²⁴Gambling is considered a sin in Islam. In a country with Shari’a-based penal code such as Iran, engaging in “sinful acts” may lead to imposition of legal penalties. Many investors interpreted these opinions as hostility towards the stock market on the part of the new administration.

See www.bbc.co.uk/persian/business/story/2007/06/070611ka-letter.shtml and www.bbc.co.uk/persian/business/story/2006/06/060615mfkaletter.shtml.

September 11 attacks on World Trade Center, the start of the war in Afghanistan, and the liberalization of foreign exchange rates.

It can be argued that including the 2002 liberalization of the USD/IR exchange rate may not qualify as an unexpected “event”, since the administration of president Khatami had clearly communicated the intention for implementation of this policy. On the other hand, previous administrations had also tried to implement similar policies and had then abandoned them in the face of criticism and pressure from state owned entities which made a handsome profit from receiving foreign currency at subsidized rates and then sold it in the black market. Thus, there was some uncertainty in the Iranian business circles about the credibility of the government and the ability to bear the presumed costs of exchange rate liberalization. Thus, we decided to include this event.

The election of president Ahmadinejad in 2005 was quite unexpected, and it induced significant negative abnormal returns. The very last event reported in Table 6 poses a particular problem. As is seen in Table 5, there is less than one trading week between passing of the UN Security Council Resolution No. 1803 and the landslide victory for conservatives in the Majlis elections. Our test results fail to reject the null of no abnormal returns for this period. But since the two events are very close, we can not distinguish which event has induced these abnormal returns. Since passing of UNSC Resolution 1747 a year earlier did not have an impact on TSE returns, it is tempting to argue that UNSC Resolution 1803 did not induce these abnormal returns. Thus one may attribute these returns to consolidation of power within the conservative circle in Iran, which ended over two years of political tension and induced some measure of certainty about the expectations and the direction of government policies in market participants. However, we advise caution in this case. We can not separate the impact of these events, and thus all we can say is that there is evidence of statistically significant abnormal returns associated with the March 2008 time period.²⁵

For the remaining cases, the start of Iraq war, scientific sanctions by the U.S. Department of the Treasury, appointment of a new chairperson for TSE, the standoff between the Iranian government and the IAEA over enrichment of Uranium at Natanz nuclear facility, sanction against Bank Saderat by the US Department of Treasury, UNSC Resolution 1747, and the fuel riots following rationing of gasoline in 2008, we fail to reject the null hypothesis of no abnormal

²⁵Cheng et al. (2010) use an alternative method to isolate events, based on Hinich and Serletis (2007). This method would not help in this case either, since it can not detect events less than the one “event window” apart. In both Cheng et al. (2010) and Hinich and Serletis (2007), these event windows are at least 35 days in length.

excess returns. It seems that either markets did not view these events as surprising, or already incorporated the signals leading to the event.

One important trend is immediately discernible. Since 2003, that is approximately five years into the time period of this study, we observe statistically significant abnormal returns with considerably lower frequency compared with the 1998-2002 period. One may interpret this observation as evidence for maturing of this market. In other words, one may view this trend as evidence that TSE market participants have mastered the skills required to incorporate non-market signals into their expectations, and hence pricing, more efficiently. In support of this view, we may add that the two events that induced abnormal returns in this period, election of president Ahmadinejad in 2005 and the combination of Resolution 1803 and parliamentary elections of 2008, contained truly unexpected political events. However, our results do not provide an irrefutable and definitive answer to this proposal. We view this issue as a good starting point for future research.

8 Conclusions

This study contributes to our understanding of the basic efficiency and volatility dynamics of the Tehran Stock Exchange excess returns. We find supporting evidence in favor of international CAPM efficiency at the monthly frequency. This characteristic is somewhat weakened once we increase the sampling frequency to daily. Empirically, we could not improve the performance of the ICAPM model through inclusion of factors such as exchange rates and oil price fluctuations or international macroeconomic factors, such as increased risk of an economic downturn reflected in term spreads. Our findings corroborate those of Foster and Kharazi (2008), and point to an interesting aspect of TSE. That is, a market dominated by presumably naive traders can still be efficient, in a classical textbook sense. The TSE is an efficient market, even in the presence of insider trading, collusion, price fixing, and considerable informational asymmetry.²⁶

The issue of suitable measures of risk-return trade-off, or volatility spillover in TSE excess returns, remains an open question. We study the risk-return trade-off in TSE returns using GARCH-in-Mean models. These results are mixed. At monthly frequency, EGARCH-in-Mean model delivers a positive and statistically significant market price of risk. This finding is encouraging, particularly since Bekaert and Harvey (1997) emphasize the use of volatility

²⁶Daragahi (2004) provides an overview from a practitioner's point of view.

measures that allow for the leverage effect, such as EGARCH. However, this result is not robust to sampling frequency. In the light of recent developments in modeling downside volatility and the shape of the risk-return relationship, our findings are not surprising and indicate scope for further research. TSE excess returns data seem to support significant international integration of this market. Our empirical findings here both corroborate ICAPM results and are also in line with the literature on the pricing of risk in the MENA region.

Our event study shows that the impact of non-market events, such as sanctions, terrorism, war, or drastic changes in economic policy or leadership, on the Tehran stock exchange returns has weakened over time. This observation requires further investigation, since our methodology can not provide a definitive answer on whether this weakening of the impact of events is a sign for growing maturity of this market or a figment of the data. We leave this important issue for future research. By construction, our sample does not include data for the recent bull market in the Tehran stock exchange in the spring and summer of 2010. We leave the study of these developments as data become available.

References

- Adler, M., Dumas, B., 1983. International Portfolio Choice and Corporation Finance: A Synthesis. *Journal of Finance* 38, 925–984.
- Alsubaie, A., Najand, M., 2009. Abnormal trading volume and autoregressive behavior in weekly stock returns in the Saudi stock market. *Emerging Markets Review* 10 (3), 207–225.
- Bekaert, G., Harvey, C. R., 1995. Time-Varying World Market Integration. *Journal of Finance* 50 (2), 403–444.
- Bekaert, G., Harvey, C. R., 1997. Emerging Equity Market Volatility. *Journal of Financial Economics* 43, 29–77.
- Bekaert, G., Harvey, C. R., 2003. Emerging markets finance. *Journal of Empirical Finance* 10, 3–55.
- Bekaert, G., Harvey, C. R., Lundblad, C. T., Siegel, S., 2008. What Segments Equity Markets? Working Paper, Columbia Business School.
- Billmeier, A., Massa, I., 2008. Go long or short in pyramids? News from the Egyptian stock market. *International Review of Financial Analysis* 17, 949–970.
- Billmeier, A., Massa, I., 2009. What drives stock market development in emerging markets - institutions, remittances, or natural resources? *Emerging Markets Review* 10 (1), 23–35.
- Bollerslev, T., 1986. Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics* 31, 307–327.
- Campbell, J. Y., Lo, A. W., MacKinlay, A. C., 1997. *The Econometrics of Financial Markets*. Princeton University Press, Princeton, N.J.
- Chen, N.-f., Roll, R., Ross, S., 1986. Economic Forces and the Stock Market. *Journal of Business* 59, 383–403.
- Cheng, A.-R., Jahan-Parvar, M. R., Rothman, P., 2010. An Empirical Investigation of Stock Market Behavior in the Middle East and North Africa. *Journal of Empirical Finance* 17 (3), 413–427.

- Daragahi, B., August 20 2004. Rewards have risks on the Tehran Stock Exchange. *New York Times Business*.
- Doornik, J. A., Ooms, M., 2008. Multimodality in GARCH regression models. *International Journal of Forecasting* 24 (3), 432–448.
- Errunza, V., 2001. Foreign portfolio equity investments, financial liberalization, and economic development. *Review of International Economics* 9, 703–726.
- Fama, E. F., 1965. The Behavior of Stock-Market Prices. *Journal of Business* 38 (1), 34–105.
- Fama, E. F., French, K. R., 1996. Multifactor Explanations of Asset Pricing Anomalies. *Journal of Finance* 51, 55–84.
- Fan, Q., Jahan-Parvar, M. R., 2010. U.S. Industry-Level Returns and Oil Prices. Working Paper, East Carolina University.
- Feunou, B., Jahan-Parvar, M. R., Tédongap, R., 2010. Modeling Market Downside Volatility. Working Paper, Duke University and Stockholm School of Economics.
- Foster, K. R., Kharazi, A., 2008. Contrarian and momentum returns on Iran's Tehran Stock Exchange. *Journal of International Financial Markets, Institutions and Money* 18, 16–30.
- Ghysels, E., Cherkaoui, M., 2003. Emerging markets and trading costs: Lessons from Casablanca. *Journal of Empirical Finance* 10, 169–198.
- Ghysels, E., Santa-Clara, P., Valkanov, R., 2005. There is a Risk-Return Trade-Off After All. *Journal of Financial Economics* 76, 509–548.
- Hakim, S. R., Rashidian, M., 2009. Properties, Linkages, and the Impact of Sanctions on the Tehran Stock Exchange. Working Paper, Pepperdine University and the University of Southern California.
- Hamilton, J. D., 1996. This Is What Happened to the Oil Price/Macroeconomy Relation. *Journal of Monetary Economics* 38 (2), 215–220.
- Harvey, C. R., 1995. Predictable Risk and Returns in Emerging Markets. *Review of Financial Studies* 8, 773–816.

- Hinich, M. J., Serletis, A., 2007. Episodic Nonlinear Event Detection in the Canadian Exchange Rate. *Journal of the American Statistical Association* 102 (477), 68–74.
- Hong, H., Stein, J., 1996. A unified theory of underreaction, momentum trading and overreaction in asset markets. *Journal of Finance* 54, 2143–2148.
- Hong, H., Torous, W., Valkanov, R., 2007. Do industries lead stock markets? *Journal of Financial Economics* 83, 367–396.
- Jahan-Parvar, M. R., Waters, G. A., 2010. Equity price bubbles in the Middle East and North African financial markets. *Emerging Markets Review* 11 (1), 39–48.
- Kilian, L., 2008. Exogenous oil supply shocks: How big are they and how much do they matter for the U.S. economy? *Review of Economics and Statistics* 90 (2), 216 – 240.
- Lagoarde-Segot, T., Lucey, B. M., 2008. Efficiency in emerging markets – Evidence from the MENA region. *Journal of International Financial Markets, Institutions and Money* 18, 94–105.
- Lintner, J., 1965. The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *Review of Economics and Statistics* 47, 13–37.
- Maasoumi, E., Racine, J., 2002. Entropy and predictability of stock market returns. *Journal of Econometrics* 107, 291–312.
- MacKinlay, A. C., 1997. Event Studies in Economics and Finance. *Journal of Economic Literature* 35 (1), 13–39.
- Merton, R. C., 1973. An Intertemporal Capital Asset Pricing Model. *Econometrica* 41, 867–887.
- Merton, R. C., 1980. On Estimating the Expected Return on the Market: An Explanatory Investigation. *Journal of Financial Economics* 8, 323–361.
- Nelson, D. B., 1991. Conditional Heteroskedasticity in Asset Returns: A New Approach. *Econometrica* 59, 347–370.
- Newey, W. K., West, K. D., 1987. A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica* 55, 703–708.

Rossi, A., Timmermann, A., 2009. What is the Shape of Risk-Return Relation? Working Paper, UCSD.

Sharpe, W. F., 1964. Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *Journal of Finance* 19, 425–442.

Sinaee, H., Moradi, H., 2010. Risk-return relationship in Iran stock market. *International Research Journal of Finance and Economics* 41, 432–448.

Table 1: **Descriptive Statistics of the Data**

	MSCI World	TEPIX
Mean	-2.41	10.66
Std. Dev.	18.30	18.13
Skewness	-1.63	1.51
Kurtosis	5.66	9.62

This table reports summary statistics of excess returns. Calculation of the returns is based on subtracting the monthly 3-month U.S. Treasury Bill rate from the log difference of market index. Mean excess returns and standard deviations are reported as annualized percentages. Excess kurtosis values are reported. The sample period spans March 1998 to May 2009.

Table 2: **Estimated Parameters of Static International CAPM**

Parameter	Monthly	Daily
α	1.0054 (0.6148)	0.0921* (0.0327)
β	0.1960‡ (0.1140)	0.0432† (0.0250)

Newey-West HAC consistent standard errors appear in parentheses. *, †, and ‡ denote rejection of the null hypothesis that the parameter equals zero at the 1%, 5%, and 10% significance levels, respectively. The estimated parameters were obtained by applying OLS to $r_t = \alpha + \beta r_t^W + \varepsilon_t$, and ε_t is assumed to be a white noise innovation process. r_t denotes excess returns of the TEPIX index and r_t^W denotes excess returns of the MSCI World index.

Table 3: **Estimated Parameters of Constant Parameter Intertemporal CAPM (GARCH-in-Mean)**

GARCH-M								
	μ	λ	ω	α	β	AIC	SBC	
Monthly	1.827* (0.554)	-0.023 (0.031)	4.072‡ (2.393)	0.494* (0.125)	0.394‡ (0.157)	736.515	750.657	
Daily	0.164* (0.030)	-0.091‡ (0.052)	0.003* (0.001)	0.040* (0.003)	0.957* (0.003)	3223.028	3249.560	
EGARCH-M								
	μ	λ	ω	α	β	θ	AIC	SBC
Monthly	0.265 (0.723)	0.055‡ (0.030)	2.399* (0.783)	0.992* (0.246)	0.218 (0.245)	0.202 (0.148)	747.845	764.815
Daily	0.187* (0.024)	-0.120* (0.042)	0.015* (0.003)	0.115* (0.015)	0.994* (0.003)	-0.103‡ (0.046)	3186.518	3218.357

This table presents maximum likelihood estimation results for TSE returns. Standard errors appear in parentheses. *, †, and ‡ denote rejection of the null hypothesis that the parameter equals zero at the 1%, 5%, and 10% significance levels, respectively. In each case, the conditional mean equation is given by $r_t = \mu + \lambda h_{t-1} + \epsilon_t$, where r_t is the excess returns, h_t is the conditional variance of the market excess returns, and $\epsilon_t \sim N(0, 1)$. Volatility dynamics follow Bollerslev (1986) for GARCH-M, and Nelson (1991) for EGARCH-M.

Table 4: **Estimated Parameters for Markov Switching CAPM**

	Daily	Monthly
Sample Statistics for $\hat{\phi}$		
Mean	0.4984	0.5607
Median	0.4998	0.6393
Standard Deviation	0.0128	0.1927
Transition Probabilities		
\hat{p}_{11}	0.7142* (0.0416)	0.9834* (0.0064)
\hat{p}_{22}	0.3785* (0.0112)	0.9736* (0.0495)
Risk Premia		
$\hat{\lambda}^W$	1.7960 (1.752)	2.329 (2.513)
$\hat{\lambda}$	1.7632 (4.301)	2.041 (2.432)

This table presents parameters from maximum likelihood estimation of $r_t = \phi_{t-1}\lambda^W Cov_{t-1}[r_t^W, r_t] + (1 - \phi_{t-1})\lambda Var_{t-1}[r_t] + \varepsilon_t$. In this equation, r_t^W and r_t represent world market excess returns and TSE excess returns, respectively. We use TEPIX and MSCI World index excess returns. The proxy for risk free rate is the U.S. 3-month T-Bill rate. λ^W and λ are risk premia associated with the world market and the domestic market respectively. $\phi_t = Prob(S_t = 1|\mathcal{F}_{t-1})$, $p_{11} = Prob(S_t = 1|S_{t-1} = 1)$, and $p_{22} = Prob(S_t = 2|S_{t-1} = 2)$. Standard errors appear in parentheses. *, †, and ‡ represent statistical significance at 1, 5, and 10% levels, respectively.

Table 5: **Important Events**

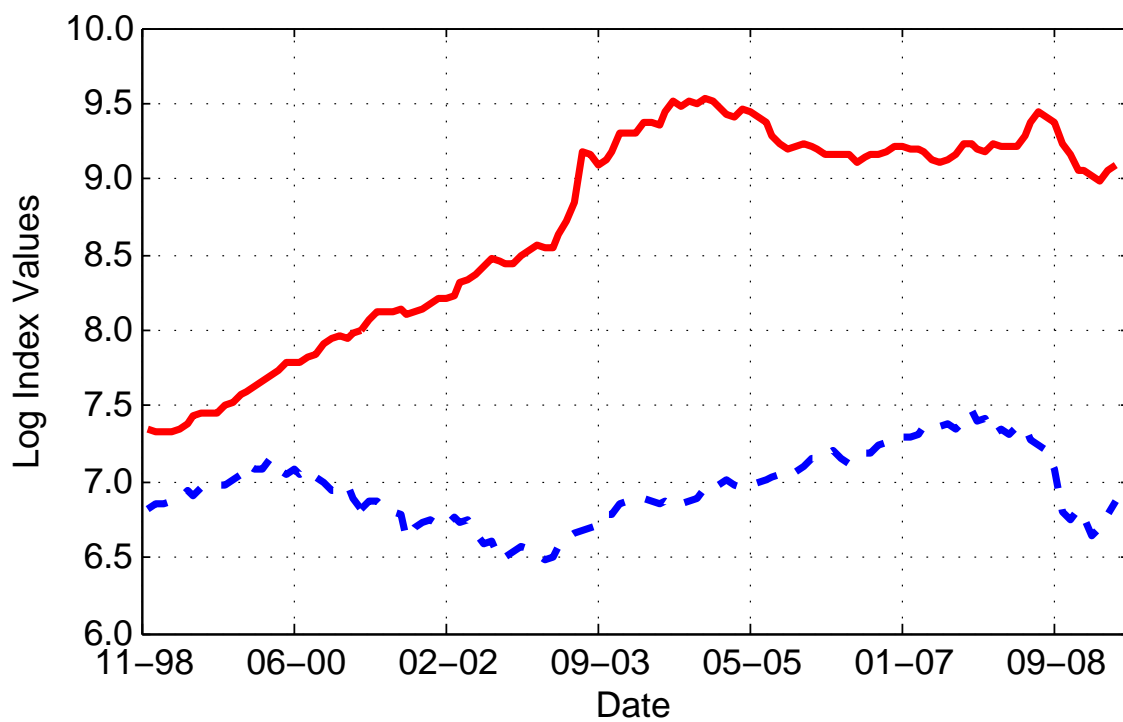
Event	Date
Iran-Lybia Act Renewal	08/05/2001
Terrorists attack WTC.	09/11/2001
Coalition operations begin in Afghanistan.	10/07/2001
Foreign exchnage rate liberalized.	03/18/2002
Operation “Iraqi Freedom” starts.	03/20/2003
Sanctions on scientific exchange with Iran	02/09/2004
Ahmadinejad elected as president.	06/17/2005
New chairperson of TSE appointed.	11/21/2005
Iran breaks IAEA seals at Natanz nuclear facility.	01/08/2006
Sanctions against Bank Saderat Iran	09/08/2006
UN Security Council Resolution 1747	03/24/2007
Street protests for rationing of fuel	06/15/2007
UN Security Council Resolution 1803	03/08/2008
Conservatives win 2/3 of the Iranian Parliment	03/14/2008

Table 6: **Event Study Results**

Event	CAR_{τ_2, τ_1}	$\sigma_{CAR_{\tau_2, \tau_1}}^2$	η
Iran-Lybia Act Renewal	9.9834	0.1938	22.6779*
September 11, 2001	-11.0091	3.7296	-5.7006*
War in Afghanistan	-8.3653	9.2976	-2.7434*
FX Liberalization	-144.6797	14.0244	-38.6336*
Iraq War	14.6418	102.4152	1.4468
Scientific sanctions	-5.7903	59.8224	-0.7486
2005 Presidential Election	-29.9482	73.2210	-3.4999*
New chairperson for TSE	-9.2549	40.1724	-1.4602
IAEA satndoff	-9.0255	38.7984	-1.4490
Bank Saderat sanction	6.9714	33.7044	1.2008
Resolution 1747	-0.5116	23.9898	-0.1045
Fuel riots	-0.6675	24.2460	-0.1356
Resolution 1803 and 2008 Election	13.0054	24.6690	2.6185*

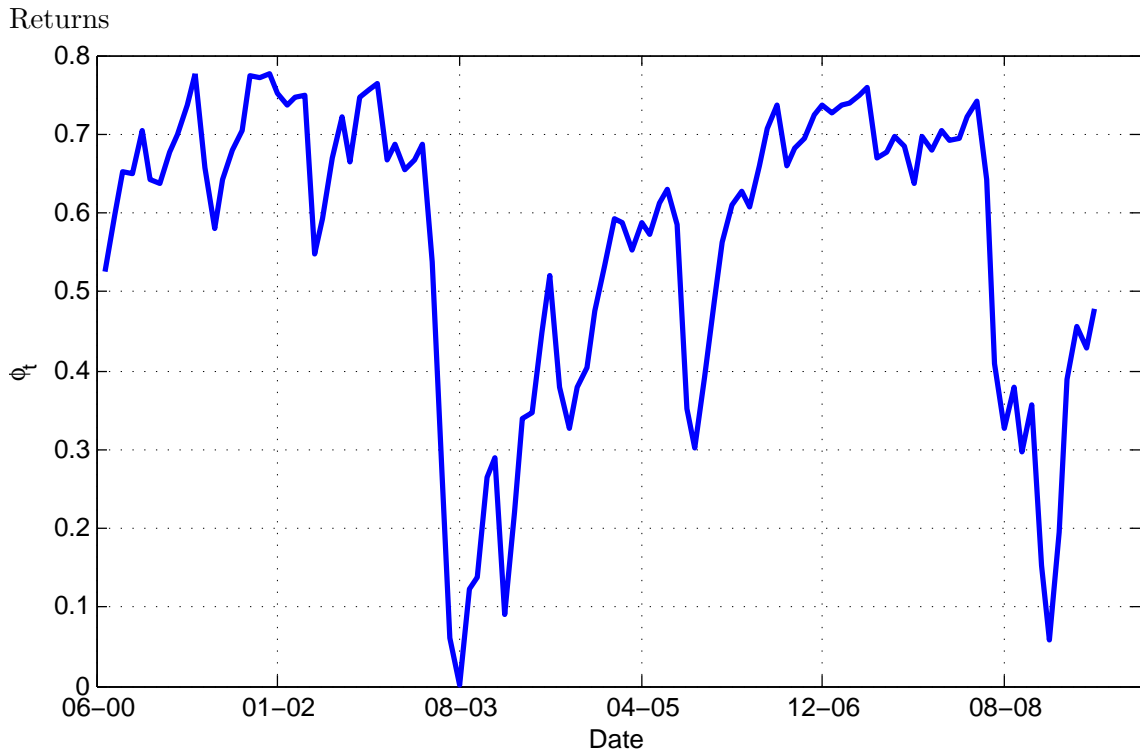
This table contains the estimation results for event studies conducted on TSE returns. The methodology follows MacKinlay (1997). Excess returns of TEPIX price index are examined. CAR_{τ_2, τ_1} denotes the cumulative sum of abnormal returns between the beginning and the end of the event window, a total of sixty observations. $\sigma_{CAR_{\tau_2, \tau_1}}^2$ denotes the variance of the abnormal returns in the event window. The test statistic $\eta = CAR_{\tau_2, \tau_1} / \sigma_{CAR_{\tau_2, \tau_1}}$, has a standard normal distribution under the null hypothesis of no abnormal returns. * represents the two-sided rejection of the null hypothesis of no abnormal returns at 5% confidence level or better.

Figure 1: Logarithmic Values of the World Market and the Tehran Stock Exchange Indices



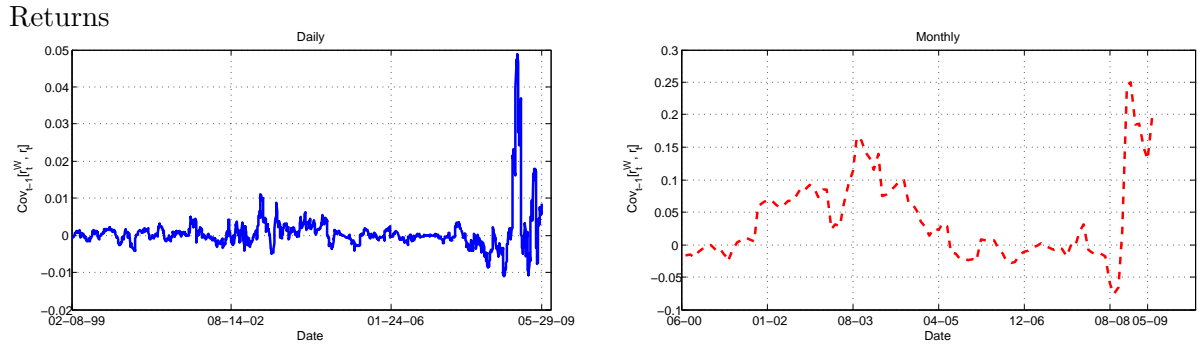
This figure depicts the log values of the MSCI World Index (dashed line) and TEPIX index (solid line) for November 1998 to May 2009 period. Source: MSCI and the Central Bank of Iran.

Figure 2: Filtered Probabilities of International Integration, ϕ_t , for Monthly TSE Excess



This figure plots the filtered probabilities of integration of TSE excess returns between June 2000 to May 2009. We estimate $\phi_{t-1} = \text{Prob}(S_t = 1 | \mathcal{F}_{t-1})$, where $S_t = 1$ denotes full integration, using maximum likelihood methods. These filtered probabilities are based on Eq. (9).

Figure 3: Daily and Monthly Conditional Covariances of TEPIX and MSCI World Index Excess Returns



This figure plots the values for rolling window estimates of conditional covariances between TEPIX and MSCI World excess returns. We use U.S. 3-month T-Bill rate as the proxy for risk free rate. Estimation window size is based on the ACF for the series. We fix the window length at 18 days for daily data, and use a 12-month rolling window for monthly data. Source: MSCI and the Central Bank of Iran.