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Response of Stock Markets to Monetary Policy: An Asian Stock Market Perspective

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Abstract

We estimate the response of Asian stock market prices to exogenous monetary policy shocks using a vector error correction model. In our paper, monetary policy transmits to stock market price through three routes: money by itself, exchange rate, and inflation. Our result points to the fact that stock prices increase persistently in response to an exogenous easing monetary policy. Variance deposition results show that, after 10 periods, the forecast error variance of beyond 53% of the Tehran Stock Exchange Price Index (TEPIX) can be explained by exogenous shocks to the US dollar–Iranian rial exchange rate, while this ratio for exogenous shocks to Iranian real gross domestic product was only 17%. We argue that such evidence can be accounted for by an endogenous response of the stock prices to the monetary policy shocks.

JEL Classification: E44, G10, G12

Contents

1. INTRODUCTION

Globally, the concern about interaction between monetary policy and asset price volatility has been increasing since the collapse of major stock market bubbles in 2000 and 2007. Is monetary policy responsible for stock market bubbles? Should monetary policy actively seek to stabilize the stock market? These classic questions have been put back on the table through experiences gained over the past two decades.

Among Asian countries, we are motivated to answer the above questions using Iran as an example because of the historical record of stock market price increases and monetary easing policies in the country. In Iran, the Tehran Stock Exchange Price Index (TEPIX) during the last 16 years has experienced skyrocketing records. While the index was 1,636 on 10 January 1998, within 15 years it reached a record high of 88,190 on 25 December 2013, an increase of almost 54 times. Simultaneously, the Central Bank of Iran has performed a highly expansionary monetary policy in recent years. One of the most recent easy monetary policy periods was in the first round of Iranian subsidy reforms, the plan passed by the Iranian Parliament on 5 January 2010. The subsidy plan was described as the "biggest surgery" to the nation's economy in half a century and "one of the most important undertakings in Iran's recent economic history." According to this plan, subsidies on food and energy (80% of the total subsidy) were replaced by targeted social assistance, in the form of cash handouts to the nation in the first phase.

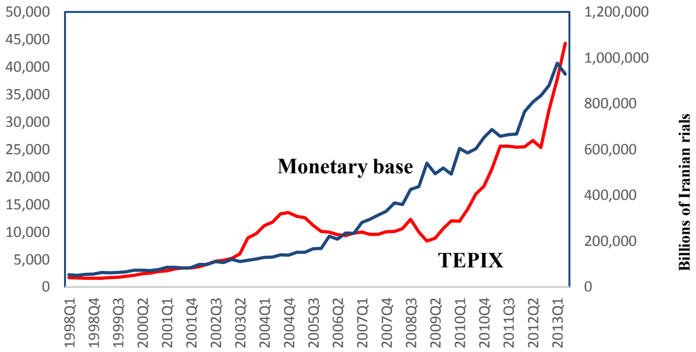
This huge amount of cash subsidies created a tremendous amount of excessive micro-capital in the whole economy, of which households invested some portions in the capital market. We believe that this was one of the reasons for the recent skyrocketing price records in the Tehran stock market.

As shown in Figure 1, the Iranian monetary base was raised from about IRR52,000 billion in Q1 1998 to beyond IRR 927,000 billion in Q2 2013, an increase of almost 18 times. In the same period, the TEPIX quarterly average level increased from 1,645 to beyond 44,000. Figure 2 shows the co-movements of the Iranian consumer price index (CPI) and the TEPIX during Q1 1998–Q4 2013. As can be seen, the CPI (2010=100) was elevated from about 17 in Q1 1998 to beyond 230 in Q4 2013.

The purpose of this research is to examine the response of stock market prices to monetary policies using the example of the Tehran stock market. In addition, we investigate the decomposition of how this boom in the Tehran stock market can be explained by economic growth, monetary factors, and inflationary expectations. In this paper, we propose a new approach to measure the relationship between monetary policy and stock market prices. Earlier studies have looked at one or two channels for the transmission of monetary policy to stock prices (see Flannery and Protopapadakis 2002; Boyd, Hu, and Jagannathan 2005; Bernanke and Kuttner 2005; Basistha and Kurov 2008; Bhamra, Kuehn, and Strebulaev 2010; Gilbert 2011; Rangel 2011; and Hassanzadeh and Kianvand 2012).

In this paper, we examine through empirical analysis three channels of transmission of exogenous monetary policy shocks to the stock market, including money by itself, the exchange rate, and the inflation rate. The importance of each of these exogenous shocks on the Tehran Stock Exchange during the period Q1 1998–Q2 2013 and the main channel will be defined.

Figure 1: TEPIX and Iranian Monetary Base
Q1 1998–Q2 2013

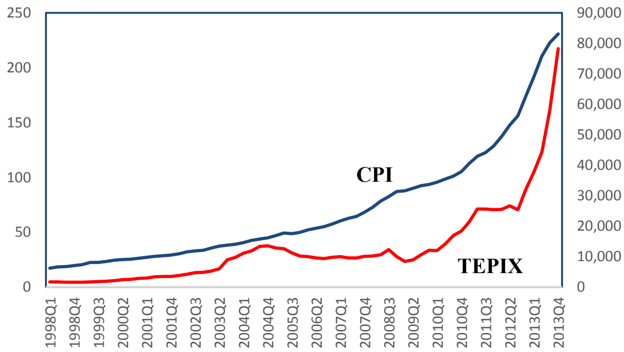


TEPIX = Tehran Stock Exchange Price Index.

Note: Scale on the left is for the TEPIX, and scale on the right is for the Iranian monetary base.

Sources: Tehran Stock Exchange for TEPIX; Central Bank of Iran for Iranian monetary base.

Figure 2: TEPIX and Iranian CPI (2010=100)
Q1 1998–Q4 2013



CPI = consumer price index, TEPIX = Tehran Stock Exchange Price Index.

Note: Scale on the left is for the CPI, and scale on the right is for the TEPIX.

Sources: Tehran Stock Exchange for TEPIX; International Monetary Fund International Financial Statistics for Iranian CPI.

This paper is structured as follows: in the second section, we conduct a comparative review with other countries. The third section presents the theoretical background and the model development. The fourth section presents the data analysis. The fifth section shows the empirical work including the vector error correction model (VECM) and variance decomposition analysis. The sixth section contains the conclusion and policy implication.

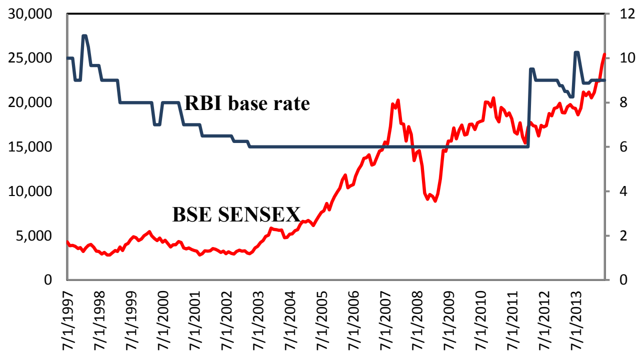
2. COMPARATIVE REVIEW WITH OTHER ASIAN STOCK MARKETS

In this section, in order to conduct a comparative review between the impacts of monetary policy on the Tehran Stock Exchange and that of other countries, we shed light on monetary policy variables in four other Asian countries, i.e. India, the Republic of Korea, Indonesia, and Singapore, and the stock market conditions in the respective countries.

Figure 3 displays the Bombay Stock Exchange Index (BSE SENSEX) and the base rate movement of the Reserve Bank of India (RBI). Monetary policy does not seem to affect the stock market in India. The RBI base rate remained at the same level for a very long period (Apr 2003–Jan 2012), while the stock index moved actively during the period. This analysis is confirmed by Asraf, Rajasekar, and Deo (2013) who analyze the impact of macroeconomic variables, including monetary policy, on the Islamic stocks in India. Figure 4 shows the Korea Composite Stock Price Index (KOSPI) and Bank of Korea (BOK) base rate movements.

Figure 3: BSE SENSEX and RBI Base Rate

1997/7–2014/6



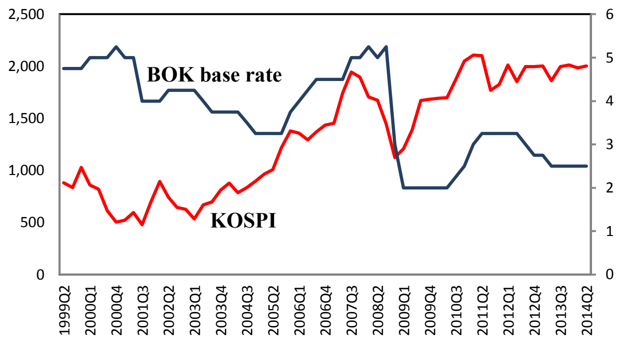
BSE SENSEX = Bombay Stock Exchange Index, RBI = Reserve Bank of India.

Note: The S&P BSE SENSEX, also-called the BSE 30 or simply the SENSEX, is a free-float market-weighted stock market index of 30 well-established and financially sound companies listed on the Bombay Stock Exchange in India.

Sources: Yahoo Finance for S&P BSE SENSEX; RBI for RBI base rate .

Figure 4: KOSPI and BOK Base Rate

Q2 1999–Q2 2014



BOK = Bank of Korea, KOSPI = Korea Composite Stock Price Index.

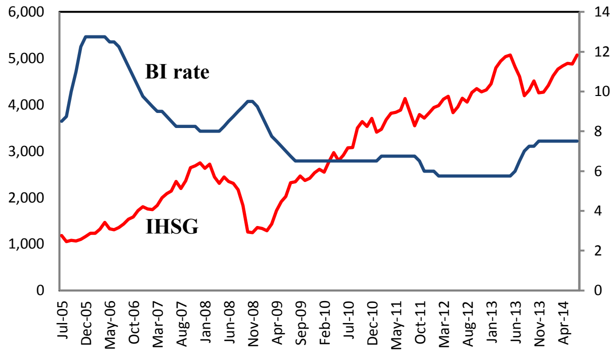
Note: KOSPI is the index of all common stocks traded on the Stock Market Division of the Korea Exchange. It is the representative stock market index of the Republic of Korea.

Sources: Yahoo Finance for KOSPI; BOK for BOK base rate.

Meanwhile, there is quite a strong negative correlation between the policy rates in the Republic of Korea and Indonesia and their respective stock market, meaning expansionary monetary policy would likely drive stock market performance. The same conclusion was also suggested by Kim (2014) and Praptiningsih (2013) who studied the impact of monetary policy on the stock market in the Republic of Korea and Indonesia, respectively. Seong (2013) suggests that monetary policy has become one of the main factors affecting the movement of the stock market in Singapore. However, the effect of monetary policy on the stock market appears to be changing. Before the

Asian financial crisis in 1998, the correlation between the Monetary Authority of Singapore (MAS) bills rate and the Singapore stock market index was negative. However, the correlation became positive after 1998 up to early 2009. It turned negative again after February 2009. Figure 5 shows the Indonesian stock exchange index (IHSG) and Bank Indonesia (BI) policy rate movements and Figure 6 the Straits Times Index (STI) and the MAS monetary policy rate (MAS bills rate) movements.

Figure 5: IHSG and BI Rate
2005/7–2014/6

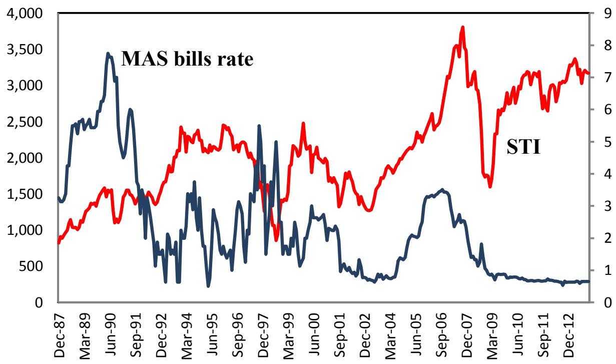


BI = Bank Indonesia, IHSG = Indeks Harga Saham Gabungan.

Note: IHSG is an index of all stocks that trade on the Indonesia Stock Exchange. The BI rate is the policy rate reflecting the monetary policy stance adopted by BI and announced to the public.

Sources: Yahoo Finance for IHSG; BI for BI rate.

Figure 6: STI and MAS Bill Rate
1987/12–2013/12



MAS = Monetary Authority of Singapore, STI = Straits Times Index.

Note: The STI tracks the performance of the top 30 companies listed on the Singapore Exchange. The MAS bills rate is the MAS monetary policy rate of the Monetary Authority of Singapore (MAS).

Sources: Yahoo Finance for STI; MAS for MAS bills rate.

3. THEORETICAL BACKGROUND AND THE MODEL

3.1 Channels of Transmission of Monetary Policy to the Stock Market

Monetary policy is likely to influence stock market prices through four mechanisms: First, changes in the money supply may be related to unanticipated increases in inflation and future inflation uncertainty and hence negatively related to the share price.

Second, changes in the money supply may positively influence the share price through its impact on economic activity. Third, portfolio theory suggests a positive relationship; an increase in the money supply is likely to shift the portfolio from non-interest bearing money to financial assets, including equities (Humpe and Macmillan 2009). Finally, changes in the money supply may positively influence the share price by raising the expected inflation and expected price of shares, hence raising the present demand for purchasing shares and present share prices.

There are three channels related to the transmission of monetary policies to the commodities market and capital market, which are the interest rate channel, exchange rate channel, and inflation channel. Channels of interest rate transmission could be completely described by classical monetarism, as well as in modern literature such as the Keynesian IS–LM (investment saving–liquidity preference money supply) model. Easing interest rates increase the demand for credit and increase aggregate demand, including the demand for investing in the capital market (Yoshino and Taghizadeh-Hesary, forthcoming). Keynes (1936) examined the effects of lowering interest rates on aggregate demand. Expansionary monetary policy reduces the interest rate. When the interest rate is lower than the marginal productivity of capital, it broadens investment demand until the marginal productivity of capital is equalized to the lower interest rate. The expansion of investment creates an accelerator–multiplier effect, causing aggregate demand to expand. The expanded aggregate demand also reflects in stock market. This expansion of demand for stock market shares puts pressure on prices. In the end, this process leads to increased stock market prices. In other words, lower interest rates will make borrowing cheaper, and this will push up the demand and prices.

The second channel is through the exchange rate. In order to study this second channel, first of all we need to review the impact of monetary policies on the exchange rate. The effect of monetary policy on exchange rates has been the subject of a large body of empirical research since the early 1990s, as studied among others by Sims (1992), Clarida and Gali (1994), Eichenbaum and Evans (1995), Clarida and Gertler (1997), Faust and Rogers (2003), Bonser-Neal, Roley, and Sellon (1998), and Bagliano and Favero (1999). Several of these empirical studies found that a tightening of US monetary policy is associated with an appreciation of the dollar, while a loosening is associated with dollar depreciation. Using a vector autoregression (VAR) methodology, Eichenbaum and Evans (1995) found that contractionary shocks to monthly values of the federal funds rate, the ratio of non-borrowed reserves to total reserves, and the Romer and Romer (1989) index over the 1974–1990 period led to a sharp increase in the differential between US and foreign interest rates and to a sharp appreciation in the dollar. These findings are also confirmed by Clarida and Gali (1994), Evans (1994), and Lewis (1995).

Nevertheless, there is a big puzzle surrounding the stock prices and exchange rate interplay. The interrelationship between the two can be investigated from two different directions. On the one hand, when the domestic currency depreciates against foreign currencies, export product prices will decrease for foreigners and, consequently, the volume of the country's exports will increase (Fama 1981). This would benefit companies whose product markets are overseas, which will be reflected by an increase of their stock price. On the other hand, currency depreciation will increase the importing expenditures of raw materials for domestic manufacturers, which is expected to have a negative impact on their cash flow and on stock prices. Thus, the net effect of the exchange rate variation on stock prices is undetermined. There is a large empirical body of literature supporting the linkage between stock returns and exchange rates (see, for example, De Santis and Gerard 1998; Patro, Wald, and Wu 2002; Phylaktis and Ravazzolo 2005; Mun 2007, 2012; and Dungey and Martin 2007).

3.2 Model Development

There are abundant economic factors that can influence stock markets. One way of linking macroeconomic variables and stock market returns is through arbitrage pricing theory (APT), which uses multiple risk factors to explain asset returns. While early empirical papers on APT focused on individual security returns, the theory may also be used in an aggregate stock market framework, where a change in a given macroeconomic variable could be a proxy for changes in an underlying systematic risk factor influencing future returns. Most of these studies are characterized by modeling a short-run relationship between macroeconomic variables and the stock price in terms of first differences, assuming a trend-stationary process.

Another approach is the discounted present value (DPV). This approach relates the stock price to future expected cash flows. Therefore, the DPV can be used to focus on the long-run relationship between the stock market and macroeconomic variables. Moreover, we can explain some economic variable effects on the stock market based on portfolio theory, where assets are substituted for each other and every change in one asset price has a direct and indirect impact on other assets.

Seeking to identify the relationship between stock prices and macroeconomic variables, the DPV of stock prices can be written as:

$$P_S = \left(\frac{[\pi(y,e)]_t}{[1+i(\Delta m,P)+\rho]_t} + \frac{[\pi(y,e)]_{t+1}}{[1+i(\Delta m,P)+\rho]_{t+1}^2} + \dots + \frac{\left[\pi(y,e)+E\left[P^S\right](E[y],E[P],E[e])\right]_{t+n}}{[1+i(\Delta m,E[P])+\rho]_{t+n}^n} \right) \quad (1)$$

where P_S denotes stock present prices and $\pi_t, \pi_{t+1}, \cdots, \pi_{t+n}$ are each year's share dividends—which are functions of economic activity in each year $(y_t, y_{t+1}, \cdots, y_{t+n})$ and the exchange rate in each year $(e_t, e_{t+1}, \cdots, e_{t+n})$. If the exchange rate fluctuates, the import prices of raw materials and natural resources will change, and changes in the exchange rate also change the export, which is why it has an impact on the dividends. i is the real interest rate. Interest rates are affected by monetary policy (Δm_t) and general price level (P). The real interest rate is equal to $\mathrm{i}_{(\mathrm{nominal})} - \mathrm{P}_{(\mathrm{general\ price\ level})}$ will be important to capture the interest rate, and ρ denotes the risk premium. Lastly, $E[P^S]$ is the future price of stock, depending on how the economy fluctuates, which is a function of expected economic activity $(E[y])$, expected exchange rate $(E[e])$, and the expected general price level $(E[P])$. So this model mainly focuses on the discounted present value of future dividends and future stock price.

In addition to the above, there are also other approaches for modeling the stock prices, such as the capital asset pricing model (CAPM), which is a mean–variance model of portfolio choice. Or Keynes' "beauty contest" effect model, whose name comes from Keynes' famous metaphor, in which he suggests that, in order to form their demand for an asset, investors not only forecast the future payouts but also try to guess other market participants' forecasts and others' forecasts of others' forecasts, etc. In this situation, investors are said to have "higher order beliefs." Townsend (1983), in a general framework, and Basak (2000), in the context of stock markets, theoretically show that higher-order beliefs induce higher price volatility than rational expectations do.

The base of most of the stock pricing models is DPV.[1] Moreover, the DPV model is able to capture both monetary and fiscal policies. For monetary policy, it will be explained in the following sections of this paper. For fiscal policy, our DPV model includes dividends and future stock prices. If fiscal policy is aggressive and positive, it will encourage gross domestic product (GDP) growth, which will increase dividends of the stock of listed companies and also the expectation of a bright future because positive fiscal policy will impact future prices in that it will push up the present stock prices as well. A government spending policy in the short run will increase stock prices, which could be captured by our model.

As is clear in our model, if the economic activity in each year shows a good performance, it has a positive impact on the stock price. However, it is possible that even during a recession, or in a no-growth era, stock markets experience growth in their price levels. This happens when the expectations are positive; for example, when investors expect the general price level to increase or the economic activity to improve in future, this would impact the present stock prices.

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[1] In order to show that the base of most of stock pricing models is DPV, here we provide how this applies for CAPM:

Assuming that model (1) shows the price of any individual risky asset in the market, the expected return on any individual risky asset after n periods will be:

$$E[R_i]_{t+n} = \left[\frac{\pi_t}{(1+i_t)} + \frac{\pi_{t+1}}{(1+i_{t+1})^2} + \dots \frac{\pi_{t+n} + E[P_i]_{t+n}}{(1+i_{t+n})^n} - P_i\right] \quad \text{(a)}$$

where $E[R_i]_{t+n}$ is the expected return on an individual risky asset after n periods, $E[P_i]_{t+n}$ is the expected price of an individual risky asset after n periods and P_i is the present market price of an individual risky asset.

In order to get the expected return on the market portfolio, we average over Equation (a), which results in:

$$E[R_m]_{t+n} = \left[\frac{\overline{\pi}_t}{(1+i_t)} + \frac{\overline{\pi}_{t+1}}{(1+i_{t+1})^2} + \dots + \frac{\overline{\pi}_{t+n} + E[P_m]_{t+n}}{(1+i_{t+n})^n} - \overline{P}\right] \quad \text{(b)}$$

where $E[R_m]_{t+n}$ is the expected return on the market portfolio after n periods and the expected "average" return from holding all assets in the optimal proportions, and $E[P_m]_{t+n}$ is the expected market portfolio price after n periods.

Equations (a) and (b) help us to obtain the following variance and covariance, which are needed to release CAPM:

(We know that: $\text{var}(X) = E[X - E(X)]^2 = E(X^2) - (E(X))^2$) and $\text{cov}(X,Y) = E[(X - E[X])(Y - E[Y])]$.)

$$\text{var}(R_i)_{t+n} = E[R_i - E(R_i)]^2_{t+n} = \left[E(R_i^2) - (E(R_i))^2\right]_{t+n} \quad \text{(c)}$$

$$\text{cov}(R_i, R_m)_{t+n} = E[(R_i - E[R_i])(R_m - E[R_m])]_{t+n} \quad \text{(d)}$$

Since actual returns on the market portfolio differ from expected returns, the term $(R_m - E[R_m])_{t+n}$ on the market portfolio is non-zero. CAPM predicts that the expected excess return on an individual risky asset $(E[R_i] - r)_{t+n}$ is directly related to the expected excess return on the market portfolio $(E[R_m] - r)_{t+n}$, with the constant of proportionality given by the beta of the individual risky asset (Cuthbertson and Nitzsche 2003):

$$(E[R_i] - r)_{t+n} = \beta_i (E[R_m] - r)_{t+n} \quad \text{where } \beta_i = [\text{cov}(R_i, R_m) / \text{var}(R_m)]_{t+n} \quad \text{(e)}$$

(r is return from risk-free asset, e.g., fixed-term bank deposit or government bond.)

The explanations above show how DPV is the base of CAPM.

Based on the aforementioned DPV model, we develop our model for our empirical work incorporating four major variables:

$$P_s = f(y, \Delta mb, e, P) \quad (2)$$

which means stock prices are a function of economic activity (y), monetary variable growth rate[2] (Δm), exchange rate (e), and general price levels (P). Equation (2) creates a condition that shapes investors' expectations for general price levels and economic activities based on present values. For this reason, we did not include the expected values in the above model. Based on the model, we shape our variables as shown in Table 1.

Table 1: Model Variables

Variable	Description
***P_S* = TEPIX**	Tehran Stock Exchange Price Index (TEPIX)
y* = *gdp	real gross domestic product (GDP) of Iran, seasonally adjusted (CPI of Iran used for releasing real GDP from the nominal one)
m* = *mb	monetary base of Iran, seasonally adjusted
e	US dollar–Iranian rial exchange rate
P* = *cpi	consumer price index (CPI) of Iran

Considering the variables mentioned above, we can rewrite Model (2) as follows:

$$TEPIX = f(gdp, mb, e, cpi) \quad (3)$$

4. DATA ANALYSIS

We used quarterly data from Q1 1998–Q2 2013, with 62 quarters in total for each variable. All variables are used in logarithmic form. The sources of data are the Central Bank of Iran (CBI), Tehran Stock Exchange (TSE), and International Financial Statistics (IFS) of the International Monetary Fund. Below, we explain the analysis conducted on these data.

4.1 Unit Root Tests

In order to evaluate the stationarity of all series, we performed three unit root tests on all variables at levels and first differences with trend and intercept. The tests used are the augmented Dickey–Fuller (ADF) test, Phillips–Perron test, and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The results are summarized in Table 2.

Our results imply that almost all variables are non-stationary in levels. These variables include the TEPIX, real GDP, monetary base, exchange rate, and CPI, all in logarithmic form. However, first differences of all variables using all three tests (ADF, Phillips–Perron, and KPSS) show stationary results. These results suggest that the TEPIX, real GDP, monetary base, exchange rate, and CPI variables each contain a unit root. Once the unit root test was performed and it was discovered that the variables are non-stationary in levels and stationary in first differences, they were integrated of order 1 or

[2] In this study, using the interest rate is not practical since Iran has implemented Islamic banking rules, which are quite different from the conventional rules. Interest rates are affected by monetary policy. Hence, instead of the real interest rate, we choose another monetary variable, i.e., monetary base, which has a high correlation with the interest rate, as shown in many earlier studies.

I(1). Because of the non-stationary series, the next step was to apply a cointegration analysis to examine whether the series are cointegrated and long-run relationships exist among these variables.

Table 2: Unit Root Tests

	Augmented Dickey–Fuller (ADF)		Phillips–Perron		Kwiatkowski–Phillips–Schmidt–Shin (KPSS)	
Variable	Levels (t-statistic)	First differences (t-statistic)	Levels (adj. t-stat)	First differences (adj. t-stat)	Levels (LM-stat.)	First differences (LM-stat.)
TEPIX	–1.28	–4.44**	–1.25	–4.42**	0.12^	0.14^
gdp	–0.54	–4.09*	–0.75	–7.55**	0.24	0.08^
mb	–1.81	v13.49**	–3.11	–13.07**	0.16	0.13^
e	–3.00	–4.55**	–1.01	–4.84**	0.17	0.13^
cpi	–0.54	–4.14**	0.60	–5.18**	0.21	0.13^

Notes: TEPIX denotes the Tehran Stock Exchange Price Index; gdp is the real gross domestic product of Iran, seasonally adjusted; mb is the monetary base of Iran, seasonally adjusted; e is the US dollar–Iranian rial exchange rate; and cpi is the consumer price index of Iran. * indicates rejection of the null hypothesis for the presence of unit root at 5% using ADF and Phillips–Perron tests, ** indicates rejection of the null hypothesis for the presence of unit root at 1% using ADF and Phillips–Perron tests, ^ shows stationary series using the KPSS test. The optimal lag lengths for ADF were found using Akaike Information Criterion (AIC). Bandwidth in Philips–Perron and KPSS was selected using the Newey–West bandwidth.

4.2 Cointegration Analysis

One main issue in VAR/VEC models is lag order selection. Ivanov and Kilian (2005) suggested six criteria for lag order selection: the Schwarz Information Criterion (SIC), the Hannan–Quinn Criterion (HQC), the Akaike Information Criterion (AIC), the general-to-specific sequential likelihood ratio (LR) test, a small-sample correction to that test (SLR), and the Lagrange multiplier (LM) test. In this present research, we selected optimal lag numbers using AIC standards, which suggested seven lags.

In the next step, in order to identify the cointegrating vectors among the TEPIX, real GDP, monetary base, exchange rate, and CPI variables, we conduct a cointegration analysis using Johansen's technique by assuming a linear deterministic trend and in two cases, with intercept and with intercept and trend.

The results of the cointegration rank test of trace are exhibited in Table 3.

Table 3: Cointegration Rank Test (Trace)

	Intercept			Intercept and Trend		
Hypothesized no. of CE(s)	**Eigenvalue**	**Trace statistic**	**Prob.**	**Eigenvalue**	**Trace statistic**	**Prob.**
r=0	0.87	247.07*	0.00	0.95	363.19*	0.00
r<=1	0.73	137.91*	0.00	0.80	207.10*	0.00
r<=2	0.53	69.44*	0.00	0.70	122.50*	0.00
r<=3	0.41	28.89*	0.00	0.45	59.48*	0.00
r<=4	0.01	0.57	0.45	0.41	28.03*	0.00

Note: * denotes rejection of the non-cointegrating hypothesis at the 5% level, Prob. shows MacKinnon-Haug-Michelis p-values.

As is clear from Table 3, the above test rejects the null hypothesis of non-cointegrating variables. This means that all variables are cointegrated and there is a long-run association among variables; or, in other words, in the long run, these five variables (TEPIX, real GDP, monetary base, exchange rate, and CPI) move together, hence we should run a vector error correction model (VECM). The AIC and SIC results of our linear deterministic VECM indicate estimating the model by including trend and intercept, which is slightly better than including just the intercept, so we have also retained this finding.

5. EMPIRICAL WORK

5.1 Vector Error Correction Model

We estimate Model (3) in a VECM setting including five variables: TEPIX, real GDP, monetary base, exchange rate, and CPI. We define all variables in logarithmic form. The VECM can be defined as:

$$DY_t = A(L)DY_t + \Pi Y_{t-1} + \varepsilon_t \quad (4)$$

for

$$Y = (TEPIX, gdp, mb, e, cpi) \quad (5)$$

where D is the first differences, L is the lag operator, and ε is an error term. Π can be written as $\Pi = \alpha\beta'$, where α and β are $p \times r$ matrices, and p is the number of variables in Y. β is a vector of the cointegrating relationship and α is a loading matrix defining the adjustment speed of the variables in Y to the long-run equilibrium defined by the cointegrating relationship. The rank of Π is denoted by r. As mentioned earlier, the AIC standard suggested seven lags.

Model (6) shows our VECM with four cointegrating equations and seven lags for each variable:

$$\begin{aligned}
D(TEPIX) &= \alpha_1[TEPIX(-1) - 22.62cpi(-1) + 0.77trend + 51.15] + \alpha_2[gdp(-1) - 1.83cpi(-1) + 0.05trend - 3.98] \\
&+ \alpha_3[mb(-1) + 7.47cpi(-1) - 0.32trend - 29.90] + \alpha_4[e(-1) - 4.06cpi(-1) + 0.17trend + 3.10] + \alpha_5 D[TEPIX(-1)] \\
&+ \alpha_6 D[TEPIX(-2)] + \alpha_7 D[TEPIX(-3)] + \alpha_8 D[TEPIX(-4)] + \alpha_9 D[TEPIX(-5)] + \alpha_{10} D[TEPIX(-6)] + \alpha_{11} D[TEPIX(-7)] \\
&+ \alpha_{12} D[gdp(-1)] + \alpha_{13} D[gdp(-2)] + \alpha_{14} D[gdp(-3)] + \alpha_{15} D[gdp(-4)] + \alpha_{16} D[gdp(-5)] + \alpha_{17} D[gdp(-6)] + \alpha_{18} D[gdp(-7)] \\
&+ \alpha_{19} D[mb(-1)] + \alpha_{20} D[mb(-2)] + \alpha_{21} D[mb(-3)] + \alpha_{22} D[mb(-4)] + \alpha_{23} D[mb(-5)] + \alpha_{24} D[mb(-6)] + \alpha_{25} D[mb(-7)] \\
&+ \alpha_{26} D[e(-1)] + \alpha_{27} D[e(-2)] + \alpha_{28} D[e(-3)] + \alpha_{29} D[e(-4)] + \alpha_{30} D[e(-5)] + \alpha_{31} D[e(-6)] + \alpha_{32} D[e(-7)] + \alpha_{33} D[cpi(-1)] \\
&+ \alpha_{34} D[cpi(-2)] + \alpha_{35} D[cpi(-3)] + \alpha_{36} D[cpi(-4)] + \alpha_{37} D[cpi(-5)] + \alpha_{38} D[cpi(-6)] + \alpha_{39} D[cpi(-7)] + \alpha_{40}
\end{aligned} \quad (6)$$

where $D(TEPIX)$, $D(gdp)$, $D(mb)$, $D(e)$, and $D(cpi)$ are the first differences of TEPIX, real GDP, monetary base, the exchange rate, and CPI, respectively. In this VECM, trend is also included, since we calculated the cointegration with intercept and trend. As mentioned earlier, the optimal number of lags was calculated as seven, so for each variable seven lags are included in the model. $\alpha_1, \alpha_2, \alpha_3$, and α_4 are the coefficients of the four cointegrating equations, and $\alpha_5, \cdots, \alpha_{39}$ are the coefficients of the seven lagged variables for the five variables of our model, and α_{40} is a constant.

Table 4: VECM Coefficients

Variable	Coefficient	t statistic		Variable	Coefficient	t statistic	
CointEq1	-2.789	-4.206	***	D(mb (-3))	6.149	5.284	***
CointEq2	-0.042	-0.042		D(mb (-4))	4.976	5.409	***
CointEq3	-8.557	-4.717	***	D(mb (-5))	3.778	5.363	***
CointEq4	-0.819	-1.860	*	D(mb (-6))	2.988	4.937	***
D(TEPIX (-1))	2.089	3.951	***	D(mb (-7))	1.281	3.071	***
D(TEPIX (-2))	2.225	4.280	***	D(e (-1))	-0.742	-1.222	
D(TEPIX (-3))	2.248	4.511	***	D(e (-2))	-0.857	-1.235	
D(TEPIX (-4))	2.305	4.543	***	D(e (-3))	0.999	1.684	*
D(TEPIX (-5))	1.688	3.823	***	D(e (-4))	3.984	4.223	***
D(TEPIX (-6))	1.194	3.470	***	D(e (-5))	1.929	1.849	*
D(TEPIX (-7))	0.622	2.379	**	D(e (-6))	-1.249	-1.758	*
D(gdp (-1))	0.329	0.503		D(e (-7))	0.361	0.609	
D(gdp (-2))	0.919	1.685	*	D(cpi (-1))	-4.992	-1.804	*
D(gdp (-3))	0.866	1.710	*	D(cpi (-2))	-5.117	-2.169	**
D(gdp (-4))	0.507	1.159		D(cpi (-3))	-3.009	-1.901	*
D(gdp (-5))	0.998	2.845	***	D(cpi (-4))	2.579	1.501	
D(gdp (-6))	0.118	0.364		D(cpi (-5))	1.462	0.646	
D(gdp (-7))	0.084	0.314		D(cpi (-6))	0.862	0.666	
D(mb (-1))	7.687	4.641	***	D(cpi (-7))	3.987	2.235	**
D(mb (-2))	6.671	4.895	***	Constant	-2.090	-4.956	***

R-squared = 0.911

Notes: CointEq is the cointegrating equation. *D* is first differences. The results of seven lags for all variables are shown. TEPIX denotes the Tehran Stock Exchange Price Index; gdp is the real gross domestic product of Iran, seasonally adjusted; mb is the monetary base of Iran, seasonally adjusted; e is the US dollar–Iranian rial exchange rate; and cpi is the consumer price index of Iran. *** denotes significance at the 1% level (p-value less than 0.01), ** denotes significance at the 5% level (p-value less than 0.05), and * denotes significance at the 10% level (p-value less than 0.1).

According to Table 4, the signs and significance of contemporaneous impacts on the stock price index merit discussion because they have important policy and theoretical implications. The key results are as follows: the impact of the real GDP growth rate on the TEPIX growth rate was significant in the second, third, and fifth lags, with the sign of these three significant coefficients being positive. This means that better economic conditions will boost the stock market price index. This result also declares that good economic conditions are not necessarily instantly exhibited in stock market price indices; it takes several quarters until it can be reflected there.

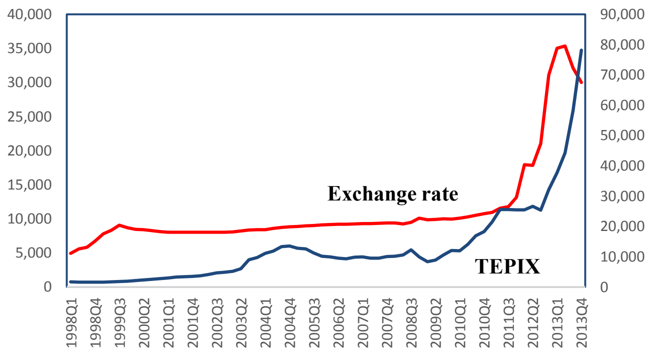
In this survey, we included two monetary variables: monetary base and US dollar–Iranian rial exchange rate. For the first variable, the result shows strictly significant and positive coefficients for all seven lags. This is in accordance with the second, third, and fourth mechanisms for monetary policies' impact on stock market, while being unlike the first mechanism already discussed in the second section of this paper. These mechanisms explain that changes in the money supply may have a positive influence on the share price through three mechanisms. The first is that an increase in money supply will have a positive impact on the stock market through the impact on economic activity. The second mechanism is in line with a portfolio theory that relates an increase in the money supply with a portfolio shift from non-interest bearing money to financial assets, including stock market shares (Humpe and Macmillan 2009), hence raising stock prices. The final mechanism is that an increase in money supply may positively influence general price levels. Thus, this would shape many people's expectations for future price levels. This would result in an increase in demand of shares, which further leads to an increase in stock market prices.

The second monetary variable in our survey is the real exchange rate of the US dollar and the Iranian rial. The coefficients for this variable are positive for some lags and negative for others. However, taking into account only significant coefficients, the positive signs outnumber the negative ones.

Figure 7, which depicts the TEPIX and US dollar–Iranian rial movements during Q1 1998–Q4 2013, could explain this large impact of the exchange rate movements on the Iranian stock market index.

Figure 7: TEPIX and US Dollar–Iranian Rial Exchange Rate

Q1 1998–Q4 2013



TEPIX = Tehran Stock Exchange Price Index.

As is clear in Figure 7, during the past decade, the Iranian rial depreciated drastically. The devaluation of the Iranian rial went from 4,938 rials on average in Q1 1998 to beyond 29,973 rials on average for each dollar in Q4 2013. There are two main reasons for this huge devaluation during the past number of years. The first reason is that easy monetary policy in Iran inflated the prices. Thus, exchange rates were adjusted based on this high inflation. The second is that financial sanctions against Iran, which intensified during the last decade, essentially created a segmented market for foreign exchange in Iran. Iran has large foreign reserves in bank accounts around the world, which were not accessible because of financial sanctions. So, for most of the daily foreign transactions in Iran (i.e., importing products, paying to relatives abroad, etc.), it is necessary to look for paper foreign currencies in the Iranian market or purchase them from neighboring countries and remit them to final destinations. Since the market is relatively small, the rial devaluation accelerated rapidly. On the other hand, this huge devaluation in the domestic currency was beneficial for export-oriented companies. About 80% of total Iranian exports relate to oil, while exchange rate fluctuations do not have a significant impact on oil supply in quantity (Taghizadeh-Hesary and Yoshino 2013, 2014). Instead, it raised the government earnings in rials from oil exports, then raised the government expenditures because of higher earnings, and the results in total were in favor of the whole economy (Taghizadeh-Hesary et al. 2013), i.e. higher stock prices. For the remaining 20%, which are non-oil exporters, the depreciation of the rial was also good news since many of these exporters are stock listed firms. They enjoy an increase in their profits due to the depreciation of the rial, which ultimately results in an increase in their stock prices.

For the last variable in our model, which is CPI, the most significant result is for the seventh lag, which shows a positive impact on the TEPIX. This result shows that a higher inflation rate influenced stock market prices after several quarters. The main channel of transmission of CPI inflation to the TEPIX is through expectations, which is the right part of our Model (1). It is possible that during a recession or no-growth era, stock markets experience growth in their price levels. This happens when the expectations are positive. For example, if investors expect the general price level increase or economic activity to improve in the future, this would have a positive impact on the present stock prices. This is what has been happening in the Iranian economy recently. Iran experienced high inflation rates and low or even negative GDP growth rates in 2012 and 2013. However, stock market indices show healthy and upward trends. This happened mainly because of investors' expectations. Investors shape their price expectations based on the current situation, which at present is inflationary in Iran. Hence, they are expecting higher prices in future—and higher stock prices as well—which is why they have raised their present demand for investing in the equity market. In order to find out what proportion of this boom in the stock market is caused by real economic activities and how much is caused by monetary easing and the inflation rate, we run a variance decomposition analysis.

5.2 Variance Decomposition Analysis

In the usual VAR/VEC framework, the portion of the total variance of an observed variable that is due to the various structural shocks is called variance decomposition. The variance decomposition indicates which one of the macroeconomic factors can provide explanatory power for a variation in stock prices over different periods (Lutkepohl 2005).

Table 5: Forecast Error Variance Decomposition of TEPIX

Period	S.E.	TEPIX	gdp	mb	e	cpi
1	0.06	100.00	0.00	0.00	0.00	0.00
2	0.09	64.56	0.25	1.42	29.18	4.59
3	0.13	50.64	2.17	4.87	32.59	9.73
4	0.15	56.87	2.07	4.55	25.05	11.47
5	0.16	55.18	2.22	5.93	25.65	11.01
6	0.17	48.44	2.34	4.96	33.71	10.55
7	0.23	32.43	9.14	7.41	44.57	6.45
8	0.24	30.83	11.2	6.82	41.25	9.84
9	0.28	23.18	11.1	5.09	53.21	7.37
10	0.32	18.38	16.9	6.07	52.63	5.98
15	0.54	26.52	9.03	15.43	43.29	5.73
20	1.72	30.04	1.92	20.90	46.00	1.14

Notes: S.E. is the standard error; TEPIX denotes the Tehran Stock Exchange Price Index; gdp is the real gross domestic product of Iran, seasonally adjusted; mb is the monetary base of Iran, seasonally adjusted; e is the US dollar–Iranian rial exchange rate; and cpi is the consumer price index of Iran.

The result of the forecast error variance decomposition (FEVD) for the TEPIX is shown in Table 5. The variance decomposition makes it possible to determine the relative importance of each variable in creating fluctuations in other variables. Results show that after 20 periods almost 30% of forecast error variance of the TEPIX is accounted for by own innovations. Variance decomposition results show that after 10 periods more than 59% of TEPIX forecast error variance can be explained by exogenous shocks to two monetary factors—the monetary base and the US dollar–Iranian rial exchange rate. As time passes, this percentage increases to 67% after 20 periods from the beginning. This large share shows the importance of these variables in TEPIX fluctuations, especially for the exchange rate which accounts for 52.63% and 46% of TEPIX forecast error variances after 10 periods and 20 periods, respectively. After 10 periods, the real GDP of Iran explains 16.94% of forecast error variance of the TEPIX and this impact fades in forward periods, as after 20 periods it decreases to only 1.92%. The last variable, which is CPI, explains 5.98% of TEPIX forecast error variance after 10 periods and 1.14% after 20 periods. Our variance decomposition results shows that a small portion of the fluctuations in the Tehran stock market is due to Iranian economic growth compared to monetary factors, which is in accordance with the present status of the Iranian economy. Of recent, the Iranian economy is shrinking and suffering from continuous recessions with zero or negative growths for GDP, but the stock market is showing skyrocketing prices and has very often hit new records, which, according to our results, is not mainly due to economic growth but due to inflationary expectations and monetary factors.

As our FEVD results show, the main reason for this skyrocketing price increase in the Tehran stock market is easy monetary policy. Such expansionary monetary policy mainly was followed during the term of the former governor of the Central Bank of Iran and inflated the TEPIX drastically. On the contrary, given the appropriate tightening monetary policy that the new governor[3] is following to halter the country's inflation rate, we should certainly expect sluggish growth or even a decline in the TEPIX and a return to the real growth path from this artificial one. The most recent fluctuations in this market affirm our assertion. The TEPIX started to decline from 78,741 on 31 March 2014 to below 70,342 on 30 June 2014, an approximately 11% drop in 3 months. Although these new tightening monetary policies will probably lead to further decline in the TEPIX, this is the best remedy to avoid blowing up this bubble more.[4]

6. CONCLUSION AND POLICY IMPLICATION

6.1 Conclusion

Although the Tehran stock market has recently shown skyrocketing prices and very often hit new record highs, the Iranian economy is suffering from continuous recessions with zero or negative GDP growth. The main objective of this paper is to answer the question as to what portion of this boom in the Tehran stock market is caused by economic growth and what portion is the result of monetary factors and inflationary expectations.

In order to answer this question, we included a group of macroeconomic variables in our analysis, such as real GDP, monetary base, US dollar–Iranian rial exchange rate, and CPI. We found that these variables are cointegrated and that there is a long-run association among variables; in other words, in the long run, these five variables

[3] The former governor of the Central Bank of Iran was Mahmoud Bahmani (in office 2 September 2008–2 September 2013) and the new governor is Valiollah Seif.

[4] The results of this paper imply that there are signs of a bubble in the Tehran stock market. In order to get more information about causes of the bubble and bubble indicators, and to answer the question of why bubbles occur in many countries, see Yoshino, Nakamura, and Sakai (2013).

(TEPIX, real GDP, monetary base, exchange rate, and CPI) move together. To address this issue, we developed a vector error correction model (VECM).

Our results show that the impact of the real GDP growth rate on the TEPIX growth rate was significant and positive in certain lags, implying that better economic conditions will boost the stock market price index. This result also demonstrates that good economic conditions are not necessarily instantly manifested in the stock markets; it takes several quarters before good economic conditions are reflected there.

For the first monetary factor in our survey, monetary base, the results show strictly significant and positive values. Changes in the money supply may positively influence the share price for three reasons. The first reason is that an increase in money supply will have a positive impact on the stock market through the positive impact on economic activity. The second reason is in line with a portfolio theory that relates an increase in the money supply to a portfolio shift from non-interest bearing money to financial assets including stock market shares (Humpe and Macmillan 2009), hence raising stock prices. The last reason is that an increase in the money supply may positively influence general price levels. Since many people shape their expectations based on current price levels, this results in a rise in their expectation for general price levels and stock prices. Hence, they increase their demand for purchasing shares, and, thus, current stock market prices will shift up.

The second monetary variable in our survey is the US dollar–Iranian rial exchange rate. The coefficients for this variable are shown as positive for some lags and negative for other lags, but the sign of the most significant one is positive, implying that an appreciation of the exchange rate would inflate the TEPIX.

As for CPI, which is the last variable analyzed in our model, the most significant result is for the seventh lag, which shows a positive impact on the TEPIX. This result shows that a higher inflation rate influenced stock market prices after several quarters. The channel of transmission of CPI inflation to the TEPIX is mainly through expectations. It is possible that during the recession or no-growth era, stock markets experience growth in their price levels. Iran has in recent years been experiencing high inflation rates, with low or even negative growth rates of GDP. However, stock market indices are showing healthy and upward trends. This happened mainly because of investors' expectations. They are expecting higher prices in future, and higher stock prices as well, which is why they have raised their present demand for investing in the equity market.

The result of the FEVD for the TEPIX shows that a small portion of fluctuations in the Tehran stock market is due to economic growth. Our results show that monetary factors, especially exchange rate and inflationary expectations, have mainly shaped the recent upward shooting in this market.

6.2 Policy Implication

Monetary policy is often represented by the Taylor rule.[5] It looks at inflation as a main objective and economic growth as a second. These are the two targets forecast by central banks in many countries. However, this study shows that changes in monetary policy affect stock prices through three routes: money by itself, exchange rate, and

[5] The Taylor rule is as follows: $r = a_1\left|\dot{P} - \dot{P}^*\right| + a_2\left|y - y^f\right|$

where, r is short-term interest rate (e.g. the federal fund rate in the United States or call rate in Japan), $\dot{P}$ is the rate of inflation, $\dot{P}^*$ is the desired rate of inflation, y is real GDP, and y^f is GDP in full employment.

inflationary expectation. When it looks like the economy is in a bubble, the central bank should also look at asset prices and stock prices, and not only at inflation and the GDP gap.[6] This study shows that stock prices are very much affected by monetary policy.

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[6] When the economy looks like it is in a bubble, monetary authorities have to look at asset prices, stock prices and the exchange rate market, and not only at inflation and the GDP gap, so the extended version of the above equation is as follows: $r = a_1\left|\dot{P} - \dot{P}^*\right| + a_2\left|y - y^f\right| + a_3\left|\dot{P}_S\right| + a_4\left|\dot{e}\right|$

where $\dot{P}_S$ is the stock price index growth rate and $\dot{e}$ is the nominal exchange rate.

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