Analyzing the Asymmetric Effects of Inflation and Exchange Rate Misalignments on the Petrochemical Stock index: The Case of Iran

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Abstract

While the petrochemical products and their revenues have been the most important part of Iranian non-oil exports, after imposing the international sanctions on Iran's economy, these revenues, reflected in the petrochemical stock index, have fluctuated. In line with this, the effects of some main macroeconomic variables on the petrochemical stock index have become more crucial than before. Among the macroeconomic variables, inflation and exchange rate are the most effective. Hence, To investigate whether the exchange rate misalignments and inflation are significant indicators of changes in the petrochemical stock index, this paper has been applied the time series data from January 2012 to January 2020 and an asymmetric and non-linear framework, NARDL. The empirical results in addition to prove the existence of asymmetric and significant relationships between the research variables, confirm that the impacts of negative components of exchange rate misalignments and, conversely, positive components of inflation have been stronger than the effects of their decomposed counterparts both in the long run and short run.

Key Words: Petrochemical Stock Index, Exchange Rate Misalignments, Inflation, NARDL Model.

Jel Classification: G11, G17, F31, E31, C22.

1. Introduction

As one of the transitional economy which has traditionally been heavily dependent on oil- and gas-related revenues, thanks to its rich oil and gas proved reserves, Iran's economy is recognized as one of the most important and strategic investment destinations especially for its energy sector (Farzanegan & Krieger, 2019; Parsa et al., 2019). Among the various subsectors of oil and gas industries, petrochemical industry plays a pivotal role in Iran's upstream documents and "Five-Year Economic, Cultural, and Social Development Plans" to prevent the economy from being hit by the exogenous oil and gas prices shocks (Sedaghat Kalmarzi et al., 2020). This outstanding position originates from some specific features includes: its Revealed Comparative Advantage, RCA, in producing petrochemical-oriented products, remarkable share in Iran's non-oil exports and total foreign currencies' revenues, high value-added products, directly and indirectly stable job creation in the middle and downstream units, high domestic and international demands, and so forth (Khosrowzadeh et al., 2020). In line with this, there is an essential question that must be answered which is why this index should be investigated or what is the importance of examining this indicator?

There are some compelling reasons that can easily address these questions: First of all, since the largest active petrochemical companies (almost all of them) have issued their shares in Tehran Stock Exchange, TSE, monitoring the Petrochemical stock index in the TSE would decisively depict the performance of petrochemical companies in Iran so that all analysis of this study will be related to the petrochemical stock index in the Tehran stock market. Second, considering the impressive characteristic and special position of this industry in the economy of Iran, investigating the effects of significant influential factors can improve the performance; consequently, the status of both this industry and its related professions in Iran. Finally, to delineate the importance of this industry in the TSE, the following reasons can be taken into consideration: the total investment volume in this industry which is far more than each of other competing areas, the significant number of petrochemical companies (over 30%) among the top 50 companies by early 2020, the remarkable ratio of daily value of traded shares of the very industry to the total traded shares in the TSE, being among the most demanding stocks (even during the sanctions) and so forth. Therefore, to have a stable and profitable investment, from the investors' perspectives, and manage a thriving and promising industry, with stable profitability, and minimal vulnerability to international exogenous shocks, from the managers' viewpoints, analyzing the effects of the most important factors affecting the performance of this industry will be of particular importance to both investors and managers (Khosrowzadeh et al., 2020; Shavvalpour et al., 2017; Eshraghi et al., 2017; Baseri et al., 2016; Nayeb et al., 2016).

The other key points that must be addressed as the main concerns of this study are why this study seeks to investigate the effects of inflation and exchange rate misalignments on the petrochemical stock index? And what does this type of analysis have to do with the current conditions of the Iranian economy? Answering these questions requires to clarify the general economic conditions of Iran, which will be presented in the theoretical framework part. Regarding the essential purpose of this study, monthly data from January 2012 to January 2020 and the NARDL model will be applied. In what follows, section 2 provides further details on the Theoretical Framework, section 3 includes Methodology and Data. In section 4, the empirical results are reported. Finally, section 5 concludes the work.

2. Theoretical Framework

In this part, the main concept of exchange rate misalignments, Iran's general economic conditions_based on which the hypotheses of this study are raised, and finally, the trends in different research variables will be illustrated.

2-1. Exchange Rate Misalignments

On the one hand, exchange rate mostly has a direct relationship with the relative prices of tradable and non-tradable goods which can give out some significant signals that how resources are allocated between these sectors. The exchange rate can be considered as a measure that can assess the effectiveness of macroeconomic policies in different sectors and also determine the status of international trade balance of an economy. On the other hand, the exchange rate is, usually, a volatile indicator and, unfortunately, the domestic currency policies seem to be unsound in some developing countries. Consequently, the policy-makers in such countries try to make some adjustments in this factor, based on the level of economic power especially in the production of goods and services. These adjustments include two different types: exchange rate undervaluation (e.g. in China) and overvaluation (e.g. in Latin American Countries, CFA zone of Africa, and Turkey after World War II, or Japan and Switzerland in 2011), taken together, that means exchange rate misalignments.

Moreover, the main rationales behind these policies include: supporting agents that tradable goods take a significant share of their income, promoting domestic producers and exporters to increase net exports, expanding economic growth and public welfare, and so forth (Huizinga, 1997; Shatz & Tarr, 2000; Kubota, 2009). However, although there is no consensus among scholars and policymakers on how to implement these policies, the extent to which these policies have been successful in different countries, and also the ramifications of implementing these policies in different sectors, are issues to be considered.

2.2. General Economic Conditions of Iran and the Main Concerns of This Study

To depict the general economic conditions of Iran, it should be considered that it has long been plagued by imbalances in macroeconomics throughout which the role of oil, gas, and related industries have been undeniable. In the recent decades, a significant portion of Iran's total investment, infrastructures, GDP, Government budget, per-capita income, and public welfare have been dependent on the exports of oil-oriented industries (Farzanegan & Krieger, 2019). On this basis, crude oil exports and the revenues of its related industries, e.g. petrochemical products, have not only been the crucial factors to keep the wheels of Iran's economy turning, but its remarkable role-playing in macroeconomic and political issues has brought about a great number of problems and ramifications in the country (like less sustainable economic growth, per capita income, and employment rate in comparison with the analogous countries with fewer natural resources), that can be named as a kind of «resource curse» or «paradox of plenty» (Nademi, 2017).

Despite being aware of these devastating consequences, the executive authorities and the macro-decision makers of the country have so far failed to significantly reduce the share of oil-related revenues in its economic growth. The main reasons behind this failure can be addressed in: (i) the large public sector, (ii) the lack of efficient financial and money markets, (iii) the continuous and inefficient macro-policymaking in the foreign exchange market like applying currency manipulating approach in determining the foreign exchange value instead of market determining procedure, (iv) do not paying enough attention to the investment and production sectors during different decades; consequently, the existence of severe dependence on imported goods and services, and more importantly, (v) the existence of international economic sanctions (Nademi and Baharvand, 2019; Parsa et al., 2019; Reed et al., 2019; Komijani et al., 2014). As a result, such conditions have made the exogenous shocks in the oil markets to be the primary source of macroeconomic fluctuations in Iran, no matter whether these shocks are increasing or decreasing. To be more precise, as it has proved in many studies, both types of these shocks, generally, have had adverse effects on different economic indicators of such countries (Farzanegan and Krieger, 2019). However, it seems that there would be a significant discrepancy, in response to oil price shocks, between different type of industries, i.e. international trade-oriented industries and domestic-centred ones.

Therefore, by monitoring the long-run effects of oil price or other exogenous shocks on different industries in Tehran stock market, obtaining equal results would not be expected (Haj Ghanbar Viliani et al., 2019).
Considering the general conditions of Iran's economy, the primary channels with which the impacts of domestic and international shocks can be transmitted (pass-through or spillover) to different indexes of TSE can mostly be attributed to movements in the foreign exchange market and inflation.
On the one hand, as the most important link of the domestic and international economy, foreign exchange market is the first key variable in transmitting the effects of the international and exogenous shocks, e.g. oil price shocks, to the domestic economy (Shahrestani & Rafei, 2020). The main issue, in Iran's economy, is the lack of sustainable equilibrium in the foreign exchange market which comes from the mistrust of market rules in determining the equilibrium exchange rate or manipulation of the foreign currencies' value. This problem can make the magnitude of the effects of oil price shocks more destructive and also the results of planning for obtaining a sustainable growth more unattainable, regardless the fragility of Iran's economy and its excessive dependence on the oil industry (Haj Ghanbar Viliani et al., 2019).
It should be noted that such conditions can be occurred due to different causes in Iran's economy like: (i) the consequences of international sanctions against Iran that significantly reduces the foreign currencies' supply; (ii) Anomalous increase in the components of monetary base (governments borrowing from central banks and, subsequently, increasing the money supply) which usually can be led to increase in inflation rate and decrease in power purchase parity, PPP, in comparison with the other foreign currencies (Farzanegan and Krieger, 2019; Sedaghat Kalmarzi et al., 2020). The main ramifications of exchange rate misalignments, which is most of the time seen in the form of exchange rate undervaluation in Iran, include unreliable relative prices, unbalanced imports and exports, negatively affected investment horizons of almost all investors and also destabilized financial markets as a result of changes in the expectations of both suppliers and investors (especially in the tradable goods sector), adversely affected total productions that can cause a disruption in the aggregate demand and supply equilibrium; consequently, lead to the spread of instability in different sectors of the economy (Mozayani & Parvizi, 2016). The failure of Iran's "Five-Year Economic, Cultural, and Social Development Plans" can be considered as an empirical example of this condition. In this regards, the results of many experimental studies have proven that the lack of attention to stabilizing the foreign exchange market was the main reason of these failures in its development

plants and other economic indicators (Motahari et al., 2018; Nademi and Baharvand, 2019). Given these stylized facts of Iran's economy indicates that in this country, exchange rate misalignments and the existence of significant inefficiencies in the foreign exchange market (like establishing a multiple exchange rate system) have been an important problem the effects of which on different businesses and industries should be investigated. In this regard, since this study tries to investigate the consequences of exchange rate misalignments in the petrochemical industry active in TSE, the first concerns of this study are:

Hypothesis 1:
Exchange rate misalignments can significantly affect the performance of the petrochemical industry in Iran.

Hypothesis 2:
The behavior of the petrochemical industry index in Iran can be asymmetrically (as well as significantly) affected by exchange rate misalignments.

On the other hand, during recent years, inflation has become a fundamental problem in the Iranian economy, analyzing its side effects in any sector of the economy requires dynamic and continuous analysis. To be more precise, features like (i) Negatively affected expectations as a result of different international shocks, (ii), anomalous increases in liquidity and money supply as the main stimulus of rising inflation in Iran, (iii) lack of monetary and financial discipline, (iv) in addition to the persistent budget deficit which have mainly culminated in governments borrowing from central bank, enhancing the money supply, and finally, increasing the inflation have been the main characteristics of Iran's economy (Ghorbani Dastgerdi et al., 2018; Davari & Kamalian, 2018). These conditions act as a relatively stable vicious cycle that is usually perceived as an increase in the inflation rate and negatively affected different sectors of the economy. On this basis, a brief review of the high inflation rates and their significant fluctuations over the past four decades, compared to most of the comparable countries in the world, indicates the lack of effective and efficient policies to control and reduce the inflation (Mohseni & Jouzaryan, 2016). As a result, in such condition, if the managers or investors of petrochemical industry aim to analyze the performance, formulate stability programs, expand profitability, and adopt development strategies, they should have a cogent response for this concern:

Hypothesis 3:
The inflation rate can significantly explain the changes in the petrochemical index.

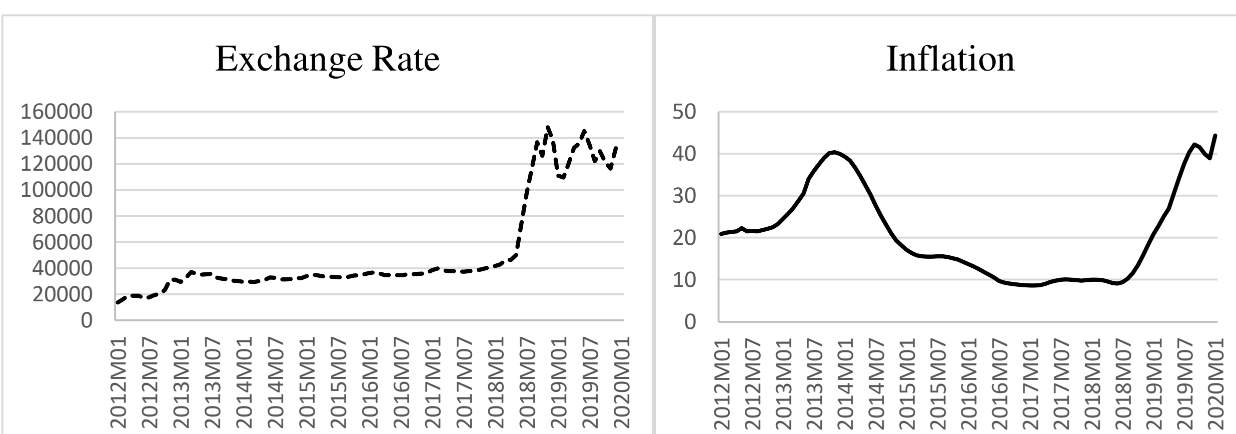
Moreover, the economic literature has paid remarkable attention to the relationship between stock indexes and inflation. although some financial economists have, traditionally, speculated that this idea would work in describing the relationship between stock returns and inflation, analysing the empirical studies in this area shows that there has been no consensus among researchers about the relationship between inflation and stock returns in different countries (Boons et al., 2019; Antonakakis et al., 2017; Pingui & Yonggen, 2016). Based on this, the differing views among researchers in this field and also the contradictory results in different periods and case studies can provide some compelling pieces of evidence of existing an asymmetric relationship between these variables. The aim of analysing this claim can propel us toward the below hypothesis:

Hypothesis 4:
The relationship between the petrochemical industry index and the inflation rate is not only significant but asymmetric as well.

In the following part, trends of Iran's foreign exchange market and inflation, during the research period, present to enhance the perception of the most monumental changes in these variables.

2.3.Trends in Different Research Variables
In this section, the most important events of different variables (Exchange Rate, Inflation, and Petrochemical Index) during the research period will be examined. For this purpose, the time-series graphs of these variables are presented below.

Figure 1: Evolution of Exchange Rate and Inflation



Source: The Databank of the Central Bank of Iran

By looking closely at the overall sample of these two graphs, includes the evolution of exchange rate (IRR to USD) and inflation, their movements can, approximately, be classified into three different periods:

(i) An increase in inflation and exchange rate from early 2012 by mid-2013 as a result of the subsidy reform ramifications and also erratic expansionary monetary policies in the previous years, intensified international and commercial sanctions imposed against Iran.

(ii) From mid-2013 to mid-2018 during which economic conditions of Iran had experienced stability and relative improvement particularly as a result of reaching an international compromise with 5+1 countries (the United Kingdom, the United States, France, China, Russia; plus Germany) on the nuclear issue under the JCPOA[1] agreement. Although this period was accompanied by considerably decrease in inflation (from around 40 to 9 percent), the exchange rate was subjected to a gradual and smoothing increase (from 32000 up to 42000 Rial) that showed a kind of stability in this market for around five years.

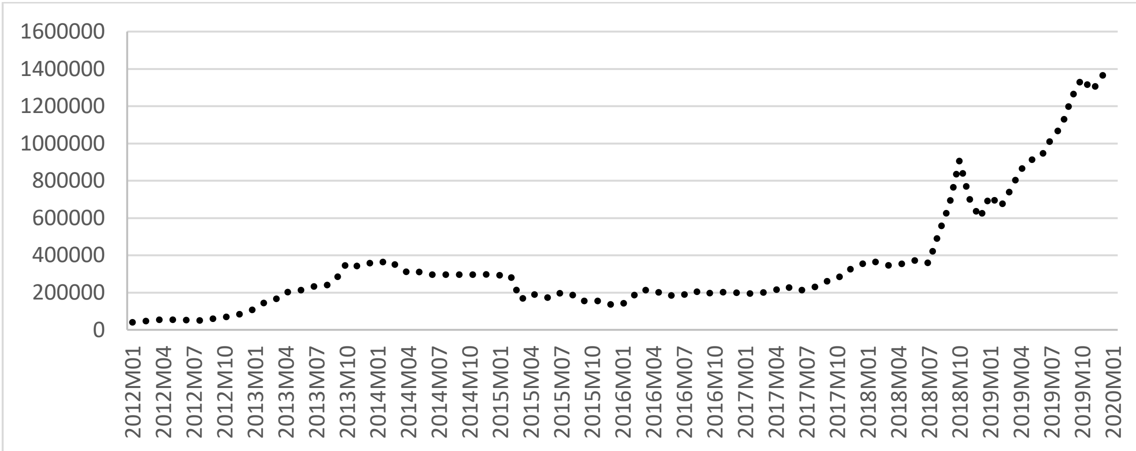
(iii) The period of exponentially increase in both exchange rate and inflation from the mid-2018 to the beginning of 2020 especially due to the uncertainty caused by withdrawal of the United State from the JCPOA international agreement, re-imposing the previous economic sanctions against Iran entitled "Maximum Pressure" policy particularly in the field of international trade and financial transactions, the ramification of widespread social discontent in the beginning of 2018, exchange rate manipulation, and the isolation of the Iran's economy in the international arena.

After analysing the movements of exogenous variables[2], i.e. inflation and exchange rate, the main question here is whether there are any considerable similarities between the time series data of the exogenous variables and petrochemical index that can be highlighted. To do this graphical comparison, the time-series graph of the petrochemical index is presented below.

[1] The Joint Comprehensive Plan of Action, JCPOA.

[2] Independent Variables

Figure 2: Evolution of Petrochemical Index



Source: The Databank of the Tehran Stock Exchange Organization

By comparing this graph with that of the exchange rate and inflation, it can be noted that the general behavior of these variables has a remarkable structural resemblance. To be more precise, the mentioned three classified periods for both the exchange rate and inflation can be approximately applied for this index as well. However, there are some little differences include:

i. It seems that the length of the three classified periods on the petrochemical industry index case is slightly longer. It can be attributed to the transmission (pass-through) time (the required time for transmitting the impacts of movements in the exchange rate, inflation, and other influential macro-factors into the petrochemical index).

ii. In the second classified period, the story was a little complicated for the petrochemical stock index owing to the fact that unlike exchange rate and inflation that have had a certain trend (rising and falling respectively), this index has had a slight and smoothing mix of rising and falling trends.

iii. In some special times like in the late months of 2018, the behaviour of the petrochemical index was become different and accompanied by a very sharp increase. The reason behind this event is due to setting some successive new records as a result of a chain of reasons includes: increasing inflation, manipulated foreign currency market through foreign exchange intervention, inefficient monetary markets, imposing economic uncertainties due to the international sanctions on investors (Hot Money), lack of alternative investment markets, and so forth. However, speculative activities and over-weighing the real impact of the sanctions doubled the pressure on the stock price to fall after reaching its historic record in less than three months.

3. Methodology

In this study, to investigate the relationship between Iran's petrochemical stock index, inflation, and exchange rate misalignments, a nonlinear and asymmetric ARDL method, NARDL, will be used on the ground that this model gives some special opportunity to researchers for analyzing the relationship between variables from assorted aspects. To be more precise, the NARDL model, like ARDL one, considers various time horizons (both dynamic short and long -run). It is a subclass of Error Correction Models (ECM) which can figure out an adaptation velocity of instability in equilibrium path among short-run to long-run horizons. Furthermore, this model can distinctively determine the exact numbers of lag distribution for either dependent and independent variables[1] so that NARDL model can avoid unnecessarily losing the degree of freedom. Moreover, the remarkable features of NARDL are the possibility of analyzing nonlinear and asymmetric relationships between different variables, make a distinction between the asymmetric effects of positive and negative changes in exogenous variables on endogenous one separately and in the form of divided coefficients (Motahari et al., 2018).

Although the NARDL model has different abilities to accurately evaluate the relationship between variables, it has some pre-requirements if are ignored, the results of the NARDL estimation could not be valid and reliable. One of the most essential prerequisites of this model is examining the non-stationary of variables owing to the fact that like the other ECM estimations, the NARDL model can be used for non-stationary variables to have assorted horizons' estimations. The other pre-requirement of the model is probing the existence of co-integration, or stable long-run, the relationship among non-stationary variables. After confirming the existence of long-run relationship among the variables, two stages based on which the NARDL model estimates, i.e. separately estimating the long-run and short-run relationships, will be presented (Shin et al. 2014). In line with this, the general form of long-run relationship, in NARDL framework, is evaluated as follows:

$$(1)\quad \text{The Dynamic Short-run Equation}: \Delta Y_t = C_4 + \sum_{j=1}^{p} \alpha_j \ \Delta Y_{t-j} + \sum_{i=0}^{q_1} \beta_i \ \Delta X^{+}_{t-i} + \sum_{k=0}^{q_2} \beta_k \ \Delta X^{-}_{t-k} + \underbrace{\rho Y_{t-1} + \theta_1 X^{+}_{t-1} + \theta_2 X^{-}_{t-1}}_{\text{The Long-Run Equation}} + \varepsilon_t$$

For more information about the model and related calculation, like ECT, refer to [Ullah et al., 2020; Hussain et al., 2019; Hamid & Kamalian, 2018; Shin et al., 2014]. It should be noted that exchange rate misalignments time series data are reached by differences in the exchange rate trend data, calculated by Hodrick Prescott filter, from its actual ones. In other words, the calculated exchange rate trend is considered

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[1] Endogenous and Exogenous Variables

as the equilibrium exchange rate. This way, the differences of actual exchange rate from the equilibrium amounts in each period of time is supposed as the exchange rate misalignments.

4. Empirical Results

Considering the main purpose of the research, using the NARDL model, the monthly logarithmic data of Petrochemical stock index, inflation and exchange rate misalignments, from 2012:01 to 2020:01, have been applied. In this regard, the abbreviations of applied variables in this study are as follows:

Table (1): Introducing the Research Variables

Raw	Variable	Description
1	LPI	The Logarithm of Petrochemical stock index
2	dLPI	The first difference of LPI
3	$LEXM_t$	The logarithm of exchange rate misalignments
4	$LEXM^+_t$	The positive component of LEXM based on the NARDL decomposition process
5	$LEXM^-_t$	The negative component of LEXM based on the NARDL decomposition process
6	$dLEXM^+_t$	The first difference of $LEXM^+_t$
7	$dLEXM^-_t$	The first difference of $LEXM^-_t$
8	$LINF_t$	The logarithm of inflation
9	$LINF^+_t$	The positive component of LINF based on the NARDL decomposition process
10	$LINF^-_t$	The negative component of LINF based on the NARDL decomposition process
11	$dLINF^+_t$	The first difference of $LINF^+_t$
12	$dLINF^-_t$	The first difference of $LINF^-_t$

At first, the exogenous variables must be decomposed according to the NARDL model structure. Based on this, before estimating the NARDL model, it should be answered that what is the practical concept of the positive and negative components of inflation and exchange rate misalignments? To answer, it is interesting to know that while the $LEXM^+$ refers to the amounts of exchange rates that are valued more than its actual value, the $LEXM^-$ presents the under-valued exchange rates. In addition, the $LINF^+$ includes the increases in inflation and, conversely, $LINF^-$ represents the decreases in inflation.

Basically, every general statistical modelling process consists of three different parts: pre-modelling tests, modelling, and diagnostic tests. In this part, the pre-modelling tests presents, unit-root and co-integration tests. Then, the results of modelling and its diagnostic tests will be provided. In this regard, the most essential pre-modelling test in using time series data is a unit root that should be done to avoid spurious regression. In line with this, the ADF stationary test, introduced by Dicky and Fuller (1979), has been exerted on the research variables, as follows:

Table (2): Unit-Root Test

	At Level			At First difference	
	None	**Intercept**	**Intercept and Trend**	**None**	**Result**
LPI	2.694 (0.998)	-1.004 (0.749)	-1.416 (0.850)	-8.443 (0.000)	I(1)
$LEXM^{+}_{t}$	1.931 (0.986)	-0.205 (0.933)	-1.512 (0.818)	-5.699 (0.000)	I(1)
$LEXM^{-}_{t}$	3.673 (1.000)	2.410 (1.000)	0.978 (0.999)	-2.657 (0.008)	I(1)
$LINF^{+}_{t}$	3.352 (0.999)	2.846 (1.000)	-0.543 (0.829)	-4.351 (0.000)	I(1)
$LINF^{-}_{t}$	0.195 (0.741)	-1.453 (0.552)	-1.831 (0.681)	-2.019 (0.029)	I(1)

The table above illustrates that all research variables are first difference integrated, i.e. I(1). This issue corroborates with the error correction models' conditions owing to the fact that in such models, at least two non-stationary variables are required to have long and dynamic short-run relationships. Furthermore, to, there should be at least one co-integration vector among non-stationary variables is required to have convergence dynamic short-run and stable long-run relationships. Therefore, in table 3, the co-integration among LPI, $LEXM^{-}$, $LEXM^{+}$, $LINF^{+}$, and $LINF^{-}$ will be tested by the Johansen- Juelius method, proposed in 1990.

Table (3): Co-Integration Test

Unrestricted Cointegration Rank Test (Trace)				
The Null Hypothesis	Eigenvalue	Trace Statistic	Critical Value at 0.05	Probability
None *	0.350871	86.58305	69.81889	0.0013
At most 1	0.289487	47.25977	47.85613	0.0568
At most 2	0.099392	16.15893	29.79707	0.7011
At most 3	0.068064	6.632597	15.49471	0.6207
At most 4	0.002392	0.217935	3.841466	0.6406
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
The Null Hypothesis	Eigenvalue	Max-Eigen Statistic	Critical Value at 0.05	Probability
None *	0.350871	39.32328	33.87687	0.0101
At most 1 *	0.289487	31.10084	27.58434	0.0169
At most 2	0.099392	9.526334	21.13162	0.7878
At most 3	0.068064	6.414663	14.26460	0.5606
At most 4	0.002392	0.217935	3.841466	0.6406

According to the results of table 3, based on Trace and Max-Eigenvalue tests, at least one and two co-integration relationships, respectively, are existence among the non-stationary research variables. Thus, applying the NARDL model to estimate the relationship among the research variables is allowed.

Table (4): NARDL Estimation Results

Long-Run			Dynamic Short-Run		
The Dependent Variable: LPI			The Dependent Variable: dLPI		
Coefficient Name in the Equation	**Independent Variables**	**Coefficient**	**Coefficient Name in the Equation**	**Independent Variables**	**Coefficient**
C(1)	C	10.53*	C(7)	LPI_{t-1}	-0.837*
C(2)	$LEXM^{+}_{t}$	2.36***	C(8)	$LEXM^{+}_{t-1}$	0.118*
C(3)	$LEXM^{-}_{t}$	-3.21*	C(9)	$LEXM^{-}_{t-1}$	-0.133*
C(4)	$LINF^{+}_{t}$	-2.58*	C(10)	$LINF^{+}_{t-1}$	-0.083*
C(5)	$LINF^{-}_{t}$	1.52*	C(11)	$LINF^{-}_{t-1}$	0.059**
F-Bound		4/65*	C(12)	$dLPI_{t-1}$	0.63*
Diagnostic criteria			C(13)	$dLPI_{t-2}$	0.21**
Adjusted R-squared		0.97	C(14)	$dLEXM^{+}_{t}$	0.38**
F-statistics		667.133	C(15)	$dLEXM^{-}_{t}$	-0.45*
F-Probability		(0.000)	C(16)	$dLEXM^{-}_{t-1}$	-0.08*
Ljung-Box [Q-Statistics (1)]		0.0084	C(17)	$dLINF^{+}_{t}$	-0.32*
Q-Probability		(0.927)	C(18)	$dLINF^{+}_{t-1}$	-0.11*
ARCH (1)		0.389	C(19)	$dLINF^{-}_{t}$	0.19*
ARCH-Probability		(0.534)	C(20)	$dLINF^{-}_{t-1}$	0.06*
Durbin Watson statistics		1.9981	C(6)	C	1.76*

*, **, and ***, respectively, represent 99%, 95%, and 90% significance level.

With regard to table 5 results, it can be stated that the coefficients of all variables are statistically significant at the confidence level of 95%, despite from the coefficient of $LEXM^{+}_{t}$ in the long term which is significant at the 90% confidence level. In this regard, the amount of Adjusted R-squared and F statistics of the model, in order, presenting that 0.97 percent of dependent variable behavior is explained by the research independent variables and the explicit form of the estimated model is significant, is consistency with the coefficients probability of variables. In line with this, based on the results of F-bound test, the null hypothesis of this test which is “there is no significant stability in the long-run equation of the NARDL model” is rejected. Moreover, the statistics and probability of Ljung-Box test, like Durbin Watson statistics, prove that the number of lag distribution are accurately determined due to the fact that there is no serial correlation among residuals of the estimated model. Besides, the results of ARCH test demonstrate that there is no heteroscedasticity in residuals of the model. Hence, the finding of the estimated NARDL model is valid and reliable. Although the diagnostic tests have proven the reliability and validity of estimated model presented in the table (4), the graphic tests, like Cusum and Cusum square ones, have been done and the results of which can be seen in the figures (3) and (4):

Figure 3: Graph of Cusum test

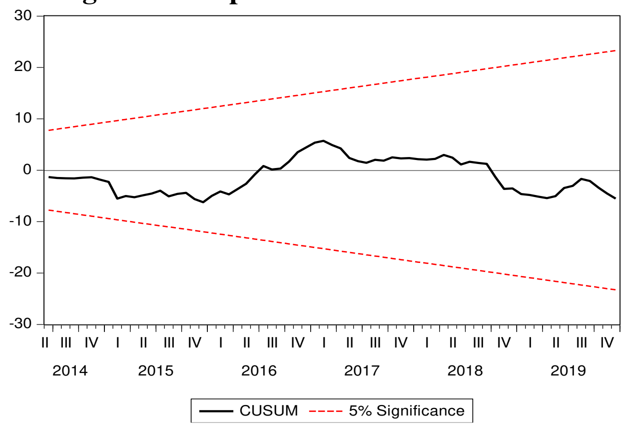
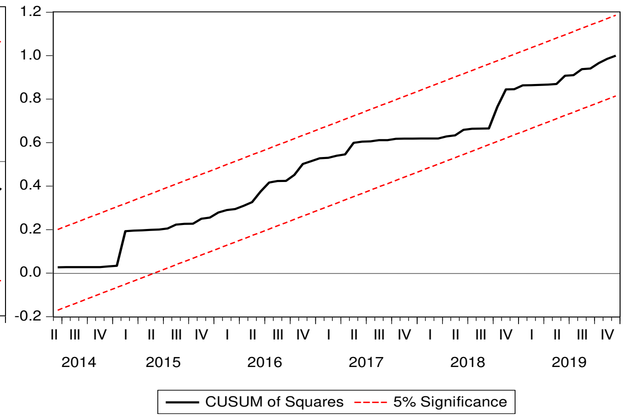


Figure 4: Graph of Cusum Square test



As it can be seen in the above graphs, the results of CUSUM and CUSUM Square tests verify the existence of stability in the estimated model because the model's residuals in both graphs are located in the threshold bound which (based on the theoretical background of this test) it means the standard errors and squared standard errors of the estimated model are low enough to trust on its results.

Therefore, the results of the mentioned tests corroborate the authenticity of the model findings, and it should be stated that the coefficients of variables are significantly consistency with the economic theories and Iran's real experiments. More interestingly, after achieving an accurate estimation and results, analyzing the coefficients of each component of the independent variables (particularly based on theories and empirical pieces of evidence) confirm that the relationships between the independent variables and petrochemical index are asymmetric. To provide another evidence, the most key terms of the NARDL model, ECT, are presented in table 5. Generally, the results of ECT coefficients which shows the dynamic relationship in the estimated model, indicates that if an exogenous positive or negative shock (from each component of independent variables) makes the model lose its long-term equilibrium path, the impact of this shock (i.e. its longevity) will be disappeared or neutralized, respectively, after how many periods (these time can be calculated through reversing the coefficients of positive and negative ECTs). Based on these concepts, the longevity of any independent shocks, produced by each of $LEXM^-$, $LEXM^+$, $LINF^+$, and $LINF^-$ variables, will be measured and analyzed.

Table (5): Calculating ECT of the NARDL Estimation

Variable	ECT	Longevity
$LEXM^+_{t-1}$	-0.14098	7.09322
$LEXM^-_{t-1}$	-0.1589	6.293233

$LINF^{+}_{t-1}$	-0.09916	10.08434
$LINF^{-}_{t-1}$	-0.07049	14.18644

Based on the NARDL framework, ECT for each of the independent components, i.e. positive and negative, is derivative of LPI_{t-1} relative to that variable like below equations:

(2) $$m_{h_1}^{+} = ECT^{+} = \sum_{r=0}^{h} \frac{\partial LPI_{t+r}}{\partial LEXM_{t+r}^{+}} = -\left|\frac{C(8)}{C(7)}\right| = -0.14098$$

(3) $$m_{h_1}^{-} = ECT^{-} = \sum_{r=0}^{h} \frac{\partial LPI_{t+r}}{\partial LEXM_{t+r}^{-}} = -\left|\frac{C(9)}{C(7)}\right| = -0.15890$$

(4) $$m_{h_2}^{+} = ECT^{+} = \sum_{r=0}^{h} \frac{\partial LPI_{t+r}}{\partial LINF_{t+r}^{+}} = -\left|\frac{C(10)}{C(7)}\right| = -0.09916$$

(5) $$m_{h_2}^{-} = ECT^{-} = \sum_{r=0}^{h} \frac{\partial LPI_{t+r}}{\partial LINF_{t+r}^{-}} = -\left|\frac{C(11)}{C(7)}\right| = -0.07049$$

For instance, in table 5, if the shock rises from the positive changes in exchange rate misalignments, the amount of ECT can be measured through equation 2. The interpretation of this parameter is if a shock from $LEXM^{+}_{t-1}$ gives rise to the instability of long-run relationship, 0.14 of the instability will be eliminated in each period, consequently, after roughly 7 periods, days, the new long-run equilibrium will be reached. This process is the same for the other independent variables.

Ultimately, to statistically evaluate the authenticity of applying NARDL, the final test, Wald, should be done. The Wald test, with considering H_0 and Chi-square statistics, examines whether the coefficients of the variables are equal or whether there is any significant difference between two coefficients of the variables. On this basis, to statistically assess the validity and accuracy of the estimated NARDL model, the existence of an asymmetric relationship between the positive and negative components of exchange rate misalignments and inflation (separately) in the long-run, dynamic short-run, and error correction model will be tested in table 6.

Table (6): Testing Asymmetric Coefficients

H_0	Value	Chi-square	Probability	Results
Long-Run				
C(2)-C(3) =0	5.58655	9.830796	0.0009	Rejected
C(4)-C(5) =0	-4.11454	8.104115	0.0024	Rejected
Dynamic Short-Run				
$\sum_{i=0}^{q_1} \beta_{i_1} - \sum_{k=0}^{q_2} \beta_{k_1} = 0$	0.924957	4.675237	0.0178	Rejected

$\sum_{i=0}^{q_1}\beta_{i_2} - \sum_{k=0}^{q_2}\beta_{k_2} = 0$	-0.70695	6.542356	0.0059	Rejected
Error Correction Model				
$m_{h_1}^{+} - m_{h_1}^{-} = 0$	-0.30093	5.431245	0.0113	Rejected
$m_{h_2}^{+} - m_{h_2}^{-} = 0$	0.170757	4.81195	0.0164	Rejected

Providing the Wald test, it has been approved that there are statistically significant asymmetric relationships between positive and negative components of the exchange rate and inflation in all the mentioned equations.

5. Conclusion

Using the monthly period of January 2012 to January 2020, the primary contribution of this research to the literature is asymmetrically considering the recent fluctuations of economic indexes through changes in the foreign exchange market (in the form of changes in exchange rate misalignments) and also inflation by applying a dynamic and nonlinear framework, i.e. NARDL. Overall, the results Wald test both in long-run and dynamic short-run along with the stability of the results based on the Cusum and Cusum square tests have proved the main concerns of this study, on the ground that, both exchange rate misalignments and inflation have had significant asymmetric effects on the petrochemical stock index.

To be more precise, both in the long-run and short-run, the total effects of exchange rate misalignments have been more than that of inflation which means that this industry is more significantly affected by the movements in the exchange market. This is because the role of international trade in this business like exporting its products and importing the raw materials and technologies, on one hand, and relatively low dependence of the most important inputs of the industry (e.g. subsidized natural gas prices) on the changes in the general price level or inflation, on the other hand.

Moreover, providing asymmetric analysis is another attractive finding of applying the NARDL model. In the case of the relationship between exchange rate misalignments and petrochemical stock index, the effects of negative components of exchange rate misalignments are more than its positive components. It means that generally, the exchange rate undervaluation has had more effects on the petrochemical index's rate of returns than its overvaluation. Although it may have occurred due to the remarkable frequency of the exchange rate undervaluation occurrence in Iran, there can be a direct relationship between how the currency is valued with export-oriented industries. In this regard, the longer the period of exchange rate undervaluation, the cheaper the export of Iranian petrochemical products to foreign buyers, the greater the return on petrochemical industry's shareholders, and vice versa. Therefore, as long as there is evidence of an undervaluation of the exchange rate in economy of Iran, investing in export-oriented industries like petrochemical industry would be relatively profitable.

However, to provide more accurate analysis about the relationship between inflation and petrochemical stock index, it should be considered that the positive components inflation has had more impacts on the stock index than its negative components. This finding shows the fact that an increase in inflation can averagely be led to more increase in the stock index than the effects of the same amount of decline in the inflation; consequently, the investors as well as brokers in Iran must take more proactive response to rising inflation. Besides, as another attractive finding of this study, the high level of validity and statistical reliability of the results shows that applying the non-linear and asymmetrical analysis can be considered as a significant cause for the lack of consensus among empirical studies about the relationship between inflation and stock returns.

Furthermore, as the results show, the roots of existing nonlinear and asymmetric relationships among different components of independent variables with the petrochemical stock index are so strong that changes in time horizons, from short run to long run, have also not been able to change the type of relationship between these variables as well as the difference in the magnitude of effects of positive and negative components of the independent variables on the stock index. In line with this, the findings based on the Error Correction Model demonstrate that the longevity of exchange rate misalignments components shocks is, generally, will be disappeared faster than the impacts of the shocks from inflation components. This means not only do investors and brokers respond more strongly to foreign currency market movements in comparison with changes in inflation, but they react quickly to the foreign currency market movements as well.

Ultimately, not only has nonlinear modelling been able to significantly model the relationships of different components of exchange rate misalignments and inflation with petrochemical stock index, but combining this modelling technique with an asymmetric analysis approach has shown that it can lead to more reliable results. this finding indicates as long as the economic sanctions and especially the “Maximum Pressure” policy is underway, the central bank does not apply market rules to regulate the foreign currency market, and existing inflationary monetary policies are not corrected and implemented, behaviors of economic agents cannot follow a linear and symmetric structure. Consequently, to overcome the concerns about occurring bias in making efficient economic and financial decisions and optimizing the investment portfolio in the Tehran Stock Market, using the nonlinear and asymmetrical approach would lead us to significant results.

6. Reference

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