Economic activity and financial variables in Mexico

Francisco López-Herrera*
Alejandra Cabello**
Edgar Ortiz***

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Abstract

This paper analyzes the relationship between economic activity in Mexico and a set of relevant Mexican financial variables. Monthly data for the period January 1993 to August 2018 includes time series of global economic activity index, consumer price index, peso-USD exchange rate, international reserves, interest rate of short-term Mexican T-bills, Mexico’s stock market index and its level of activity as measured by the volume of operations on variable income assets. The analysis is based on an Autoregressive Distributed Lag (ADRL) model. The empirical evidence reveals that all explanatory variables, except the stock market index, show a long-run relationship with the level of Mexican economy activity.

Keywords: economic activity, financial variables, ARDL.

JEL classification: E44, G10, O16.

* Profesor-investigador en la Universidad Nacional Autónoma de México. Address: Yucalpetén 260, col. Héroes de Padierna, Alcaldía de Tlalpan, cp. 14200, CDMX. México, <francisco_lopez_herrera@yahoo.com.mx>.
** Profesor-investigador en la Universidad Nacional Autónoma de México. Address: Costado del Atrio 40-2, Barrio de San Francisco, Alcaldía de Coyoacán, cp. 04320, Ciudad de México.
*** Profesor-investigador en la Universidad Nacional Autónoma de México. Apartado 21-244, Alcaldía de Coyoacán, cp. 04000, Ciudad de México, <edgaro@unam.mx>.
Actividad económica y variables financieras en México

Resumen

Este artículo analiza la relación entre la actividad económica en México y un conjunto de variables financieras mexicanas relevantes. Los datos mensuales para el periodo enero de 1993-agosto de 2018 incluyen series temporales del indicador global de la actividad económica, índice de precios al consumidor, tipo de cambio peso-USD, reservas internacionales, tasa de interés de los T-Bills mexicanos a corto plazo, el índice bursátil mexicano y su nivel de actividad medido por el volumen de operaciones en activos de renta variable. El análisis se basa en un modelo autoregresivo de rezagos distribuidos (ARDL). La evidencia empírica revela que todas las variables explicativas, excepto el índice bursátil, muestran una relación de largo plazo con el nivel de actividad de la economía mexicana.

Palabras clave: actividad económica, variables financieras, ARDL.
Clasificación JEL: E44, G10, O16.

1. Introduction

The relationship between economic activity and key financial variables has motivated numerous studies since economic growth depends largely of capital formation and in addition on an efficient allocation of resources carried out in equilibrium conditions. One course of research on this theme has dealt it as part of asset pricing theory considering financial and macroeconomic variables as a source of stock returns’ risk that must be priced, paying to investors a corresponding risk premium; the emphasis is on an efficient market rewarding investors. This process should lead to strengthen economic growth by enhancing liquidity for corporate growth and fostering a diversified, less risky and competitive real sector. The intention is to identify those variables that built up the stock market and the financial sector in general to foster investments; in this framework stock markets are an important part of the financial infrastructure a country needs to support a vigorous and sustainable economy. To this trend of though
belong the Capital Asset Pricing Model (CPM), asset oriented multifactorial models (AMFM), and Arbitrage Pricing Theory (APT).

Another strand of research goes in the opposite direction; its interests are concerned with the influence of financial variables performance on the overall economy, which is treated as the dependent variable. The key issue here is the contribution of financial and macroeconomic variables on economic growth and prosperity. To this trend of reasoning belong growth oriented multifactorial models (GMFM) and autoregressive multifactorial models, among which for its dynamic long-term approach stands out the Autoregressive Distributed Lag Model (ADRL) employed in our analysis. In this regard, identifying the sources of growth is crucial to construct a path of long-term stable growth based on strong inputs and coordinated policies. An important discussion about it, for example, is the debate about dependency of economic growth on the financial sector; within that issue stands out the role of financial markets and financial variables because they link and are linked to all consumption, and investment decisions of all sectors of an economy. Therefore, the articulation, mutual impacts between the real and financial sectors is paramount to determine economic growth. This subject deserves special concern for developing countries. Despite of important advances in their financial systems, they remain fragile and vulnerable to external shocks. Moreover, because of economic and financial openness, in very volatile and speculative global markets, financial markets and institutions from emerging markets and corresponding economic policies (mainly monetary and exchange rate policies) intended to foster growth become ineffective, often ensuing crisis which generate large economic setbacks and increase inequalities. Taking into account global financial trends, and the recurrent local and financial crisis, the financial sector becomes a crucial economic risk for economic growth; potentially its instability and cracks can undermine monetary policies and economic growth of developing countries. This is precisely the point of departure and contribution of this paper. It aims to identify the relationships between financial variables and economic activity for the case of Mexico.

The paper is organized in four sections. The second section reviews related literature. The third section presents the methodology. The fourth section presents the data and the empirical evidence. Finally, a section of conclusions ends the work.
2. Related studies

As previously pointed out, research concerning the importance of financial variables and economic growth has followed two courses. One dealing with their importance on asset valuation, and another strand of research concerned with the influence of financial variables performance on the overall economy. Both lines of research are important to ascertain variables germane to the Mexican economy.

Based on the Capital Asset Pricing Model (CAPM) advanced by Sharp (1964), to overcome its limited one factor approach and assumption of linearity and a constant beta, to study the relationship between key financial variables and stock market, two models have been applied: multifactor models and the Arbitrage Pricing Theory model (APT) created by Ross (1976).

The first approach assumes that the return of an asset can be described by a linear multifactor model (Elton and Gruber, 1992): different stocks can have different systematic risk (betas) for different factors. Arbitrage Pricing Theory on the other hand, is an equilibrium model. Market returns are a function of various factors, but the associated risk factor is common to different assets; hence, two identical assets cannot sell at different prices. In the absence of explicit theoretical principles, selection of variables for the multifactor models depends entirely on empirical research, tested with various econometric criteria.

The first challenge to CAPM was advanced by Fama and French (1992; 1993; and 2015); based on their multi three factor model, they pointed out that there is no linear relationship between the expected return of an asset and systemic risk; their model included five common risk factors: an overall market factor, firm size, book-to-market equity, and two bond market yield differentials. An extension of this model by Carhart (1997) includes a momentum factor, the likelihood of a price movement to continue either increasing or decreasing. Numerous studies have included financial variables to determine asset returns; however, the complexity of financial markets and economic forces has often induced researchers to include macroeconomic factors in their studies.

Hence, recent APT multifactor studies have included stock price, operating cash flow, government bills rates (Rebello and Reddy, 2010); trade deficit, unexpected inflation, country risk premium (Mateev and Videv, 2008), Fama’s three-factor model; (Nieto, 2001); corporate profitability, past stock
price movement, and imitation of other traders (Pyo, 2014); Fama and French (2014) five factor model which adds profitability, and investment; and a comparison among CAPM, the three factor model and the four factor model (Afzali and Monfared, 2016; and Abeysekera and Nimal, 2017) application of the four factor model.

APT (Ross, 1976) is an important advancement in asset valuation, essentially it requires less and more reliant assumptions than CAPM; Ross introduced its theory as an equilibrium model alternative to CAPM. It calls for less and more realistic assumptions to be generated by a simple arbitrage argument and its explanatory power is potentially better since it is a multifactor model proposed to capture some nonmarket impacts that cause securities risk premia, Jecheche (2011). Factors to be include in the model are uncorrelated and their selection is accomplished employing factor analysis or principal component analysis; modelling may require different factors for different periods and different markets.

Ross did not identify specific factors for his model and no major applications appeared in the literature for some time. Nonetheless, a key work by Chen, Roll and Ross (1986) recognized five factors for the US market: non expected inflation; changes on expected inflation; innovations in industrial production (a proxy for GNP); innovations in default premium in corporate bonds; and innovations in the yield curve; the work became a case in point and many studies have followed, but relatively fewer than those carried out for CAPM. Hence, following Ross innovations different factors have been identified for the markets analyzed. Some studies dealing with developed countries are those by Kryzanowski and Zhang (1992); Clare and Thomas (1994); Cagnetti (2002); Günsel and Çukur (2007); Hamao (2008); Talla (2011); Factors identified by these authors include inflation, currency depreciation, term structure of interest rate, money supply, GDP and Industrial production.

For the case of emerging markets some studies worth mentioning include de la Calle (1992); Navarro (1999); Niarchos and Alexakis (2000); Tursoy, Günsel and Rjoub (2008); Faruque (2011); Balint (2011); Jecheche (2011); and Zhu (2008). Variables associated with systematic risk in these markets are stock prices, GNP, industrial production consumer price index, foreign exchange rate, exports, foreign reserves; unemployment rate; interest rate; money supply; imports, Standard & Poor’s 500 price series; dollar oil price; Dow Jones Index; and gold price.
Research devoted to determining the impact of financial variables on economic growth employing multifactor growth-oriented models (GMFM) is ample.

Their interest does not focus on demonstrating equilibrium conditions, but simply highlighting the dynamics of that relationship, as well as the contribution (positive or negative) of each factor to output, but orienting analysis of the evidence to improve monetary and exchange rate policies. Some studies, akin to the multivariate approach employed in this paper, for the case of developed markets include Eridisuriya (1995); Erdem and Tsardinas; Ferrara and Marsilli (2014); Kuosmanen and Vataja (2017). To predict Australia’s GDP growth Eridisuriya (1995) employs financial variables, such as the 90-day Treasury bill rate, 10-year Treasury bond rate, interest rate spread, Australian stock index data, and housing prices (obtained by probit maximum likelihood estimation).

The empirical evidence confirm that financial variables are a useful tool for forecasting future economic activities in Australia. Erdem and Tsardinas (2013) examine lead-lag statistical relationships between financial and real sector variables for the case of four countries: Canada, Germany, the United Kingdom and the United States: Their evidence shows consistently across countries, financial factors do contain information about macroeconomic variables. This is more evident in the case of output. Including financial factors and their lags in the forecasting equations for real and nominal GDP growth significantly improves their explanatory power compared to using past values of real variables only.

The financial factors also improve the fit of the forecasting regressions for inflation, but their contribution is weaker. Ferrara and Marcelli (2014) examine the predictive power of key financial variables to anticipate GDP growth in Euro area countries during the 2008-2009 Great Recession. Implementing a Mixed Data Sampling (MIDAS) based modelling approach to forecast quarterly Gross Domestic Product (GDP) growth rates. Their evidence shows that, overall, stock prices help to improve the accuracy of GDP forecasts, but oil prices and term spread seemingly are less informative. Finally, Kuosmanen and Vataja (2017) explore the predictive ability of term spread, short-term interest rate and stock returns for real GDP growth in the G-7 countries. They compare the predictive content of nominal financial variables versus that of real financial variables and consider the proper number of financial predictors and time variations of forecasting performance. The
Empirical evidence shows that financial variables have regained their predictive power since the financial crisis.

Concerning evidence dealing with developing countries are the works by Hondroyannis and Papapetrou (2001); Ozbay (2009); Ngoo and Ling (2014); Usman and Adejare (2014); Hondroyannis and Papapetrou (2001) examined, for the period January 1 1984 to September 1999, the dynamic relationship between the Greek stock market and interest rates, exchange rate, real oil prices, and the behavior of the US stock market represented by the S&P index. Ozbay (2009) explore macroeconomic causes of the Istanbul Stock Exchange (ISE) during the 1998-2008 period; variables included inflation, interest rate, money supply, real economy, and exchange rate. Findings of the study, based on correlation analysis, indicate negative significant relationships between stock returns and interest rates and a positive significant relationship between stock returns and foreign investors transactions.

Moreover, results indicate insignificant relationships between stock returns and other factors such as inflation, exchange rate, money supply, and industrial production. However, Granger causality test signal a bidirectional causal relationship and overnight interest rate and stock returns; the study also shows the unidirectional causal relationship running from stock returns to Treasury interest rate. In turn, Usman and Adejare (2014) examine the effect of financial variables on Nigeria economy for the period 1988 to 2010. Multiple regressions are employed to analyze Gross Domestic Product (GDP) and the relationship with narrow money, broad money, exchange rate and interest rate. Results show that all variables were found having significant effects on economic growth.

Other works regarding the relationship between financial variables and growth for the case of developing economies have been presented by Hidayat, Suman and Kaluge (2014); Semuel and Nurina (2015); Moroşan and Zubaş (2015). Hidayat, Suman and Kuldege (2014) examine the impact of inflation, interest rates and government expenditure in Indonesia between 2005-2012. Their evidence shows a high influence of those variables on economic growth. Results are in line with Keynesian theory for government spending impulses economic growth. In turn, Semuel and Nurina (2015) employ Partial Least Squares to study the relationship between inflation, interest rates, and exchange rates and GDP. Their evidence reveals a significant negative relationship of interest rates on GDP and a significant positive relationship of the exchange rates on GDP; however, apparently, inflation
has no significant influence on GDP. Data used included the June 2005 to December 2013 period. Moroşan, and Zubaş (2015) consider the Romanian case. Their modeling includes current and lagged variables for the period 2005-2014. Results show that the influence of the exchange rate and inflation do not have an immediate effect in the case of Romania but do have a delayed effect.

Financial research in India reveals to be a healthy and growing area. Concerning the links between stock markets and macroeconomic factors recent research is ample. Worth mentioning are recent papers by Singh (2014), Patel (2012), Mohanamani and Sigagnanasith (2014), Gurloveleen and Bz-thia (2015), Kotha and Sahu (2016). Singh (2014) examines the relationship between macroeconomic variables applying a multivariate step regression and causality tests. Granger’s causality test are applied to analyze a dynamic causality test among the variables. The set of variables include the BSE Sensex and S&P CNX NIFTY, industrial production, wholesale price index, money supply (M3), interest rates, trade deficit, foreign institutional investment, exchange rate, crude oil price, and gold price. The time series include monthly data from January 2011 to December 2012.

Empirical results reveal the presence of a significative impact on the Indian stock market. Gold prices have a negative impact; this active has been used as an alternative investment restricting share prices growth; however foreign institutional investment inflows and money supply have a positive effect on the market and, exchange rate leads to adverse effects. The evidence indicates also a long run relationship between macroeconomic variables and stock market indices; while causality runs from exchange rate to stock market indices, to industrial production, and to oil price. The authors suggest government controls to reduce interest of investors in gold and enhance the investment in share market through improving the confidence level of investors in the Indian stock market.

correction Model. The evidence also found a long run relationship between macroeconomic variables and stock market indices; finally, the study also revealed that causality runs from exchange rate to stock market indices, to industrial production, and to oil price. Mohanamani and Sigagnanasith (2014) deal with the impact of macroeconomic variables on the behavior of Indian Stock market. Monthly data of six macroeconomic variables which include BSE Sensex index, call money rate, exchange rate between Indian rupees and US dollar, foreign institutional investment, Industrial productivity, money supply and whole sale price index for the period 2006:04 to 2013:07.

In addition to descriptive statistics, the econometric modeling comprises Pearson’s correlation matrix, unit root test and Granger causality tests. The empirical evidence reveals that Indian stock market is positively whole sale price index, money supply and industrial productivity. The exchange rate and inflow of foreign institutional investment are found to be insignificant to Indian Stock market. In the Granger Causality sense, whole sale price index and industrial productivity influence the stock market considerably.

Gurloveleen and Bzthia (2015) present a detailed study on the impact of macroeconomic variables on the functioning of Indian Stock Market. Monthly data of ten macroeconomic variables is employed: Broad Money, Call Money Rate, Crude Oil Price, Exchange Rate, Foreign Exchange Reserve, Foreign Institutional Investors, Gross Fiscal Deficit, Index of Industrial Production, Inflation Rate and Trade Balance and one stock market index, that is, BSE. The methodology applied includes Augmented Dickey Fuller (ADF) Test, Multiple Regression and Granger Causality Tests.

Results indicate that foreign institutional investors became stationary at level; call money rate, crude oil price, exchange rate, foreign exchange reserve, gross fiscal deficit, inflation rate and trade balance at first difference and broad money and index of industrial production at second difference. This stationary data was been applied to find out the significant macroeconomic variables through multiple regression technique. Two macroeconomic variables, foreign institutional investors and exchange rate were found significant. Granger causality test was used to check the causality relationship between these two significant variables and average closing prices of 10 manufacturing firms of BSE 500. The evidence revealed that these variables have no relationship with closing prices of BSE 500 manufacturing firms. The study also revealed that the Indian Stock Market was a weak form efficient because no relationship was found
amongst the variables during the study period. Kotha and Sahu (2016) explore long and short run relations between the Indian Stock Market Index and key financial variables for the period July 2001 to 2015. Important reforms were introduced in this period, mainly a ban of Badla system a traditional carryforward system which was substituted by a rolling settlement and the introduction of stock derivatives. The authors employ cointegration analysis and error correction model (ECM). Results reveal the presence of long run relation between the BSE Sensex and exchange rate, wholesale price index, T-bill rates and M3.

Surprisingly, research on China about stock markets and financial variables is limited in scientific journals in English. Two works are worth mentioning, both relating oil prices to stock market performance. Cong, Wei, Jia, and Fan (2008) investigate the interactive relationships between oil price shocks and Chinese stock market using multivariate vector auto-regression. Oil price shocks do not show statistically significant impact on the real stock returns of most Chinese stock market indices, except for manufacturing index and some oil companies. Some "important" oil price shocks depress oil company stock prices. In turn, the work by Yun and Yoon (2015) focus on the relationship between change of international crude oil price and Chinese stock price. They present ARMA-GARCH class models to test Granger causality test.

They also test volatility of crude price and stock price to analyzes their relationship and measure their degree of influence employing by impulse response function and variance decomposition. Their evidence of the Granger causality test show that comparing with, volatility of crude oil price holds a clear impact on the volatility of China’s stock prices, particularly Brent oil prices. Comparing by industries, China National Petroleum Corporation (CNPC) and energy industries are shocked largely by the price fluctuation of Brent, with high risk level, while industries such as consumption and IT face smaller changes, with low risk level in the market.

Five other works concerning emerging markets must be mentioned because the employ the ADRL methodology used in this work. Altaee, Al-Jafari, and Khalid (2016) report an analysis on the relationship between GDP and on gross fixed capital formation, export, import, and financial development for the Kingdom of Saudi Arabia. Annual data comprises the 1980-2014 period. The methodology includes an autoregressive distributed lag model (ARDL) and the error correction method (ECM). Their
evidence suggests a positive relationship between fixed capital formation, export, and economic growth, both in the short-run and the long-run.

However, the financial development variable showed a negative effect in the short-run but a positive effect in the long run. Finally, the import variable showed a negative contribution to growth in the long-run as well as in the short-run. The other work employing ADRL methodology does not take into consideration financial variables, but it is worth mentioning it. Ngoo and Loi (2014) examine the existence of Okun’s relationship (employment and losses in output) for Malaysia.

The relationship is measured by applying the first difference and gap model with Hodrick-Prescott filter (HP filter), furthered with Autogressive Distributed Lag (ARDL) to determine cointegration between the variables and their causality. A bidirectional relationship is found between unemployment rate and output growth. In line with the same line of studies, Tajudeen, and Abraham (2015) investigate, but only for Brent oil prices their impact on the performance of the Nigerian stock market. They apply an autoregressive distributed lag model including daily data for the period November 2007 to July 2009, i.e. during the Global Crisis period. Results signal that oil prices have a positive impact on the performance of the Nigerian stock market after a dynamic response lag of seven day, i.e. the Nigerian stock market is sensitive to oil prices.

The authors also suggest that policy makers should stabilize oil prices in Nigeria tightening regulations to shield the Nigerian stock market away from oil market shocks which would help to minimize the adverse effect that oil prices on stock prices. However, the authors acknowledge that while stabilizing of oil prices is important for overall macroeconomic management, oil prices are in turn driven by world demand, supply and speculative factors.

Chia and Lim (2015) examine the response of the Malaysian stock market on selected macroeconomic variables, namely industrial production, inflation, money supply (M1), interest rate and exchange rate over the period 1980:Q1 to 2011:Q3. By using the autoregressive distributed lag (ARDL) bounds test, this study documents the presence of a long-run relationship between share prices and economic activity. The long-run coefficients suggest that Malaysian share prices are influenced positively by money supply and interest rates, and negatively by inflation. Results from the error correction mechanism indicate that real returns are Granger caused by real money
growth and real interest rates. When the exchange rate is included in the estimation, significant relationship is observed, and this implies that exchange rate fluctuations can cause movement in stock prices. From the policy perspective, the results suggest that, monetary policies aimed at stabilizing inflation can impact the stock market positively. Since the movement of stock market is highly elastic to inflation, the relationship needs to be taken into account in developing policy for the benefit of the Malaysian economy.

The work by Tweneboah and Yeboah (2017) must be also reported; they examine the links among the foreign exchange market, money market, and stock market in the Ghana stock market. The sample period includes January 2000 to March 2015 and the econometric study includes the Autoregressive Distributed Lag framework and error correction analysis. Their evidence reveals the presence of a long-run relationship among exchange rates, interest rates, stock prices, and inflation. Additionally, exchange rate shows a statistically significant positive long-run effect on inflation; however, interest rates and stock prices were statistically insignificant, and the error correction term indicates that deviations from the long-run equilibrium relationship are corrected. Concerning the impulse response functions, inflation responds to its own shocks and shocks from nominal exchange rates, while the rest of the shock-response patterns not statistically significant. Finally, none of the variables has significant influence on exchange rates except a slightly significant for the case of consumer price index. His evidence suggests exchange rate is determined exogenously.

Finally, a few works related to Mexico must be mentioned. Ho (2016) presents a bivariate structural VAR model looking at the interrelationships between the stock market indexes of the MINT economies (Mexico, Indonesia, Nigeria and Turkey) and industrial production using monthly data from 2000:1 to 2014:12. A Granger/Block exogeneity test reveals that, the null hypothesis is not rejected in all cases, except the hypothesis that stock returns has a lead-lag effect on industrial production for the case of Mexico during the precrisis period but the reverse is not the case. VAR estimation revealed that real activity shocks hardly explain the variability in real stock prices during the precrisis period than the postcrisis period in the case of Indonesia, Nigeria and Turkey excluding Mexico which explained larger variation in the precrisis than the postcrisis period for both stock returns and real activity. Similarly, the evidence also reveals smaller variation of each variable on one another for variation of real activities due to innovations from
stock returns for Nigeria and Indonesia alone while Mexico and Turkey depict the opposite.

Consequently, his research shows additional evidence about the absence of a direct linkage between real stock returns and real economic activities, suggesting that the market is inefficient and most likely not derived or guided by fundamentals. López-Herrera and Ortiz (2006) apply a multivariate model to estimate the contribution of some key macroeconomic variables (selected through principal component analysis) to systematic risk of the Mexican Stock Market. Additional variables include the stock indexes from Canada and US share markets the Morgan Stanley International Capital Index and the one-month Libor rate to assess the degree of integration of the Mexican market to its neighboring partners of the North American Free Trade Agreement, as well as to the world market.

Findings reveal that risk premia are strongly associated with interest rates, and changes in money supply. Results also indicate that the stock market can serve investors to hedge against inflation. Finally, the evidence reveals that the Mexican Stock Market is only partially integrated with the Canadian, US, and world capital markets. This suggests the presence of opportunities for international portfolio diversification. Cermeño-Bazán and Solís-Montes (2012) examine the relationship about the arrival of news concerning macroeconomic performance and the Mexican Stock Market. The data includes daily series for the Mexican stock market index, seven sectorial indexes, and interest rates. The study looks at the reaction to announcements of macroeconomic news from US and Mexico of daily excess returns of the Mexican Stock Market Index. The methodology employed includes GARCH models focusing on unexpected news dealing with macroeconomic performance. The evidence shows that the dynamics of daily returns of the Mexican markets are linked to the arrival of fundamental news from the US and Mexico.

Summing up, research on the relationship between financial variables and either asset returns, or else on economic activity has identified important variables determining those liaisons. ADRL models offer a powerful alternative to study this issue, particularly for the case of emerging economies because their economic fragility and limited financial systems inhibit their development. Identifying the role of financial variables on economic activity is an imperative to promote sound long run economic growth policies.
3. Methodological issues

Pursuing the lines of research reviewed in the previous section, to implement its empirical tests, the analysis results showed in the next section is based on the Autoregressive Distributed Lag (ARDL) model:

\[ y_t = c_0 + c_1 t + \sum_{i=1}^{p} \phi_i y_{t-i} + \sum_{j=0}^{q} \beta_j x_{t-j} + u_t \]

\[ t = \text{max}(p,q),...,T \] (1)

Assuming that the lag order, \( q \), is the same for all the variables contained in the \( k \times 1 \) vector \( x_t' \), according to Pesaran, Shin and Smith (1998; 2001), the variables in such vector so that the dependent variable can be \( I(0), I(1) \) or even cointegrated ones. Nevertheless, the possibility of both stationary unit root process or explosive roots is ruled out. Needless to say, this approach provides with a very readily method to address the analysis of long-run relationships among the time series of economic variables, having as a starting point the testing of the null hypothesis of no cointegration. Although the ARDL model it is not a new strand of modeling, its popularity enjoyed has increased notoriously because, as a byproduct, the Pesaran, Shin y Smith cointegration test allows for a reparameterization in a specification that includes an error correction mechanism (a.k.a. correction mechanism to the long-run equilibrium), giving place to the representation:

\[ \Delta y_t = c_0 + c_1 t + \alpha (y_{t-1} - \theta \bar{x}_{t-1}) + \sum_{i=1}^{p-1} \psi_i \Delta y_{t-i} + \omega' \Delta \bar{x}_t + \sum_{j=1}^{q} \beta_j' \Delta \bar{x}_{t-j} + \xi_t \] (2)

where the adjustment velocity coefficient \( \alpha = 1 - \sum_{i=1}^{p} \phi_i \) and the long-run coefficients \( \theta_{kj} = \frac{\sum_{j=0}^{q} \beta_{kj}}{\alpha} \)

Based in the results provided by the estimation of this model, is obtained the value of the \( F \) statistic under the null \( H_0: (\alpha = 0) \cap \left( \sum_{j=0}^{q} \beta_j = 0 \right) \), which can be compared against the corresponding critical values; if that hypothesis is rejected, then the value of the \( t \) statistic under the null \( H_0: a = 0 \) is computed and contrasted against the critical values. Pesaran, Shin and Smith (2001) provide lower and upper bounds for the asymptotic critical values; the bounds are conditional to the number of regressors, their integration order, and the deterministic terms included in the specified model. If the computed values for
the $F$ and $t$ statistics are nearer cero than their corresponding lower bounds the decision to reject the two null hypothesis cannot be supported, but they can be rejected in the case if the computed values of both statistics are greater than their corresponding upper bounds; and, if both null hypothesis are rejected then it can be considered that the evidence confirms the existence of a long-run relationship among the variables under analysis.

3. Empirical evidence

The Global Economic Activity Index (IGAE), the National Price Consumer Index (INPC), the volume of stocks operated into the Mexican Stock Exchange (OP_RV), the Peso-USD exchange rate (USD), the rate of the 28 days Mexican T-bill (CETE), the international reserves (RESERVAS) and the Mexican Stock Exchange Index (IPC) were gathered from the INEGI (National Institute of Statistics and Geography) web page. These variables were chosen considering financial research and their availability and continuity of public information. All the data are observed in a monthly basis comprising the period January 1993 to August 2018.

Except for the T-bills’ rate, logarithms were calculated for all variables’ time series. Table 1 shows the results of the ADF unit root tests where can be seen that the most part of the variables under analysis can be regarded as non-stationary I(1) variables at the levels but stationary I(0) variables when first differenced. Nevertheless, some non-comfortable tests’ results are observed, but it does not pose a major challenge.

Table 2 displays the results obtained in the estimation of the ARDL (6,6,4,0,1,6,1) model selected by the Akaike Information Criterion as the best one with the (log) economic activity index (LIGAE) as the dependent variable. As can be seen, several coefficients are highly significant, remarkably some

lags values of economic activity, consumer price index, international reserves and peso/USD exchange rate. One lag Mexican T-bill rate and the log of the actual volume of stocks operated into the Mexican Stock are also significant but at the 5% level. Some of the estimated coefficients are not significant; nevertheless, the equation shows goodness of fit and the residuals do not suffer troubles own to non-normality, autocorrelation and heteroscedasticity.

Table 3 shows the ARDL model, estimated as an error correction mechanism, so the long-run relationships parameters of the error correction mechanism are reported together with the parameters giving account of the estimated long-run adjustment’s velocity coefficient and the coefficients associated to the short-run dynamics.
Table 2
ARDL model estimated

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<th>Variable</th>
<th>Coefficient</th>
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<td>LIGAE(-1)</td>
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<tr>
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<td>R-squared</td>
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<tr>
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<tr>
<td>Log likelihood</td>
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<tr>
<td>Normality Shapiro-Wilk test</td>
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<tr>
<td>LM Breusch-Pagan test (1)</td>
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<tr>
<td>Breusch-Pagan-Godfrey test</td>
<td>1.2668</td>
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</table>

***, **, and, *, respectively 1%, 5% and 10% significance level.
First, the Pesaran, Shin & Smith (2001) cointegration tests statistics, both $F$ and $t$ at the bottom of the table, allow the strong rejection of the null hypothesis of no long-run relationship of the variables at their log-levels. It can be observed in the same table, according with the estimated speed of adjustment coefficient almost a 24% of a disequilibrium is corrected in one month, implying that the effect of a shock lasts a little more than 4 months before the joint process turns back to the long-run relationship between the growth of rate of the economic activity and the growth rate of the set of explanatory variables and the change of the Mexican T-bill rate.

In the equation corresponding to the long-run relationship is observed that only the (log) Mexican stock market index has not a significant coefficient, and the T-bill rate is weakly significant (only at the 10%) with a very

Figure 1, the Cusum graph shows that the cumulative sum of the recursive residuals does not exceed the ±5% band, suggesting the stability of the estimated parameters.

Fuente: elaboración propia.
small coefficient. It is worth to note that only the inflation rate, the operated volume of stocks traded at the Mexican stock exchange, the international reserves and the Mexican stock market index have significant coefficients; contrary to the negative inflation coefficient, the other significant explanatory variables have positive coefficients. The positive signs of these variables suggest that the economic activity can be favored by their performance, specifically, we can say that their increments yield enhancements on the performance of the economic activity.

The dynamics of economic activity’s growth rate is mainly governed by its own past performance, the effect of the past inflation rate, the exchange rate and on a smaller scale by the stock market returns. Surprisingly, the changes of the interest rate do not show significant effects on the economic activity and the negative sign of the rate of exchange depreciation of the peso against the dollar is also striking. It is a very important issue claiming for a deeper inquiry because those variables are milestone of the monetary policy followed by the Mexican central bank.
### Table 3
ECM model & long-run equilibrium equation

<table>
<thead>
<tr>
<th>Error correction model</th>
<th>Coefficient</th>
<th>Long-run equilibrium</th>
<th>Coefficient</th>
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<tr>
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<tr>
<td>CointEq(-1)*</td>
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</table>

**NCNT** = no constant nor trend, C = constant, CT = constant & trend
Lag selection done by means of Akaike Information Criterion
* , ** & ***, respectively, significant at the 10%, 5%, 1%.
5. Concluding remarks

Based on an ADRL model, the analysis described in this paper shows that some financial variables have a significant long-run relationship with the level of the Mexican economy activity. Apparently, Mexico’s strategy of accumulating a large stock of international reserves has been successful to enhance economic activity. This opens the door for further research to determine the optimal level of reserves required to foster economic growth.

Although small in magnitude but significant, the impact of the Mexican stock market’s activity on economic activity can be interpreted as evidence that good stock market performance is a sign of positive economic expectations. The downside is that the Mexican stock market is a thin secondary market, integrated by very few firms and characterized by scant public offerings; thus, it can be affirmed that nurturing market sentiment would strengthen Mexico’s economic growth. Additionally, it is important pointing out that performance of the two significant variables affecting it, is a critical risk factor for the overall performance of the Mexican economy which seemingly calls to cushion and review monetary policy, considering its importance managing the economy.

Surprisingly, Mexico’s Treasury Bills rate and exchange rate do no influence growth. It is important to point out that performance of these two significant variables constitute a key factor for the overall performance of the Mexican economy considering their importance determining Central bank’s policies and the overall management of the economy, so, this is another issue needing further research.
References


Afzali, M. A. and M. V. (2016). "Compare the three and four and five factor models of pricing of Fama and French capital assets to predict stock returns of companies listed in Tehran Stock Exchange". UCT Journal of Management and Accounting Studies, Iran, pp. 71-76.


