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Preface

This book covers key areas of Economics and Management. The contributions by the authors include Stock return, volatility, trading volume, stable TGARCH, Return Volatility, Threshold GARCH Models, Gaussian distribution, The likelihood ratio test, Agricultural commodity, volatility spillover, volatility impulse response function, Food and Agriculture Organization, Golf participation rates, Tiger Woods effect, celebrity endorser, Electoral lemon problem, campaign expenditures, candidate quality, quality signaling, Bayesian equilibrium, asymmetric information, Attribute value quality index, data profiling, data quality, data value quality index, feature scaling, attribute value quality index (AVQI), structured data value quality index (SDVQI), Industrial Revolution, Assessing, NDE, strategy, poverty, reduction, problem of unemployment and poverty, Nigerian factors, people's progress and national development, Human capital management practices, organizational climate, organizational commitment, perceived organizational performance, human capital in Latin America, Commitment and Performance, Financial theory, Egyptian investors, stock analysis, anchoring theory, loss aversion, standards of the behavioral finance, investors' perception regarding market trend, B2B e-commerce, e-readiness, small medium enterprises, maturity assessment application, maturity level, business-to-business (B2B), International multimodal multicommodity network, simultaneous transportation network equilibrium model, integrated transport network, integrated transport system, international freight transport, exporters, importers, External reserves, economic growth, foreign direct investment, exchange rate etc. This book contains various materials suitable for students, researchers and academicians in the field of Economics and Management.

Chapter 1
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Assessment and Analysis of Trading Volume and Return Volatility Relationship on Dow Jones Index Using Stable Paretian GARCH and Threshold GARCH Models

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ABSTRACT

Many models in finance are often based on the assumption that the random variables follow a Gaussian distribution. It is now well known that empirical data have frequently occurring extreme values and cannot be modeled with the Gaussian distribution. The stable distributions, a class of probability distributions that allow skewness and heavy tails, have received great interest in the last decade because of their success in modeling financial data that depart from the Gaussian distribution. This paper examines the volatility of Dow Jones Industrial Average stock returns and the trading volume by employing stable Paretian GARCH and Threshold GARCH (TGARCH) models. Our results indicate that the trading volume significantly contributes to the volatility of stock returns. Additionally, strong leverage effects exist with negative shocks having a larger impact on volatility than positive shocks. The likelihood ratio tests and goodness of fit support the use of stable Paretian GARCH and TGARCH models over Gaussian models.

Keywords: Stock return; volatility; trading volume; stable TGARCH.

1. INTRODUCTION

Statistical inferences regarding the empirical studies of financial economics heavily rely on the assumption that the random variables under investigation follow a normal distribution, yet finance data often depart from the assumptions of Gaussian distributions. Daily stock returns are, in general, known to be skewed and leptokurtic rather than normally distributed. Mandelbrot [1] and Fama [2] were early advocates of using stable Paretian distributions to examine financial data. While different heavy-tailed distributions, such as Student's t and Generalized Error Distributions (GED), have been used in the literature, stable distributions have distinct advantages over these distributions. The widespread use of statistical inference methods in scientific research has recently been scrutinized and questioned, for reasons outlined in the "ASA Statement on Statistical Significance and P-values" [3,4]. Stable Paretian distributions, which are also called Levy-Pareto distributions, allow for skewness and leptokurtosis and are consistent with the Generalized Central Limit Theorem. This theorem states that regardless of the existence of the variance, the limiting distribution of a sum of independent and identically distributed random variables is stable [5]. In spite of these advantages of a stable distribution, this distribution is not well utilized due to complexity of estimation processes.

Although use of stable distributions to analyze financial data has been presented in the literature, the application to GARCH models is relatively new. The application of stable distributions in finance is traced way back in the late 50s when Mandelbrot [6-8] developed a hypothesis that revolutionalized the way economists viewed and interpreted prices in speculative markets such as grains and securities markets [9]. Paolella and Taschini [10], Tavares et al. [11], Curto et al. [12], and Parrini [13]

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use GARCH models with stable Paretian distributions to examine volatility of financial markets, and these models show better results in terms of goodness of fit criteria compared with models using Gaussian distributions. Mozumder et al. [14] propose GARCH models with stable Paretian innovations in measuring the value-at-risk, expected shortfall and spectral risk measures that promise a noticeably better performance while sustaining simplicity. This paper adds to the literature by focusing on the relationship between stock return volatility and trading volumes. Specifically, we examine the volatility of Dow Jones Industrial Average (DJIA) returns and the trading volume by employing stable Paretian stable GARCH and Threshold GARCH (TGARCH) models and determine whether a choice of distributions improves the empirical results.

Lamoureux and Lastrapes [15] are the first to apply GARCH models to examine the volatility relationship with the trading volume as a proxy for information arrival time according to the mixture of distribution hypothesis (MDH). They find that volume has positive effects on the volatility of stock returns. However, Suominen [16] presents a theoretical model that incorporates the GARCH-like conditional variance as a function of trading volume and argues that the trading volume and the asset volatility can be either positively or negatively correlated. Fong [17], Darrat, et al. [18], Chuang, et al. [19] and others show positive and causal relationships between return volatility and volume traded. Further, Girard and Biswas [20] support the results found by Lamoureux and Lastrapes by using both developed and emerging markets with asymmetric GARCH models.[1]

2. STABLE PARETIAN DISTRIBUTIONS AND TGARCH MODEL

Stable distributions are a rich class of probability distributions that allows skewness and heavy tails, and suitable to model heavy tailed data such as stock returns, and other financial data. Stable distributions do not have an analytic closed form but can be expressed by their characteristic function. Let a stable Paretian distribution, $S_{\alpha\beta}(\delta, c)$, be expressed as its characteristic function:

$$\phi_X(t) = E\left(e^{itX}\right) = \exp\left(i\delta t - |ct|^{\alpha}\left[1 + i\beta\,\mathrm{sgn}(t)\,w(t,\alpha)\right]\right) , \tag{1}$$

where

$$w(t,\alpha) = \begin{cases} -\tan\left(\dfrac{\pi\alpha}{2}\right) & , \quad \alpha \neq 1 \\ (2/\pi)\ln|t| & , \quad \alpha = 1 \end{cases} .$$

Assume that $-\infty<t<\infty$, $0<\alpha\leq 2$, $-1\leq\beta\leq 1$, $c>0$, and $-\infty<\delta<\infty$. Symbols α, β, c, and δ are respectively called characteristic exponent, skewness, scale, and location parameters. When $\alpha=2$, a stable distribution becomes a Gaussian distribution. The tail thickness increases as α decreases, and the distribution becomes more leptokurtic. When β is positive, the distribution is skewed to the right; when negative, it is skewed to the left. If β is zero, the distribution becomes symmetric around location parameter δ [21].

To examine the stock returns and volume relationships, we assume the following simple mean equation which directly addresses those relationships as shown below:

$$y_t = \mu + u_t , \tag{2}$$

where y_t is the returns of DJIA, and $u_t = \sigma_t\varepsilon_t$, with $\varepsilon_t \sim$ iid $S_{\alpha,\beta}(0,1)$. $S_{\alpha,\beta}(0, 1)$ denotes the standard asymmetric stable Paretian distribution with location parameter ($\delta = 0$), and unit scale parameter ($c = 1$). These assumptions simplify the estimation without altering the properties of the stable distribution, and are commonly imposed in the literature.

[1] *Taylor [22] presents comprehensive discussion regarding the volatility of financial assets.*

In this paper, the GARCH(1,1) and TGARCH (1,1) equations for a stable Paretian distribution are modified by adding the daily trading volume (V) in order to analyze how the volume affects the volatility of stock returns. The volume is thought as a proxy variable for unobserved information that flows into the markets and it is assumed to be weakly exogenous.[2] Because the residual is given in the standard asymmetric stable Paretian distribution, the conditional variance is expressed in terms of the standard deviation form such as:

$$\sigma_t = \theta_0 + \theta_1|u_{t-1}| + \eta S_{t-1}|u_{t-1}| + \phi_1\sigma_{t-1} + \gamma\sqrt{V_t}\ , \tag{3}$$

where S_{t-1} = 1 for $u_{t-1} < 0$, and S_{t-1} = 0 for $u_{t-1} \geq 0$. A parameter η addresses leverage effects, which indicate that the potential for negative shocks or news to information have a larger impact on volatility than positive shocks. We impose stability conditions to estimate the stable GARCH and TGARCH models so that these processes will have strictly stationary solutions.[3] When η is zero, we have a symmetric GARCH (1,1) process. We note that a Gaussian TGARCH with the volume is given:

$$\sigma_t^2 = \theta_0 + \theta_1 u_{t-1}^2 + \eta S_{t-1}u_{t-1}^2 + \phi_1\sigma_{t-1}^2 + \gamma V_t. \tag{4}$$

The probability density and the likelihood functions of the stable distribution GARCH and TGARCH models are nontrivial, and a Fast Fourier Transforms (FFT) procedure is employed for the maximum likelihood estimation (MLE) algorithm. In this paper, we follow the MLE procedure presented by Mittnik et al. [23]. Their estimation method deals with conditional heteroskedasticity models with a stable Paretian distribution by employing a computationally efficient density calculation. The MLE estimation with a FFT is based on the characteristic function expressed in equation (1). The optimum estimates of parameter vector θ for the $S_{\alpha,\beta}$ (0, 1) with GARCH models are attained by maximizing the logarithm of the following likelihood function:[4]

$$L(\theta; u_1,\ldots,u_T) = \prod_{t=1}^{T} \sigma_t^{-1} S_{\alpha,\beta}(\varepsilon_t).$$

DuMouchel [24] shows that the MLE estimates of a stable density are consistent and asymptotically normal with the covariance matrix given by the inverse of the Fisher information matrix.

3. EMPIRICAL RESULTS

Table 1 presents the summary statistics of the data. The sample spans from January 4, 1990 to December 31, 2009, and a total of 5,043 daily observations (5,042 for returns) are obtained from Yahoo finance. DJIA denotes the closing price of the Dow Jones Industrial Average, Returns are the log differences of DJIA, and Volume is the trading volume at the end of day. We use two sets of volume specifications for robustness check. They are the square root of the natural logarithm of volume V1* and the square root of the absolute value of the log difference of volume V2*, where taking square root of volume is required due to the specifications of stable GACH and TGACH models given in equation (3). From Table 1, the average daily return is 0.026% (annualized return of 9.45%), while the largest daily gain is 10.5% and the largest loss is 8.2%, resulting in substantial variations in the daily returns. According to the Augmented Dickey and Fuller (ADF) tests, $V1^*$ is stationary with intercept and trend at one percent significance level, but nonstationary without trend. $V2^*$ is stationary regardless of its specifications. We also used other unit root tests and the results are basically the same.[5] DJIA and Returns show negative skewness, but Volume series are positively skewed. Returns and V2* show kurtosis, and according to the Jarque-Bera statistics, all variables are non-normally distributed. Further, the residuals from equation (1) indicate strong ARCH effect (not presented).

[2] *Refer to Engle, et al. [25] for the definition.*
[3] *See Curto, et al. [12].*
[4] *We thank Professor Curto for providing us with the Matlab codes.*
[5] *The results of unit root tests are available upon request.*

Table 1. Summary statistics

DJIA is the closing price of the Dow Jones Industrial Average, Returns are log differences of DJIA, and Volume is the number of shares traded. V1* and V2* are the square root of the natural logarithm of Volume and the absolute value of the logarithmic difference of Volume, respectively.

	DJIA	Returns	Volume	V1*	V2*
Mean	7878.665	0.000260	1.42E+09	4.527965	0.323263
Median	8773.570	0.000460	8.81E+08	4.538282	0.306426
Maximum	14164.53	0.105083	1.15E+10	4.812671	2.761391
Minimum	2365.100	-0.0820050	2200000	3.821514	0.000000
Std. Dev.	3329.070	0.011238	1.60E+09	0.119787	0.175573
Skewness	-0.2683290	-0.118954	2.024760	0.016763	2.314690
Kurtosis	1.692637	11.50240	2.27961	2.27961	20.92803
Jarque-Bera	419.6614	15198.99	7231.383	109.28	72026.12

Table 2 shows the estimation results of Gaussian and stable Paretian GARCH models. Standard errors and t-statistics are presented in parentheses and in square brackets. For the volume specification of a Gaussian model, the variables V1 and V2 are respectively the natural logarithm of volume and the absolute value of the log difference of volume. As for the cases of V1* and V2*, V1 is stationary with intercept and trend but nonstationary without trend, and V2 is always stationary. The parameters of GARCH specifications are significant for both distributions with two volume specifications. The estimates of volume are also significant except Gaussian GARCH with V1, and they are positive. The results indicate that as trading volume increases, so does volatility. Because the trading volume is assumed to be a proxy for unobserved information flow, we conjecture that as information flow increases, the volatility also increases. They support the findings of Lamoureux and Lastrapes [15] although the GARCH parameters become insignificant after adding the trading volume. From the stable distributions, the estimates of the shape parameter α are statistically significant at the one percent level, and both are less than 2 based on t-tests, implying heavy tailed pattern, i.e., leptokurtic, and rejecting a Gaussian distribution. The estimates of the skewness parameters β are negative and significant. Curto et al. [12] also find the negative skewness parameters for three different equity index returns (including DJIA). These findings are agreeable with the results of unconditional skewness shown in Table 1. The point estimates and the standard errors of α and β are similar for both volume specifications.

Table 2. GARCH models with volume

V1 and V2 are respectively the natural logarithm of volume and the absolute value of the log difference of volume. V1* and V2* are the square root of the natural logarithm of volume and the square root of the absolute value of the log difference of volume, respectively. Standard errors are presented in parentheses, and t-statistics are in square brackets.

	Gaussian GARCH		Stable GARCH	
	V1	**V2**	**V1***	**V2***
Intercept	0.000523 (1.17E-04) [4.47]	0.000526 (1.17E-04) [4.48]	0.000435 (1.22E-04) [3.56]	0.000438 (1.22E-04) [3.60]
θ_0	-0.000000 (9.86E-07) [-0.14]	0.000110 (2.62E-07) 1.43743	0.000000 (0.0000) [0.0000]	0.000056 (3.43E-05) [1.64]
θ_1	0.068804 (4.23E-03) [16.29]	0.071088 (0.0043) 16.36923	0.043011 (4.15E-03) [10.37]	0.043369 (4.17E-03) [10.39]
ϕ_1	0.922403 (5.08E-03) [181.46]	0.918869 (0.0051) [178.50]	0.926650 (7.31E-03) [126.80]	0.926040 (7.25E-03) [127.60]

	Gaussian GARCH		Stable GARCH	
	V1	**V2**	**V1***	**V2***
γ	0.0000001 (4.72E-08) [1.23]	0.000006 (1.97E-06) [3.02]	0.000029 (4.53E-06) [6.51]	0.000245 (9.77E-05) [2.50]
α	-	-	1.880 (1.95E-02) [96.53]	1.881 (1.94E-02) [96.73]
β	-	-	-0.368 (1.21E-01) [-3.03]	-0.374 (1.24E-01) [-3.03]
Log Likelihood	16444	16447	16517	16518
AIC	-32878	-32884	-33032	-33034
SBC	-32845	-32852	-33034	-33036

The estimation results of Gaussian and stable TGARCH models are reported in Table 3. We observe that the estimates of the conditional variances are statistically significant, though the estimates of ARCH term are not. Also we find that the estimates of volume are positive and significant except Gaussian TGARCH with V1, where they are qualitatively the same as the results found in Table 2. The asymmetric parameters are positive and statistically significant at the one percent level for all specifications, indicating the presence of the leverage effect, i.e., negative residuals have larger effects on the volatility. The results are consistent with the existing literature. These findings support the findings by Girard and Biswas [20] who present the leverage effects as well as positive relationships between volatility and volume. The likelihood ratio tests reject GARCH against TGARCH regardless of the volume specifications. We conclude that there exist strong leverage effects, where negative shocks have larger effect on volatility of DJIA returns. As found in Table 2, the estimates of the stable distributions with the shape parameter α are statistically significant at the one percent level, and the estimates of the skewness parameters β are negative and significant.

Table 3. TGARCH models with volume

V1 and V2 are respectively the natural logarithm of volume and the absolute value of the log difference of volume. V1* and V2* are the square root of the natural logarithm of volume and the square root of the absolute value of the log difference of volume, respectively. Standard errors are presented in parentheses, and t-statistics are in square brackets.

	Gaussian TGARCH		Stable TGARCH	
	V1	**V2**	**V1***	**V2***
Intercept	0.000282 (1.19E-04) [2.37]	0.000285 (0.00012) (2.41)	0.000216 (1.17E-04) [1.84]	0.000222 (1.18E-04) [1.89]
θ_0	0.000002 (9.73E-07) [2.07]	0.000006 (0.00000) [2.57]	0.000000 (0.00000) [0.00]	0.000051 (2.95E-05) [1.72]
θ_1	0.007779 (5.06E-03) [1.54]	0.007197 (0.00529) [1.36]	0.002704 (4.23E-03) [0.64]	0.002199 (4.28E-03) [0.51]
ϕ_1	0.926318 (5.06E-03) [183.06]	0.924445 (0.00532) [173.79]	0.937730 (5.89E-03) [159.10]	0.938290 (5.86E-03) [160.00]
η	0.104815 (7.34E-03) [14.27]	0.107206 (0.00743) [14.41]	0.067618 (5.43E-03) [12.46]	0.067972 (5.38E-03) [12.62]
γ	0.0000000 (4.71E-08) [0.75]	0.000006 (1.85E-06) [3.24]	0.000026 (3.66E-06) [7.08]	0.000205 (8.30E-05) [2.47]

	Gaussian TGARCH		Stable TGARCH	
	V1	**V2**	**V1***	**V2***
α	-	-	1.909 (1.74E-02) [109.50]	1.912 (1.73E-02) [110.70]
β	-	-	-0.559 (1.46E-01) [-3.84]	-0.587 (1.53E-01) [-3.85]
Log Likelihood	16502	16506	16591	16592
AIC	-32992	-32999	-33179	-33183
SBC	-32953	-32960	-33181	-33185

From the results presented in Tables 2 and 3, the stable Paretian GARCH and TGARCH models appear to be preferable based on the goodness of fit. The stable GARCH and TGARCH models show higher log likelihood values compared to the Gaussian GARCH and TGARCH models and yield much smaller values of the Akaike Information Criterion (AIC) and Schwartz Information Criterion (SBC). Further, the stable TGARCH specification appears to be a preferable model based on the goodness of fit. The results confirm the advantages of using stable distributions that can take into account the non-normal nature of the time series data examined. However, we point out that difficulty of estimating the stable distribution models compare to Gaussian models because the distribution does not have a closed form analytical form, and is expressed only by its characteristic function.

4. CONCLUSIONS

This paper examines the volatility of Dow Jones Industrial Average stock returns and the trading volume by employing stable Paretian GARCH and Threshold GARCH (TGARCH) models. Stable distribution, which includes the normal distribution as a special case, has interesting theoretical and practical properties and has preferable properties that may capture the specific features associated with financial variable such as equity returns. Our results indicate that the trading volume significantly contributes to the volatility of stock returns and there exist leverage effects on the stock return volatility. The likelihood ratio tests and goodness of fit support the use of stable Paretian GARCH and TGARCH models over Gaussian models.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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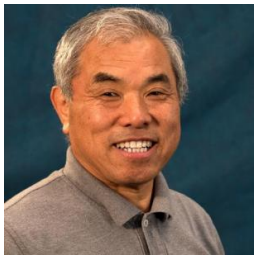

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Chapter 2
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Do Agriculture Commodities Spill over onto Latin Stock Markets?

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ABSTRACT

Addressing the volatility spillovers of agricultural commodities is important for at least two reasons. First, for the last several years, the volatility of agricultural commodity prices seems to have increased. Second, according to the Food and Agriculture Organization, there is a strong need for understanding the potential (negative) impacts on food security caused by food commodity volatilities. This paper aims at investigating the presence, the size, and the persistence of volatility spillovers among five agricultural commodities (corn, sugar, wheat, soybean and bioethanol) and five Latin American (Argentina, Brazil, Chile, Colombia, Peru) stock market indexes. It is possible to identify a spillover index (and hence the direction), the main sources, and the recipients of the spillovers. It was shown that there exist some (more precisely, seven) volatility spillovers, robust to different lagged periods, that is: corn $\rightarrow$ Chile, corn $\rightarrow$ Colombia, and corn $\rightarrow$ Peru; sugar $\rightarrow$ Colombia and sugar $\rightarrow$ Peru; and, finally, wheat $\rightarrow$ Chile and wheat $\rightarrow$ Peru. Overall, when a negative shock hits the commodity market, Latin American stock market volatility tends to increase. This happens, for instance, for the relationships from corn to Chile and Colombia and from wheat to Peru and Chile.

Keywords: Agricultural commodity; volatility spillover; volatility impulse response function.

1. INTRODUCTION

Since the beginning of the 1990s, the financial literature has displayed remarkable interest in the transmission of volatility, alternatively called volatility spillover, from a source to a recipient. In this regard, how volatility spillover can be estimated and how long it lasts has been largely investigated ([1,2,3], among others).

There are two main approaches to estimating volatility spillover. The first method, proposed by Diebold and Yilmaz [4] and subsequently generalized in a further contribution [5], lies in the vector autoregressive context and relies on forecast-error variance decomposition. By means of the latter, it is possible to identify a spillover index (and hence the direction), the main sources, and the recipients of the spillovers. A second method uses the multivariate generalized autoregressive conditional heteroskedastic (MGARCH) class of models (surveyed in Bauwens et al. [6]) to firstly estimate the conditional covariance matrices of the variables under investigation, and to then apply the volatility impulse response function (VIRF) methodology proposed by Hafner and Herwartz [7]. The VIRF allows the calculation of the impact, in terms of size and persistence, of shocks on expected conditional volatility. Recently, the MGARCH-VIRF methodology has been applied in different contributions. For instance, Kang et al. [8] examined the volatility spillovers between the United States and six Asian stock markets (China, Hong Kong, Japan, Korea, Singapore, and Taiwan). Nazlioglu et al. [9] investigated the volatility transmission between the Dow Jones Islamic equity market and the United States, European, and Asian stock markets. By using only MGARCH models, Mohammadi and Tan [10] evaluated the interdependencies among the equity markets in the United States, Hong Kong,

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and China. The work of Allen et al. [11] uses both of the previously cited methodologies to capture the spillover effects across markets. All of these contributions share the feature of investigating volatility transmission that originates from one stock market and affects another stock market. Chi et al. [12] performed an empirical study on the volatility spillover effect between the exchange and stock markets through multi resolution wavelet analysis. They found that in different trading periods, the volatility spillover effect demonstrated no coherence over a short time, indicating only a one-way volatility spillover from the stock market to the exchange market [13]. However, as pointed out by Amendola et al. [14] and references therein, the analysis of commodity volatility has recently received significantly increased interest. Within this framework, a rising number of contributions have focused on the volatility spillovers of commodity returns. Moreover, while there are many works examining how energy (or metals) commodity volatilities affect stock markets ([15,16,17] for instance), or how these volatilities influence each other [18,19,20], few contributions focus on volatility spillovers in the context of agricultural commodities. Among these, Nazlioglu et al. [21], using daily data spanning from January 1986 to March 2011 concerning the spot prices of the world's oil, corn, soybeans, wheat, and sugar, found that, after the Great Recession period, the oil market transferred volatility to three agricultural commodities (corn, wheat, and soybean). A rich literature has offered various possible reasons for the strong fluctuations in agricultural commodity prices [22,23,24,25]. Recently, Hamadi et al. [26] found significant bidirectional volatility spillovers among four agricultural commodities (corn, wheat, soybeans, and soybean oil) by employing daily data covering the period from December 1999 to May 2015. In addition, 'Smiech et al. [27] investigated the volatility spillovers among four agricultural commodities (corn, soybean, wheat and rice) and some financial and energy variables (US dollar, S&P 500 futures and crude oil). Interestingly, they found that these latter variables have a limited impact in transferring volatility to food commodities. To the best of our knowledge, there is a gap in this literature regarding the other way around, which is the possible transmission of volatility from agricultural commodities to stock markets. The aim of this work is to fill this gap. In particular, our goal is to analyze the volatility spillovers originating from corn, sugar, wheat, soybean, and bioethanol (log-)returns and affecting the stock markets of five Latin American countries: Argentina, Brazil, Chile, Colombia and Peru. Interestingly, according to the International Money Fund[1], all of these economies are developing markets (DMs). In this framework, we first apply the recently proposed test for causality in volatility [28]. Robust to different lagged periods, the test is able to control whether a commodity transfers volatility to a stock market. Afterwards, we adopt the MGARCH-VIRF methodology to verify the size and the persistence of a volatility spillover on a Latin American stock market after a given shock affecting the commodity. Addressing the volatility spillovers of agricultural commodities is important for at least two reasons. First, during the last several years, the volatility of agricultural commodity prices seems to have increased. As argued by Hamadi et al. [26], during the period of 2007–2009, agricultural commodity prices exhibited large and unexpected variations. In support of this thesis, the Food Price Index of the Food and Agriculture Organization (FAO) was quite unchanged before 2007, after which it drastically grew until March 2008. This confirms the fact that, during that period, the food prices generally exhibited an uprising trend. In the spirit of Gilbert and Morgan [28], we perform a preliminary analysis to verify if the five commodity log-returns exhibited different levels of volatility. The results are given in Section 2. In line with the literature, for all the commodities, the hypothesis of variance homogeneity is largely rejected. There is also a second noteworthy reason for investigating the agricultural commodity spillovers, that is, mainly to determine if the volatility originated from or transferred to Latin American countries. In fact, according to the reports of the Food and of The United Nations [29] and OCED-FAO [30], this region has become the largest net exporter of food since 2002, with a projection of 60 billion US$ in 2024 in terms of net exports of cereals, oilseeds, sugar crops, meats, fish, and dairy products. More specifically, the Latin American countries are grain and sugar net exporters. Nevertheless, the flow of exports is not homogeneous among the five countries considered here, of which the most predominant role is played by Brazil, who, for instance, trades more than half of the global sugar exports. Among the countries under investigation, Peru is not only a DM, but also a net food-importing DM (NFIDM), according to the World Trade Organization (WTO). Thus, it is of great interest to understand to what extent the variation in some agricultural commodities can affect both DMs and NFIDMs. One of the key messages in Food and of The United Nations [29] is the need for understanding the potential

[1] *https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD*

(negative) impacts on food security[2] caused by food commodity volatilities. This contribution attempts to achieve this goal, by studying the interdependencies among food prices and Latin American stock markets. Moreover, according to Cashin and McDermott [31] and UNDP [32], higher commodity volatility leads to severe consequences for developing countries, which mostly base their economy on commodity exports [33]. In general, higher food commodity volatilities may induce economic weakness, mainly in food-exporter countries, such as some of those under investigation. Furthermore, in turn, a more fragile economy can heavily undermine the food security. This confirms recent empirical evidence: both the high food prices (from 2007 to mid-2008) and the Great Recession (2007–2009) are intertwined phenomena that have important implications in terms not only of financial, economic and political stability but also in terms of food security, as underlined by Von Braun [34], among others. Our study assumes particular relevance because it investigates the volatility spillovers originating from commodities primarily generated in Latin American countries (for instance, corn, sugar, soybean and bioethanol are mainly produced in Brazil) and affecting precisely those Latin American stock markets.

The rest of the paper is organized as follows. Section 2 verifies the heteroskedasticity for the commodities' variances. Section 3 illustrates the econometric methodology adopted in this work. Section 4 details the data and results of the analysis. The conclusions follow.

2. CHANGING IN VOLATILITY OF AGRICUTURAL COMMODITIES

In this paper the commodities of interest are: corn, sugar, wheat, soybean, and bioethanol. All these data were collected from the Datastream database. In line with other contributions, information on commodities are derived from commodity future prices. First five columns of Table 1 illustrate the begin and the end period for the commodity datasets at our disposal, the relative number of daily observations, the Jarque–Bera test and the (full) sample standard deviations (SDs). As expected, all the returns are far from being normally distributed, given that the null of the Jarque–Bera test is always rejected. As stated in the previous section, a noteworthy reason for investigating the volatility spillovers of the agricultural commodities is that these latter seem to exhibit high levels of heteroskedasticity, mainly during or after the recent Great Recession period (2007-2009). It can be easily noted that the SDs of all the commodities during this period of crisis (identified in the table as sample S6) are larger than the corresponding SDs occurring in the full sample periods. Thus, in order to test the homogeneity of variances, we employed the non-parametric Fligner test [35], whose null is that the variances in each of the samples are the same. It results that, for all the commodities, the hypothesis of variance homogeneity is largely rejected.

3. ECONOMETRIC METHODOLOGY

Throughout the paper, let *i* and *j* denote the series receiving and originating the volatility spillover, respectively. Moreover, let the expression $"j \to i"$ synthetically indicate the volatility spillover from series *j* to *i*. Adopting a standard notation, let y_{kt} be the log-difference of the commodity price k at time t, that is: $y_{k,t} = \log(P_{k,t}) - \log(P_{k,t-1})$. Moreover, we assume that:

$$y_{k,t} = E\left(y_{k,t}|I_{t-1}\right) + \varepsilon_{k,t}, \quad \text{with } k = i, j, \tag{1}$$

where E $\left(y_{k,t}|I_{t-1}|\right)$ represents the return expectation conditionally on the information set I_{t-1} and $\varepsilon_{k,t}$ is the heteroskedastic error term, such that $\varepsilon_{k,t} = h_{k,t} z_t$. In particular, z_t is a random sequence of i.i.d. normally distributed variables with mean zero and unit variance and $h_{k,t}$ is the conditional standard deviation for series k. The GARCH specification proposed by Bollerslev [37] to model the conditional variance $h_{k,t}^2$ of commodity k is:

[2] *The food security definition elaborated in the 1996 World Food Summit [36] is: "Food security, at the individual, household, national, regional and global levels (is achieved) when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".*

$$h_{k,t}^2 = w_k + \alpha_k \varepsilon_{k,t-1}^2 + \beta_k h_{k,t-1}^2, \tag{2}$$

where w_k is the constant and α_k and β_k are the so-called ARCH and GARCH parameters, respectively. In order to test the volatility spillover from commodity *j* (origin) to series *i* (recipient), Chang and McAleer [38] added lagged squared returns and variances of series *j* to eq. (2), which becomes:

$$h_{i,t}^2 = w_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{k,t-1}^2 + \alpha_j \varepsilon_{j,t-1}^2 + \beta_j h_{j,t-1}^2. \tag{3}$$

In this formulation, α_j represents the effect of a shock spillover from series *j* to series *i*, while β_j represents the effect of a volatility spillover. Hence, the null of no (shock and) volatility spillover, alternatively defined as Granger non-causality [39], is:

$$H_0 : \alpha_j = \beta_j = 0. \tag{4}$$

In this contribution, we test the null hypothesis by means of a Likelihood Ratio (LR) test, where the (log-)likelihood of the unrestricted model (eq. (3)) is evaluated against that of the restricted model (eq. (2)). Note that both the restricted and the unrestricted models can include specific lagged terms, in addition to or in substitution of *t* - 1.

Let us suppose that a volatility spillover exists between the series *i* and *j*. In order to further investigate the interdependencies in volatilities, we use the VIRF methodology proposed by Hafner and Herwartz [7], which provides the impact (that is: the size and the persistence) of independent shocks on volatility. To make effective the VIRF methodology, the conditional covariance matrix H_t is derived using the BEKK [40] model. Generalizing the previous framework to a bivariate conditional heteroskedastic model implies that univariate error term for series $k\ \varepsilon_{k,t}$ becomes bold, namely $\boldsymbol{\varepsilon}_t$, which denotes a 2 x 1 vector of daily-log returns (if $E\left(y_{k,t}|I_{t-1}\right) = 0,$ for *k* = *i, j*) or residuals, such that:

$$\boldsymbol{\varepsilon}_t = H_t^{1/2} \mathbf{z}_t, \quad t = 1, \ldots, T, \tag{5}$$

where the random vector $\mathbf{z}_t$ is assumed to have zero means $(E(\mathbf{z}_t) = \mathbf{0})$ and that $E\left(\mathbf{z}_t \mathbf{z}_t'\right) = I_2,$ with I_2 indicating a 2 x 2 diagonal matrix of ones. Moreover, we also assume that the (multivariate) Normal distribution for $\mathbf{z}_t$ holds. In eq. (5), $H_t^{1/2}$ a positive definite matrix such that $H_t^{1/2} H_t^{(1/2)'} = H_t = VAR(\boldsymbol{\varepsilon}_t | I_{t-1}).$ In other words, H_t is the conditional covariance matrix of returns (or residuals). In the BEKK(1,1) representation, H_t is:

$$H_t = CC' + A\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t' A' + GH_{t-1}G', \tag{6}$$

where *C, A* and *B* are respectively a lower triangular and 2 x 2 matrices:

$$\begin{bmatrix} H_{ii,t} & H_{ij,t} \\ H_{ji,t} & H_{jj,t} \end{bmatrix} = \begin{bmatrix} C_{ii} & 0 \\ C_{ji} & C_{jj} \end{bmatrix} \begin{bmatrix} C_{ii} & C_{ji} \\ 0 & c_{jj} \end{bmatrix} + \\ + \begin{bmatrix} A_{ii} & A_{ij} \\ A_{ji} & A_{jj} \end{bmatrix} \begin{bmatrix} \varepsilon_{ii,t-1}^2 & \varepsilon_{i,t-1}\varepsilon_{j,t-1} \\ \varepsilon_{j,t-1}\varepsilon_{i,t-1} & \varepsilon_{jj,t-1}^2 \end{bmatrix} \begin{bmatrix} A_{ii} & A_{ji} \\ A_{ij} & A_{jj} \end{bmatrix} + \\ + \begin{bmatrix} G_{ii} & G_{ij} \\ G_{ji} & G_{jj} \end{bmatrix} \begin{bmatrix} H_{ii,t-1} & H_{ij,t-1} \\ H_{ji,t-1} & H_{jj,t-1} \end{bmatrix} \begin{bmatrix} G_{ii} & G_{ji} \\ G_{ij} & G_{jj} \end{bmatrix},$$

with H_{ii}, H_{jj} and H_{ij} respectively denoting the conditional variances for series *i* and *j* and their conditional covariance. The coefficients A_{ij} and A_{ji} capture the shock spillovers, while G_{ij} and G_{ji} represent the volatility spillovers. Given that the relationship of interest is from series *j* to series *i*, attention is mainly devoted to the coefficients (and estimated signs) for A_{ij} and G_{ij}, which contribute to explain $H_{ii,t}$ by the following formulation:

$$H_{ii,t} = C_{ii}^2 + A_{ii}^2 \varepsilon_{i,t-1}^2 + 2A_{ii}A_{ij}\varepsilon_{i,t-1}\varepsilon_{j,t-1} + A_{ij}^2 \varepsilon_{j,t-1}^2 + G_{ii}^2 H_{ii,t-1} + G_{ii}G_{ij}H_{ij,t-1} + G_{ij}^2 H_{jj,t-1} \tag{7}$$

The VIRF methodology identifies independent shocks affecting H_t by computing the Jordan decomposition of the conditional covariance matrix, such that:

$$H_t^{1/2} = \Gamma_t \Lambda_t^{1/2} \Gamma_t', \tag{8}$$

where Λ_t is a diagonal matrix containing the eigenvalues of H_t, and Γ_t is a 2 x 2 matrix of the corresponding eigenvectors. Hence, the independent shocks z_t are defined as:

$$z_t = H_t^{-1/2} \boldsymbol{\varepsilon}_t. \tag{9}$$

As shown in Hafner and Herwartz [7], if the hypothesis of non-Normal distribution holds, z_t is uniquely defined. This means that z_t may be considered some unpredictable vector of innovations (or shocks) that occurred in the past and affect the future. Finally, in order to identify the VIRF, the *vech* representation of the model in (6) is used:

$$vech(H_t) = vech(C) + R \cdot vech\left(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t'\right) + F \cdot vech(H_{t-1}), \tag{10}$$

where $vech(\cdot)$ is the operator stacking the lower fraction of an *N* x *N* matrix into an N* = N(N+1)/2 dimensional vector and *R* and *F* are matrices with $(N^*)^2$ elements.

Let $E[vech(H_t|I_{t-1})]$ be the baseline expectation, that is, the expectation of H_t, given the available information set (and without any additional shocks). The VIRF *h*-step-ahead is the difference between the *h*-step-ahead expected conditional covariance matrix, given a shock at time *t*, and its history and the baseline expectation, that is:

$$V_h(\boldsymbol{z}_t) = E[vech(H_{t+h}|\boldsymbol{z}_t, I_{t-1})] - E[vech(H_{t+h}|I_{t-1})]. \tag{11}$$

According to our notation, let us suppose that a shock occurred in series *j* on day *t*. By eq. (11), it is possible to quantify the impact of the shock both on series *j* and, more interestingly, on the series receiving the volatility spillover, that is, series *i*. Following the *vech* representation used in (10), the one-step-ahead VIRF is:

$$V_1(\boldsymbol{z}_t) = R \cdot \left\{ vech\left(H_t^{1/2} \boldsymbol{z}_t \boldsymbol{z}_t' H_t^{1/2}\right) - vech(H_t) \right\}, \tag{12}$$

where z_t is obtained by (9). Finally, for h ≥ 2, the VIRF becomes:

$$V_h(\boldsymbol{z}_t) = (R + F) \cdot V_{h-1}(\boldsymbol{z}_t), \tag{13}$$

Table 1. Agricultural log-return volatilities over time

	BP	EP	Obs.	Jarque-Bera	SD(FS)	SD(S1)	SD(S2)	SD(S3)	SD(S4)	SD(S5)	SD(S6)	Fligner
Corn	Jan-1973	Feb-2018	11,398	0.000	0.017	0.020 (1973/1980)	0.015 (1981/1990)	0.015 (1991/2000)	0.019 (2001/2010)	0.018 (2011/Feb-2018)	0.026(Dec-2007/Jun-2009)	0.000
Sugar	May-1998	Feb-2018	4,954	0.000	0.023	0.028 (May-1998/2000)	0.023 (2001/2010)	0.019 (2011/Feb-2018)	-	-	0.028(Dec-2007/Jun-2009)	0.000
Wheat	Aug-1998	Feb-2018	4,912	0.000	0.020	0.016 (May-1998/2000)	0.021 (2001/2010)	0.018 (2011/Feb-2018)	-	-	0.030(Dec-2007/Jun-2009)	0.000
Soybean	Aug - 1998	Feb-2018	4,912	0.000	0.017	0.013 (May-1998/2000)	0.019 (2001/2010)	0.014 (2011/Feb-2018)	-	-	0.028(Dec-2007/Jun-2009)	0.000
Bioethanol	May-2005	Feb-2018	3,230	0.000	0.022	0.021 (May-2005/2010)	0.022 (2011/Feb-2018)	-	-	-	0.022(Dec-2007/Jun-2009)	0.002

Notes: The table reports the standard deviations (SDs) of the agricultural log-returns over the full sample (FS), and up to five subsamples (S1,….., S6). BP and EP identify the begin and end period. Column labeled Jarque–Bera reports the p-value of the Jarque–Bera test, whose null is of normality. Column labeled Fligner reports the p-value of the Fligner test, whose null is that the variances in each of the groups (samples) are the same

4. DATA AND RESULTS

As stated in the Introduction, the countries under investigation belong to the Latin America and are: Argentina, Brazil, Chile, Colombia and Peru. Some of these countries play a prominent role in the production of agricultural commodities. According to the FAO, the world's largest producer of corn is the United States of America (in 2016, 384,777,890 tonnes), followed by China (in 2016, 231,673,946 tonnes) and Brazil (in 2016, 64,143,414 tonnes). In terms of sugar production, Brazil has an undisputed global leadership, with its 768,678,382 tonnes of production in 2016. Among the countries under consideration, wheat does not have the same importance. In fact, none of the five countries lie in the FAO's most recent (2016) Top 10 Country Production of Wheat report. As regards the total supply of soybeans, according to the Agricultural Market Information System (AMIS) database[3], the top country is United States (127.73 million tonnes in 2017/2018), followed by Brazil (125.02 million tonnes in 2017/2018). Bioethanol is a hybrid agricultural commodity, because it is used as fuel but comes from camp fields. In particular, it derives from corn (in United States, the world's largest producer) and from sugar (in Brazil, who represents the world's second largest producer). Unfortunately, data at our disposal do not cover the same period in the beginning of the samples. Globally, the longest commodity series is that of corn, which starts in January 1973. The shortest series is bioethanol, which begins in May 2005. Interestingly, in 2005, bioethanol production began to be heavily subsidized by the United States and other governments [41]. Daily data on Latin American stock markets have been collected from Yahoo Finance. Table 2 synthesizes some summary statistics. All series are not symmetric and not-Normally distributed due to their high skewness and kurtosis.

Table 2. Summary statistics of Latin American stock market indexes

	Argentina	**Brazil**	**Chile**	**Colombia**	**Peru**
Symbol	MERV	BVSP	IPSA	GXG	SPBLPGPT
Begin Period	1996-10-08	1993-04-27	2002-01-02	1998-05-22	1997-03-31
End Period	2018-02-28	2018-02-28	2018-02-28	2018-02-28	2018-02-28
Obs	5245	6149	4028	4954	5072
Min*	-14.765	-17.208	-7.236	-18.038	-13.291
Max*	16.117	28.832	11.803	23.547	12.816
Mean*	0.077	0.133	0.039	0.008	0.05
SD	0.022	0.023	0.01	0.023	0.014
Skew.	-0.307	0.489	0.013	-0.077	-0.416
Kurt.	4.813	10.46	10.206	6.044	10.782

*Notes: The table presents the number of observations (Obs), the minimum (Min) and the maximum (Max) observation values, the mean, the standard deviation (SD), the skewness (Skew.), and the (excess) kurtosis (Kurt.) for the daily log-returns of the stock market indexes. * means that data have been multiplied by 100*

The patterns of the five commodity prices over time are shown in Fig. 1. Even if the samples differ among the commodities, due to different starting periods, some points can be highlighted. First, all the series exhibit a spike during the period 2007–2009. Second, after the Great Recession period, the behavior of the five commodity prices is not homogeneous. For instance, corn price continued to increase until 2014, when it started to decrease.

The results of the LR tests concerning the presence of volatility spillovers are highlighted in Table 3. In particular, series *i*, the one receiving the spillover, is represented by a Latin American stock market index; series *j*, the one that originates the spillover, is given by the commodity. To be straightforward in our analysis, we verify the interdependencies between the pair of series *i* and *j* for different lagged periods, not only t - 1, but also t - 5 and t - 10. This means that the test deals with commodity transferring volatility up to 10 days ahead. The results are quite unequivocal for the biggest countries. Argentina and Brazil do not receive volatility spillovers from the commodities (and periods) under consideration, at a significance level of at least 10%. Interestingly, Chile, which is a developed country, has to manage with three volatility spillovers in its stock market caused by corn, sugar, and

[3] *http://statistics.amis-outlook.org/data/index.html*

wheat. Colombia, which is a DM, seems to be independent of volatility spillovers caused by sugar, wheat and bioethanol, while it receives a spillover from corn for t – 1 and t - 5 at a 10% significance level. Finally, the only NFIDM in our set of countries, that is, Peru, receives strong volatility spillover from corn and wheat, regardless of the lagged period in which the volatility spillover arises.

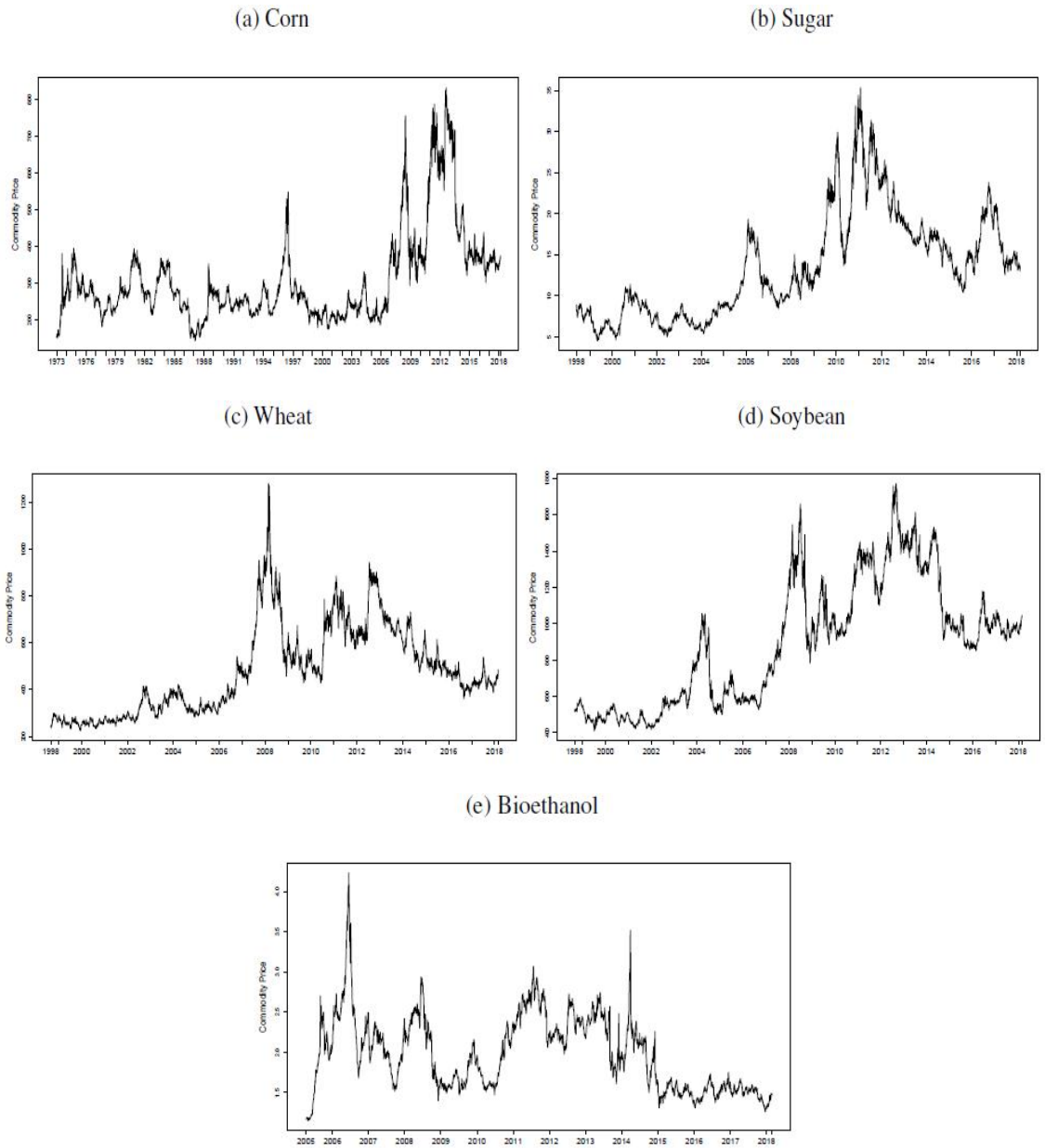

Fig. 1. Commodity prices over time

Once we analyzed which commodity originated a volatility spillover towards a Latin American country, we focus on the size and persistence of such a spillover by using the MGARCH-VIRF methodology summarized before. Taking advantage of the relationships obtained in Table 3, we estimated the BEKK model only when the test signaled the presence of (shock and) volatility spillover. Results are summarized in Table 4.

Table 3. P-values of the causality in the volatility test

		Argentina	Brazil	Chile	Colombia	Peru
Corn	*t-1*	0.071	0.115	0.022	0.050	0.000
	t-5	0.324	0.194	0.008	0.084	0.000
	t-10	0.895	0.353	0.003	0.125	0.000
Sugar	*t-1*	0.351	0.887	0.658	0.000	0.016
	t-5	0.380	0.729	0.876	0.000	0.041
	t-10	0.517	0.911	0.570	0.000	0.481
Wheat	*t-1*	0.279	0.994	0.081	0.185	0.062
	t-5	0.404	0.997	0.080	0.687	0.048
	t-10	0.577	0.949	0.046	0.619	0.018
Soybean	*t-1*	0.047	0.607	0.121	0.779	0.736
	t-5	0.266	0.998	0.684	0.142	0.992
	t-10	0.392	0.847	0.833	0.003	1.000
Bioethanol	*t-1*	0.020	0.381	0.278	0.971	0.606
	t-5	0.846	0.728	0.860	0.465	0.465
	t-10	0.959	0.811	0.981	0.391	0.131

Notes: The table presents the p-values of the LR test to detect the volatility spillover originating from series j (first column) and transferring to series i (first row), for different lagged periods (second column). Dark, medium-dark, and light shades of gray denote significance at the 1%, 5% and 10% levels, respectively

Table 4. BEKK estimates

j (origin) i (recipient)	Corn Chile	Corn Colombia	Corn Peru	Sugar Colombia	Sugar Peru	Wheat Chile	Wheat Peru
C_{ii}	-0.003***	0.007*	-0.002***	0.009***	-0.003***	0.003***	0.003***
	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
C_{ji}	0.004***	-0.002	0.007*	0.008***	0.003***	-0.004***	-0.001
	(0.001)	(0.004)	(0.004)	(0.000)	(0.001)	(0.001)	(0.001)
C_{jj}	0.017***	0.016***	-0.016***	0.000	-0.018***	-0.009***	0.013***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)	(0.000)
A_{ii}	-0.498***	-0.343***	0.548***	1.426	-0.498***	0.496***	0.475***
	(0.019)	(0.026)	(0.020)	(16.330)	(0.018)	(0.020)	(0.019)
A_{ji}	0.001	-0.011	-0.006	1.426	-0.003	0.002	0.028***
	(0.011)	(0.032)	(0.008)	(16.330)	(0.007)	(0.010)	(0.010)
A_{ij}	0.148**	-0.011	0.063**	1.913	-0.024	0.041	0.026
	(0.058)	(0.017)	(0.032)	(15.307)	(0.037)	(0.049)	(0.036)
A_{jj}	-0.327***	-0.404***	-0.036	1.013	0.343***	-0.275***	0.278***
	(0.040)	(0.041)	(0.033)	(15.307)	(0.024)	(0.021)	(0.024)
G_{ii}	0.801***	0.607***	-0.758***	0.339	-0.823***	0.799***	-0.828***
	(0.018)	(0.052)	(0.011)	(0.756)	(0.012)	(0.020)	(0.015)
G_{ji}	0.022	-0.963***	-0.210***	-0.035	-0.051***	0.019	0.183***
	(0.024)	(0.134)	(0.009)	(0.742)	(0.010)	(0.021)	(0.014)
G_{ij}	0.419***	0.205***	-0.236***	0.021	-0.144***	0.709***	0.189***
	(0.068)	(0.057)	(0.036)	(0.757)	(0.039)	(0.090)	(0.017)
G_{jj}	0.006	-0.091***	-0.051	0.282	-0.397***	-0.781***	0.684***
	(0.025)	(0.035)	(0.043)	(0.743)	(0.121)	(0.040)	(0.013)

Notes: Standard errors are in parentheses., ** and *** denote significance at the 10%, 5%, and 1% levels, respectively*

Some interesting points can be underlined. First, there is no evidence of bidirectional (shock and volatility) spillovers between the commodities and Latin American countries under investigation. In fact, we did not find that all the coefficients—A_{ij}, A_{ji} and G_{ij}, G_{ji}—are significant. Second, there is evidence of strong shock and volatility spillovers from corn to Chile and Peru, because of the significance of A_{ij} and G_{ij}. For G_{ij}, the coefficient associated with past commodity conditional variance (namely, $H_{jj,t-1}$), considered in squared terms, results in past increased volatility in the corn market

increasing today's volatility in Chile and Peru's stock market. A third aspect to underline is the presence of volatility spillover from corn to Colombia, from sugar and wheat to Peru, and from wheat to Chile. This derives from the significance of the coefficient G_{ij} for the previous relationships. Summarizing, the BEKK analysis largely confirms what was found for the causality in the volatility test, except for the relationship "sugar → Colombia", which is not supported by the significance of the coefficients A_{ij} and G_{ij}. Recall that the causality in the volatility test only focuses on the presence or absence of the volatility (and shock) spillover originating from series *j* and hitting series *i*, whereas the subsequent BEKK analysis provides additional details on the interdependencies between the commodities and countries under investigation.

The last step of our analysis consists of investigating the response of volatility to a given shock in the series of the commodity. This step employs the VIRF methodology and is focused on the six relationships previously underlined (corn → Chile, corn → Colombia and corn → Peru; sugar → Peru; and, finally, wheat → Peru wheat → Chile). For each of the previous relationships, we report the volatility impulse responses for three situations. The first situation consists of a calm period, where the commodity log-returns is approximately equal to zero. The second and the third situations occur when the commodity log-returns are (heavily) negative and positive, respectively. We call these situations t_c, t_n, and t_p, where the suffixes c, n, and p stand for "calm", "negative" and "positive" periods. All the volatility responses during t_c, t_n, and t_p periods are illustrated in Figs. 2–7, which express the variation of the expected conditional variance with and without the shock (as described above), in annualized percentage terms.

4.1 Volatility Impulse Response from Corn to Chile

Fig. 2 depicts the impulse response of Chile's volatility after a huge decrease and increase in corn daily log-returns (left and right plot), and the response when the daily log-return of corn at time t_c is invariant (middle plot). After a large corn decrease, the volatility of Chile's stock market increases by a negligible amount (at most, the one-step ahead variance increases by 0.10%). This effect disappears after about 40 days. When the corn price from one day to another exhibits no change, the volatility of Chile's stock market decreases, this time by an even smaller amount. Interestingly, also when the corn price substantially increases, the volatility of the Chilean stock market decreases, but by relatively less than in the previous case.

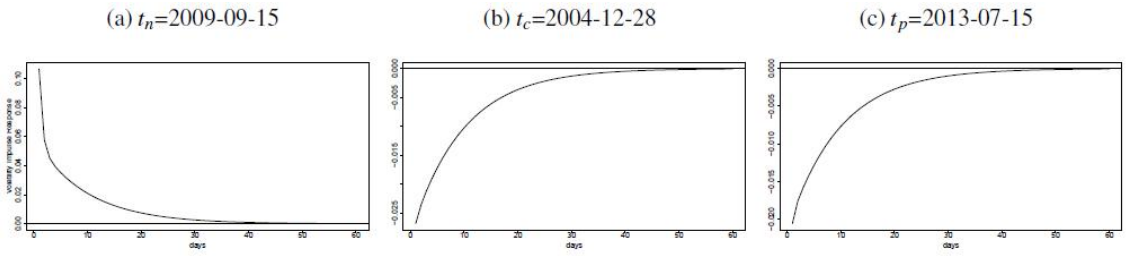

Fig. 2. Volatility impulse response from corn to Chile

4.2 Volatility Impulse Response from Corn to Colombia

With respect to the previous case, the impact of a shock in the corn prices on Colombia's stock market is much more pronounced, as reported in Fig. 3. In more detail, both a decrease (left plot) and an increase (right plot) in the corn log-returns lead to greater Colombian stock market volatility. Not surprisingly, the effect of a fall in corn is relatively larger: The volatility is expected to increase by more than 15%. Another interesting aspect to underline is the fact that any volatility response (to a corn decrease, increase, or invariance) vanishes in less than 10 days.

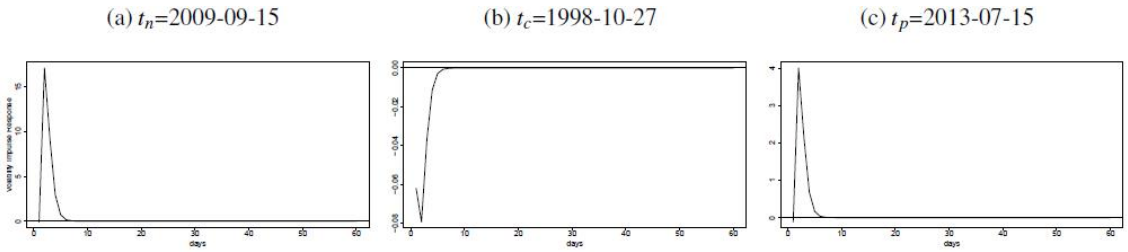

Fig. 3. Volatility impulse response from corn to Colombia

4.3 Volatility Impulse Response from Corn to Peru

Three main points can be highlighted in Fig. 4. First, after both a corn price increase and decrease, Peru's stock market decreases in its volatility, while it increases if corn prices are practically invariant from one day to another. Second, the effects on volatility last for at least 60 days. In general, all the volatility responses appear to be of limited importance.

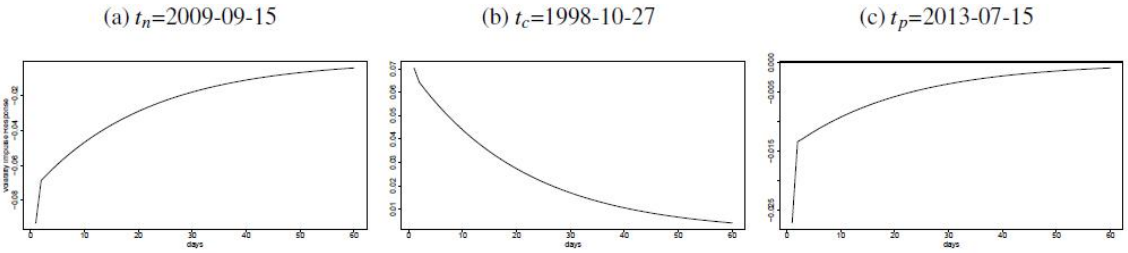

Fig. 4. Volatility impulse response from corn to Peru

4.4 Volatility Impulse Response from Sugar to Peru

The volatility responses of Peru's stock market to shocks in the sugar log-returns are depicted in Fig. 5. Surprisingly, the largest impact on volatility follows a calm period (middle plot). In this case, the volatility of Peru's stock market decreases. In the first days after an increase in the sugar prices, Peru's volatility falls. Moreover, any volatility responses drop off after approximately 60 days.

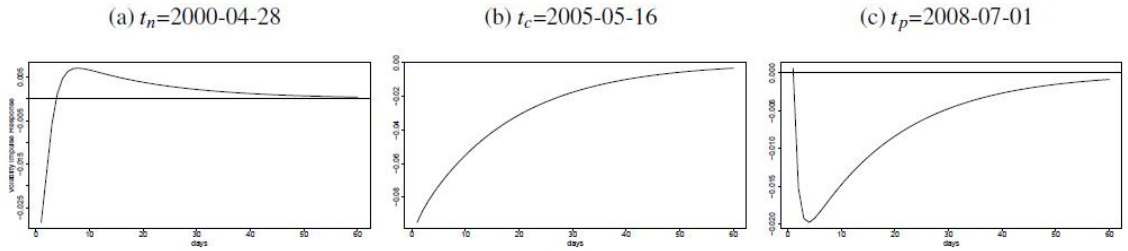

Fig. 5. Volatility impulse response from sugar to Peru

4.5 Volatility Impulse Response from Wheat to Peru

Fig. 6 illustrates the volatility response of Peru's stock market after a given shock in wheat prices. Strangely, the impact of a positive shock (say, a huge sugar price increase) is greater than the impact of a negative shock (say, a decrease in the sugar prices). In both these circumstances, the volatility of Peru's stock market increases. The effect is much more evident after an increase in wheat returns: This leads to the stock market volatility increasing by 1.5%. Unsurprisingly, calm periods in sugar prices decrease the stock market volatility (middle plot).

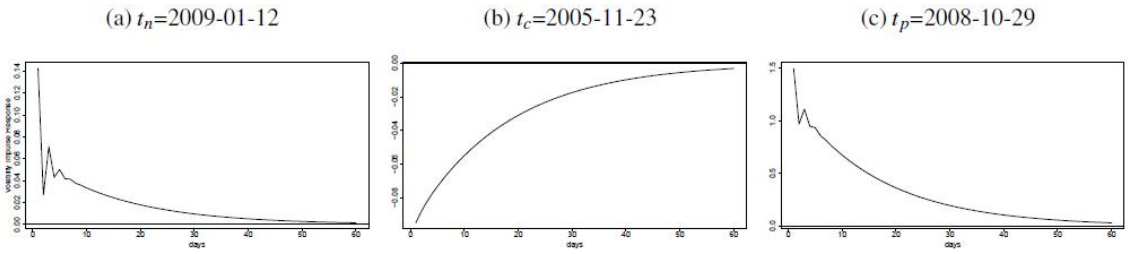

Fig. 6. Volatility impulse response from wheat to Peru

4.6 Volatility Impulse Response from Wheat to Chile

The relationship between the wheat prices and Chile's stock market volatility reported in Fig. 7 follows a standard and plausible pattern from an economic viewpoint, even if it is not of pronounced importance (0.025% increase). In fact, a turbulent period (say, huge negative returns in the wheat market) results in increased volatility in Chile (left plot). On the contrary, a period characterized by good news (say, positive wheat returns) leads to decreased Chilean volatility (middle plot). Calm periods, meaning wheat prices are invariant over time, induce a fall in Chile's volatility. All the effects drop off after 30 days, approximately.

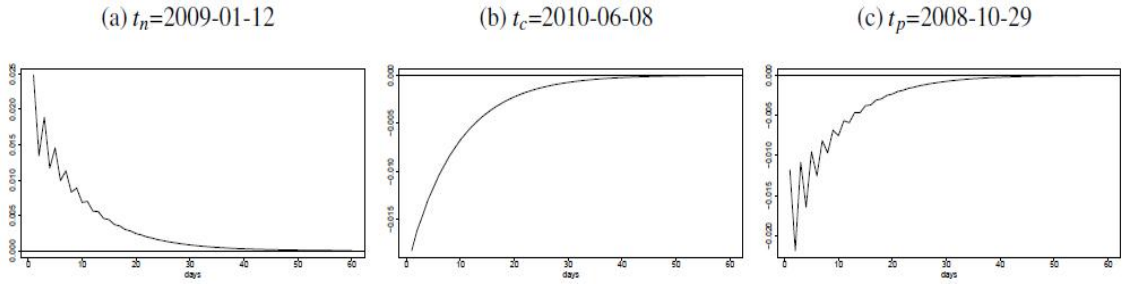

Fig. 7. Volatility impulse response from wheat to Chile

5. CONCLUSIONS

This paper focused on investigating the volatility spillovers from selected agricultural commodity markets (corn, sugar, wheat, soybean, and bioethanol) to five Latin American stock markets (Argentina, Brazil, Chile, Colombia, and Peru). Even though the literature has largely investigate the volatility transmission among countries or among commodities, the effect of volatility produced by agricultural commodities on Latin American stock markets has not received too much attention. Recently, Latin American countries have attracted increased interest because of their status of world leaders as food producers and exporters (Brazil, above all), or because of their status of developing countries as well as food net-importers (for instance, Peru). As pointed out by the FAO and OECD in the 2015–2014 Agricultural Outlook, there is a primary need for understanding the impacts on food security determined by food commodity volatilities. Therefore, it is of great interest to study the presence, the size, and the persistence of volatility originating in an agricultural commodity market and transferring additional volatility to national Latin American stock markets. Moreover, from one hand, in the countries investigated there is still a lack of diversification in production and presently few commodities are produced. From the other hand, the five commodities here analyzed are mainly exported from a few countries and are subject to international price variability. To this extent, the agricultural commodity markets have recently experienced remarkable and severe variations, mainly during the period 2007–2009. These variations can be partially explained by the recent growth in Chinese demand for commodities and raw material [42]. Additional variability has been induced by the slowdown in international demand [43], which has led to an end to the increase in prices and production that occurred in the first decade of the new millennium. The present work contributes to the

literature by employing a three-step analysis devoted to shed some light on the relationships among agricultural commodities and Latin American countries, which, as pointed out by [44], still depend strongly on commodities. First, the recent causality in the volatility test of Chang and McAleer [38] was used to verify the presence of volatility spillovers among the markets under consideration. It was shown that there exist some (more precisely, seven) volatility spillovers, robust to different lagged periods, that is: corn → Chile, corn → Colombia, and corn → Peru; sugar → Colombia and sugar → Peru; and, finally, wheat → Chile and wheat → Peru. Summarizing, neither soybean nor bioethanol produce volatility spillovers towards Latin American countries. Moreover, Argentina and Brazil are not affected by agricultural commodity volatilities, and Peru, which is a net-importer developing country, is the country that more often receives volatility from agricultural markets. In the second step, the BEKK model of Engle and Kroner [40] was employed to derive the size and the bi- or unidirectional nature of the previous seven relationships. There is clear evidence that there are no bidirectional spillovers. Moreover, among the seven relationships, only that concerning sugar transferring volatility to Colombia stock markets was rejected in terms of statistical significance. These results assume great importance in the light of the primary aim of a volatility model, that is forecasting volatility. Taking into account possible influence of other series, once that the volatility spillovers have been ascertained, helps to achieve this aim. And having accurate volatility forecasts is important for a variety of reasons: risk management, portfolio selection, derivative pricing, derivative hedging and so forth. In the last step of our analysis, the VIRF methodology of Hafner and Herwartz [7] was used to depict the volatility responses to a number of shocks in the commodity markets. More specifically, three types of situations were considered: A negative and positive price shock, such that the commodity return under analysis is respectively very low (say, bad news appears in the market) and high (say, good news affects the commodity), and a situation where the commodity return is invariant. Overall, when a negative shock hits the commodity market, Latin American stock market volatility tends to increase. This happens, for instance, for the relationships corn → Chile, corn → Colombia, wheat → Peru, and wheat → Chile. Among these latter, the largest volatility response (15% increase) concerns the relationship corn → Colombia, which curiously is the relationship having the least persistence: approximately 10 days after a negative corn shock, the effect on the Colombian stock market volatility vanishes. On the other hand, positive commodity returns generally induce a decrease in stock market volatility. This holds for the following relationships: corn → Chile, wheat → Peru, sugar → Peru, and wheat → Chile. In terms of persistence, positive shocks affecting commodity markets last quite long. The decreasing volatility in these circumstances disappears after at least 50 days. The current work could be expanded in many directions. First of all, it would be of interest investigating also opposite relationships, that is stock markets exporting volatility to (agricultural) commodities. In this regard, it has to be underlined that some contributions, like ´Smiech et al. [27], find few evidences on this aspect even though during financial crisis generally agents seek shelter in alternative and safer markets, as could be some commodity markets. Also our analysis confirms the absence of bidirectional spillovers, even though this issue merits to be further investigating, maybe replacing the national stock market indexes by a global stock market index like the S&P500. A second direction to be explored regards the spillovers produced by Brazil and affecting the other Latin American countries. As largely documented, Brazil is one of the worldwide leaderships in producing and exporting some food commodities, such corn and sugar. But, given our results, Brazil is not affected by the agricultural commodity volatilities. Thus, it could be investigated if not only the agricultural commodities have some volatility spillovers on the Latin American countries, but also if Brazil itself transfers volatility to the other countries. Finally, according to Chevallier and Ielpo [45], aggregate demand variations, usually proxied by the Industrial Production growth rate, influence the commodities. Thus, a possible limitation of our work is that we do not take into account any possible impacts of other volatility determinants in the relationship between series *j* and *i*. Therefore, a third possible extension to this work could be evaluate the presence of volatility spillovers including the Industrial Production as additional volatility determinant, in the spirit of Engle et al. [45] and Amendola et al. [14], among others.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Investigating the Celebrity ("Tiger Effect") and Other Impacts for Golf Participation in USA

Thomas Willey[1*] and Douglas Robideaux[2]

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ABSTRACT

This paper investigated whether the impact of Tiger's success led to the increase in golf participation during his first decade (1996-2005) or was there some other, better, explanatory factor. Alternate explanations explored are the growth in real household income (income adjusted for inflation) and the return on the S&P 500 for the same time period. The golf industry faces many challenges. Decreasing golf participation and a reduction in the number of courses preceded the Great Recession of 2008-2009, but were certainly exacerbated by it. The golfing establishment saw Tiger Woods as a disruption to business-as-usual, and believed his turning professional in 1996 would have a positive ripple effect on golf participation and the industry as a whole – the so-called "Tiger Effect." Golf course stakeholders bought into the hype of the early Tiger Woods era and believed that the increased TV viewership and Tiger-related discussion would translate into an increase in participation and profitability. That sustained participation never materialized and the supply of golf courses easily outstripped the demand. Using data from multiple sources, the authors investigated the impact of Tiger's off-course earnings (a form of a celebrity influence, we term as the "Tiger Effect"), on participation. Specifically, the components of total U.S. golfers (defined as the sum of core and occasional players) were used as the dependent variables in our analysis. Using regression, the impacts of Tiger's off-course earnings, real U.S. household income and the return on the S&P 500 were used as explanatory variables for the three participation groups. The results indicate that on the surface, a Tiger Effect seemed to exist in the late 1990s, but in actuality, the increasing economy was a key factor in the increase in participation. Golf is still faced with many of the same problems such as declining participation (2015 showed another year-to-year decline) and the closing of golf courses (2015 showed a net loss of 172 courses). The challenges are many, and relying on Tiger is no longer an option, and probably never was.

Keywords: Golf participation rates; tiger woods effect; celebrity endorser.

1. INTRODUCTION

Golf participation has decreased for the better part of ten years. In that time, the industry and particularly the golf course owners have seen their courses lose money and many of them shuttered. This reduction in the number of courses began before the Great Recession of 2008-2009, but was certainly exacerbated by it. As with any industry, investors look for trends and disruptions for opportunities. Investors and golf course owners bought into the hype of the early Tiger Woods era, adding 29% more courses between 1995 and 2008 – an amazing 220% greater annual growth rate than the previous 100 years [1]. By 2014, only eleven new courses were built [2].

Today, both private and public courses face persistent unprofitability [3], while facing pressure to reduce membership fees and round prices [4]. But the courses are not the only sufferers in the golf industry. Equipment makers such as Callaway and TaylorMade have both seen their stocks tumble and have only dim forecasts [5]. Retailers such as Golf Galaxy are suffering, and Dick's Sporting

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Goods made national news when it laid off 500 golf professionals in their stores [6]. In the summer of 2016, Nike announced that it was exiting the golf equipment business [7].

The golfing establishment saw Tiger Woods as a disruption to business-as-usual, and believed his turning professional in 1996 would have a positive ripple effect on golf participation and the industry as a whole – the so-called "Tiger Effect." Investors and course owners saw the early data indicating this positive impact, such as increased TV viewership for golf in general [8], but especially when Tiger was on the leaderboard. Viewership even dropped by 10% when Tiger was in the tournament but not in contention to win [9]. [10] and [11] reported that, according to Forbes, the top ten richest male and female celebrity athlete endorsers earned a total of $600 million in prize money, endorsements and other income.

It has been estimated that Tiger Wood's sponsorship income for that year was $100 million. [12] developed a continuum for endorsers that ranged for acquirable expertise endorsers, or Source Credibility types, to Source Attractiveness individuals who typically possess a high degree of likeability from consumers. The authors cite as examples for the first category fitness experts such as Denise Austin, while Tiger Woods and Michael Jordan were provided as typical endorsers for the second category.

In one study, a category of golf balls dropped by over $10 million in sales because Woods was not playing [13]. Nike's entry into golf was entirely on the back of Tiger's endorsement [13]. Early statistics showed that there were more, and younger, fans of golf [9], even though it is not clear whether these fans turned into golfers [1]. Besides increased TV ratings, he increased the number of sponsors [14]. Tiger was linked to increasing the skill level and physical fitness of golf professionals overall [1]. They got swept up in the exponential growth of endorsement deals [9].

Tournament purses went from 3.4% yearly increases pre-Tiger turning pro, to 9.3% increases post [16]. Purses have been decreasing since the recession, but also coincided with Tiger's 2007 well-publicized marital woes and the lack of a single major win since the event [14].

However, perhaps the greatest motivation for course investors and owners to build more courses was the 18% increase in golf participation from 1996 to 2000 [15]. This seemed to be further evidence of the Tiger Effect, and surely this increase in demand justified the growth in the number of courses. But that participation growth halted, and then declined, while courses continued to be built on the presumption of continued growth, and the growing supply of golf courses easily outstripped the stagnating demand.

Now, twenty years since his professional career began in 1996, we can look back on his first decade and his dominance in golf and his impact on the industry, as well as his second decade of injury and faded hopes with a degree of perspective. This paper investigated whether the impact of Tiger's success led to the increase in golf participation during his first decade (1996-2005) or was there some other, better, explanatory factor. Alternate explanations explored are the growth in real household income (income adjusted for inflation) and the return on the S&P 500 for the same time period.

2. METHODOLOGY

This paper investigated whether the Tiger Effect could explain the level of golf participation, as was suggested earlier. The golf participation is measured using three variables: (1) Core golfers – those who golfed at least eight times per year, (2) Occasional golfers – those who golfed less than eight times per year and (3) Total golfers, which is the sum of the Core golfers and the Occasional golfers. The source data for these variables is the National Golf Foundation database [16]. The trend line of long-term participation trends can be seen in Fig. 1.

Real household median income results and the return on a U.S. stock market index (S&P 500) were collected and used as independent variables. Timelines for the real household income U.S. Census

[17], the S&P 500 market index and the total golfers are illustrated in Fig. 2. One can easily see in the graph, why many assume the three variables are related.

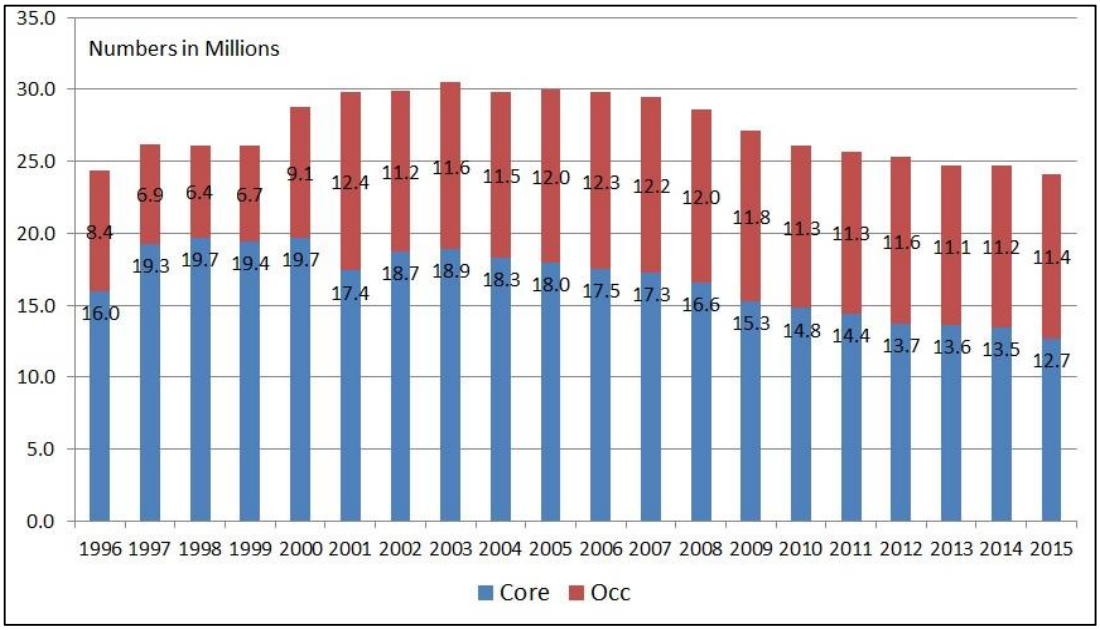

Fig. 1. Long-term participation trends

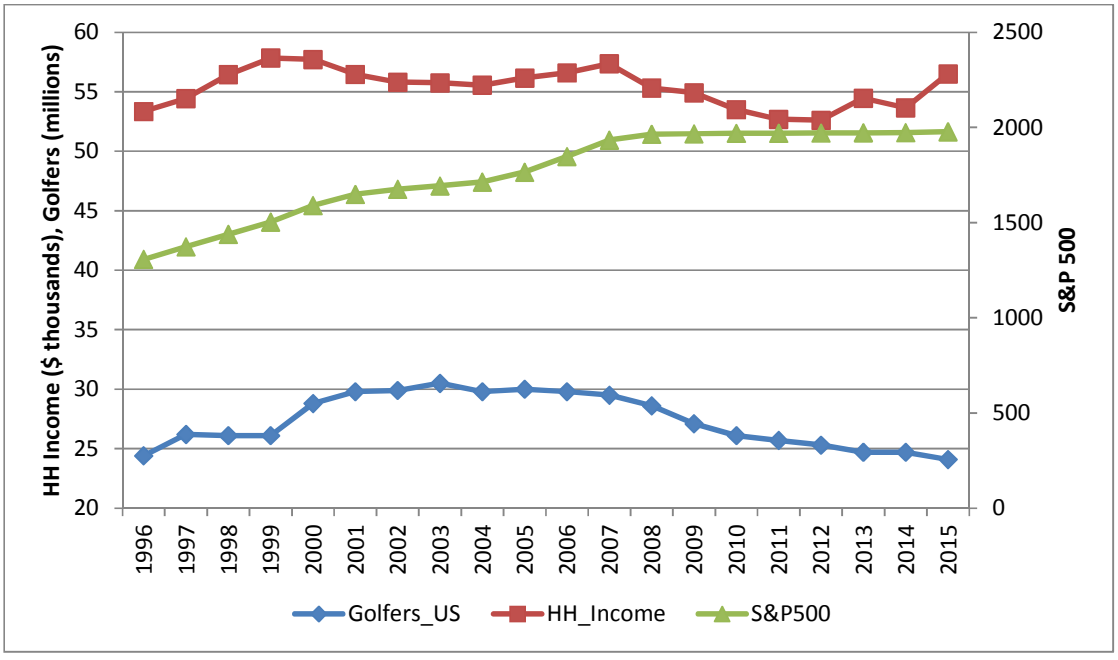

Fig. 2. Median real household, S &P 500 and golfers

2.1 Hypotheses

It has been posited by the National Golf Foundation [18] and others (e.g. [19]) that the rise in golf participation during the mid to late-1990s was largely due to the general expanding economy. In

addition to the golf-centric celebrity income effect, we look at household income and stock market returns as independent variables. Therefore:

Hypothesis 1: The Tiger Woods' Effect, operationalized as his off-course earnings, had a direct and positive impact on the level of golf participation of Core, Occasional, and Total golfers. This hypothesis reflects the impact of only Tiger's role as celebrity endorser.

Hypothesis 2 and 2(a): Real household income (or S&P 500 returns) is positively related to the level of golf participation for (a) Core golfers, (b) Occasional golfers, and (c) Total golfers.

Hypothesis 3 and 3(a): The dual impact of Tiger Woods' Effect, operationalized as his off-course earnings, combined with real household income (or S&P 500 returns) had a direct and positive impact on the level of golf participation of Core, Occasional, and Total golfers. These hypotheses were investigated utilizing linear regression.

3. SAMPLE RESULTS

The summary statistics used to investigate five hypotheses are shown in Table 1. Shown are the Means, Standard Error, Minimum levels, and Maximum levels of the dependent variables: Core golfers, Occasional golfers, and

Total golfers. The same statistics are shown for the three independent variables: Tiger's Off-Course Earnings, Real Household Income and S&P 500 annual returns. Testing Hypothesis 1 –The results of testing the first hypothesis, the Celebrity Effect, can be seen in Table 2.

Table 1. Summary statistics

Series	Mean	Std. Error	Minimum	Maximum
Core Golfers (Rounds $\geq$ 8/year, in millions)	16.74	2.33	12.70	19.70
Occasional Golfers (1 < Rounds < 7/year, in millions)	10.62	1.96	6.40	12.40
Total Golfers	27.36	2.25	24.10	30.50
Tiger Wood's Off-Course Income (in millions)	$63.18	$27.78	$12.25	$109.60
U.S. Household Income (Real Median HH Income, in thousands)	$55.36	$1.61	$52.61	$57.84
Return on S&P 500	9.82%	18.56%	(36.55%)	33.10%

Table 2. Celebrity effect

	Core	Occasional	Total
Constant	17.98	6.93	24.91
(P-Value)	(0.001)***	(0.001)***	(0.001)***
Off-Course Earnings	-0.02	0.06	0.04
(P-Value)	(0.321)	(0.001)***	(0.032)*
R^2	0.002	0.668	0.188

*Level of Significance: * = 0.05; ** = 0.01; *** = 0.001*

Off-course earnings are positively related to the level of golf participation for (a) Occasional golfers and (b) Total golfers. The independent variable of off-course earnings has a significant statistical effect on the dependent variables Occasional and Total golfers at the p=0.001 and p=0.032 levels. Approximately, 67% of the variability in Occasional golfers and 19% of the changes in Total golfers are explained by changes in Tiger Wood's off-course earnings. Therefore, Hypothesis 1 is supported for two of the three dependent variables.

Testing Hypotheses 2 and 2(a) -Household income did not have a statistically significant effect on Occasional golfers, but the direct effect on the Core golfers was significant (p=0.003 and R^2 = 35.6%). In addition, real household income showed a positive effect on the Total golfers (p=0.003 level and R^2

= 24.4%). Using the market return as the independent variable, in testing the alternative version of this hypothesis, none of the three groups of golfers indicated a statistically significant impact for changes in the market portfolio. These results provide support for Hypothesis 2, that real household income had a positive, and statistically significant, impact on the level of core and total golfer's participation. Therefore, Hypothesis 2 is supported and Hypothesis 2(a) is rejected. (Insert Tables 3 and 4 Here). To this point, we have investigated three individual independent variables on their impact on the level of golf participation, measured by Core golfers (heavy users), Occasional golfers (light users), and the total golfers. We found that two of the independent variables, Tiger's Off-Course Earnings and Median Household Income, were statistically significant for Occasional and Core groups of golfers. To test whether there might be interaction, multiple regressions was performed using Income and Off-Course Earnings as independent variables and the three golf classes level of participation as the dependent variable (Insert Tables 5 and 6 Here).

Table 3. Household income effect

	Core	Occasional	Total
Constant	-33.34	19.38	-13.96
(P-Value)	(0.037)*	(0.236)	(0.378)
Real HH Income	0.90	-0.16	0.75
(P-Value)	(0.003)**	(0.586)	(0.015)**
R^2	0.356	-0.038	0.244

*Level of Significance: * = 0.05; ** = 0.01; *** = 0.001*

Table 4. Wealth effect

	Core	**Occasional**	**Total**
Constant	16.79	11.05	27.84
(P-Value)	(0.001)***	(0.001)***	(0.001)***
S&P 500 Return (P-Value)	-0.55	-4.35	-4.90
	(0.855)	(0.071)	(0.077)
R^2	-0.054	0.123	0.117

*Level of Significance: * = 0.05; ** = 0.01; *** = 0.001*

Table 5. Celebrity and income effects

	Core	**Occasional**	**Total**
Constant	-31.92	15.02	-16.91
(P-Value)	(0.043)*	(0.114)	(0.213)
Off-Course Earnings	-0.02	0.06	0.04
(P-Value)	(0.228)	(0.001)***	(0.001)***
Real HH Income	0.90	-0.15	0.75
(P-Value)	(0.003)**	(0.381)	(0.005)**
R^2	0.376	0.665	0.465

*Level of Significance: * = 0.05; ** = 0.01; *** = 0.001*

Table 6. Celebrity and wealth effects

	Core	**Occasional**	**Total**
Constant	18.37	7.33	25.70
(P-Value)	(0.001)***	(0.001)***	(0.001)
Off-Course Earnings	-0.02	0.05	0.03
(P-Value)	(0.278)	(0.001)***	(0.087)
S&P 500 Return (P-Value)	-1.67	-1.69	-3.36
	(0.596)	(0.263)	(0.213)
R^2	-0.039	0.674	0.217

*Level of Significance: * = 0.05; ** = 0.01; *** = 0.001*

The results of the multiple regression show that Household Income is still statistically significant at the 0.003 level for the Core golfers and not statistically significant for the Occasional golfers. Again, the Total golfers are statistically significant at a similar level (p= 0.005). However, the independent variable of Tiger Wood's Off-Course Earnings remains statistically significant for the Occasional and Total golfer groups. Household Income is shown here to be the better predictor of the growth of Core golfers, as well as the growth in the Total number of golfers. When combining household income with the Tiger Effect (Off-Course Earnings), the Tiger Effect disappears for the Core and Total golfers. The effect of the return on the S&P 500, when combined with Real Household Income, does not influence the participation of any group of golfers.

4. DISCUSSION AND SUMMARY

The Tiger Effect may indeed be real – on other aspects of the ups and downs of the golf industry. In isolation, Tiger's Off-Course Earnings, viewed as a Celebrity Effect, do not support the idea that there was an effect created by Tiger on the increased golf participation, particularly the Core players. But there was an indication that the Occasional golfer, which would usually include the beginner golfer, was impacted by the success of Tiger. So, Tiger's impact on golf participation was not going to translate to all golfers, anyway. [20] identified the athlete as a celebrity endorser was largely a creation of "a pseudo-event, claiming that the omnipresent print and broadcast media have provided a means of fabricating well-knowingness." The celebrity endorser was identified by [21] "as any individual who enjoys public recognition and who uses this recognition on behalf of a consumer good by appearing with it in an advertisement".

As we added the Real Household Income (with a corresponding increase in discretionary income) for the same time period, it became evident that this variable had better overall explanatory power (R^2). This was true when Income only was used (Hypothesis 2), but especially evident when both Household Income and Off-Course earnings were combined in analysis. For Core golfers, the most significant factor for participation is Real Household Income. Occasional golfers are impacted positively by Off-Course Earnings and negatively by returns on the S&P 500.

The conclusion of this research does not support the idea that there was a Tiger Effect impact on golf participation in the late 1990s and early 2000s. It was always going to be a stretch of faith that an impact on one thing (increased TV viewership) would likely have a similar impact on all things golf (like participation). In those exciting early days of Tiger's entry into professional golf and his success and domination of the sport, it is not surprising that any – or all – of golf's problems were looking for a savior. Golf is still faced with many of the same problems such as declining participation (2015 showed another year-to-year decline) and the closing of golf courses (2015 showed a net loss of 172 courses) [22, 16]. The challenges are many, and relying on Tiger is no longer an option, and probably never was.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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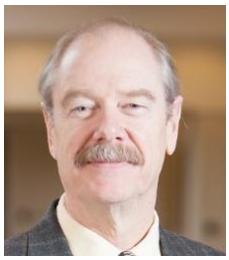

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Investigating the Effect of Campaign Advertising Expenditures on Candidate Quality Signaling in an Election

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ABSTRACT

The electoral market has the *asymmetric information* between candidates and voters with regard to candidate *quality characteristics*, and the asymmetric information causes the adverse selection problem in the electoral market. In an electoral market, if voters cannot distinguish between good-quality and bad-quality candidates before voting, bad-quality candidates may drive good-quality ones out of the election market: this is known as *electoral lemon problem*. That is, good-quality candidates may not win the election against bad-quality populist ones. This electoral lemon problem due to adverse selection can be eliminated or reduced by the screening by voters or by the signaling by high-quality candidates. Voters can screen candidate quality or candidates may send signal to voters. We attempt to examine the signaling model by candidates to inform voters that they are of high quality through campaign advertising and its expenditures. We examine a signaling model to explain the empirical results in which incumbent candidates have substantial positive effect on votes and also inefficient outcome from higher spending. Campaign expenditures can increase vote productivity. The campaign advertising of candidates serves to identify the candidates who possess high-quality characteristics. In reality, campaign expenditures can be spent by candidates for the purpose of sending a signal for candidate's personal quality. But quality signaling is often unproductive and thus results in the inefficient outcome. The variable representing the candidate quality is not directly observable and thus immeasurable. In the absence of a good measure of candidate quality, attempts to estimate its effect will suffer from biased estimates. Because of this, further research should be focused on the development of estimation technique to measure *candidate quality*.

Keywords: Electoral lemon problem; campaign expenditures; candidate quality; quality signaling; Bayesian equilibrium.

JEL classification: D70, D72, D79.

1. INTRODUCTION

The electoral market has the *asymmetric information* between candidates and voters with regard to candidate *quality characteristics*, and the asymmetric information causes the adverse selection problem in the electoral market.

Voters' ignorance about candidate quality or voters' illusion on policy characteristics can keep high-quality candidates out of the electoral market and this corresponds to a lemon problem in an electoral market [1-3]. Thus, high-quality candidates are willing to send information about their quality to less-informed voters [4,5,6]. That is, high-quality candidates may have an incentive to send a signal about their quality to voters through high campaign advertising and expenditures.

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In general, signaling is a way for an informed player to communicate his type about his ability or his quality to uninformed players. In the context of an electoral competition game, *electoral signaling* is an effective way for an informed candidate to communicate his quality on personal characteristics to voters who may be uninformed or who may have policy illusions [7,8,9]. Thus, the signaling mechanism between candidates and voters may help to specify voter's behavior that depends on observable characteristics which informed candidates choose for themselves for given their quality type [10,11].

Since Spence [12] introduced the idea of signaling in the context of education, the applications in economics have become enormously widespread. In particular, he shows that education may not increase a worker's ability or productivity, but may still be useful to display the ability of workers to employers.

In reality, a candidate's personal attributes may dominate the policy characteristics of the candidate or party involved [13-15]. Because of voter's rational ignorance or illusion on the policy issues, voters are likely to focus on the candidate's quality attributes rather than policy characteristics.[1] In such an environment, bad-quality candidates can be elected. We can call this phenomenon the *electoral lemon* problem. By sending signals via campaign advertising, good candidates with high quality might be elected [16-18].

Our aim is twofold in this essay. One is to provide a theoretical background for incumbent candidates (high-quality candidates) to engage in high campaign advertising, and the other is to help to explain the empirical results. The growing volume of political advertising, and its possible effects on voters' choices, has contributed to a growing debate about campaign fundraising and spending limits in elections (Soberman and Sadoulet [19], Centre for Law and Democracy [20], Gordon and Hartmann [21]). Various empirical estimation models showed that incumbent (or high-quality) candidates are less vote productive, even if outspending, than challengers. Most of the campaign spending literature focuses on the question of whether incumbent's spending is as effective as challenger's spending. Their conclusion is that the marginal effect of challenger spending is likely to exceed that of incumbent spending (see Jacobson [22]). However, *incumbents* typically tend to *outspend* their challengers or opponents. Thus, incumbents are able to offset the effects of campaign expenditures by challengers by their spendthrift ability. In other words, incumbents make up for whatever productivity advantage that challengers enjoy by *outspending* their opponents [23]. Therefore, incumbents can buy their votes with their lavish expenditures. Furthermore, the existing empirical literature says that campaign spending is less important for incumbent candidates than for non-incumbent candidates, challengers. This is the case when we focus only on the 'resource effect'. Social scientists have long been interested in the consequences of political mass communication. Fearing that voters may be easily manipulated by self-interested agents, some equate persuasion with propaganda (Herman and Chomsky [24], Lippmann [25], Spenkuch and Toniatti [26]).

But, according to the estimation result by Lee [27], the interaction between incumbent (high-quality) candidates and their high spending turned out to have negative impact on votes for all three political parties in U.K. This indicates that spending is less productive as candidates are high quality: we refer to this as an *inefficient* vote outcome. This suggests that there is an inefficient vote outcome when incumbent (high quality) candidates engage in 'high spending'. As high quality candidates spend more money, the vote productivity is likely to decrease. That is, quality signaling may be effective, but vote outcome is inefficient [28-30]. In contrast, spending will more productive as candidates are non-incumbents and thus low quality. As non-incumbent or low quality candidates spend more money, the vote productivity is shown to increase.

In this essay, we attempt to explain these two different results using a signaling model. We suppose that when spending increases and the name recognition of the incumbent candidates becomes well known to voters, the candidate-centered aspects, such as candidate quality, in the election contest will be more important. In other words, the candidate's general aspects, such as name recognition,

[1]*Alternatively, from the policy point of view, a candidate with populist or short-term policy attributes may dominate a candidate with implementable or long-term policy characteristics.*

will matter in the low and medium spending levels, but the candidate's quality factors will count in the higher spending level. In what follows, we will show that campaign spending will be more important for *incumbent* candidates than for non-incumbent candidates in a quality signaling model because they attempt to signal their high quality. A signaling framework may provide us not only with some explanation of many existing empirical results, but also with an incentive for incumbent to engage in high spending.

We proceed our analysis as follows. In section 2, we introduce the signaling idea which implies that 'actions speak louder than words', and discuss bad-quality and good-quality candidates. In sections 3 and 4, we build a basic model and derive equilibrium using a useful concept known as Bayesian perfect equilibrium, and interpret this equilibrium based on the separating equilibria. Then, in section 5, we provide the literature review, and concluding remarks are in section 6.

2. ELECTORAL MARKET WITH LEMON CANDIDATE AND THE SIGNALING IDEA

An electoral competition game can be characterized by information asymmetry between candidates and voters. Candidates have some private information that affects voters' decisions in an election. For example, some innate characteristics of candidates' personality are not likely to be known to voters. Or the policy issues available to candidates are not fully known to voters. Even when the possible policy actions are known, the actual policy actions taken by candidates may not be observable to voters.

In our electoral model, we suppose that there is asymmetric information between candidates and voters with regard to candidate quality characteristics: candidates know their quality about personal characteristics, but voters do not. In an asymmetric information environment, a more informed party (candidates) may exploit a less informed party (voters). Such opportunistic behavior due to asymmetric information may lead to market failures, violating many desirable properties of competitive markets. If voters do not know the quality of a candidate they are considering voting, some candidates may try to sell them bad information. Since obtaining the quality information of candidates is expensive, voters will not have an incentive to distinguish between good and bad candidates, and thus may be unwilling to cast a vote for good-quality candidates. Thus, voters are likely to support bad-quality candidates. Bad-quality candidates may drive good-quality candidates out of the electoral market. Voters' ignorance and illusion about candidates' quality will cause to drive out high-quality candidates. If voters cannot distinguish between bad and good candidates before casting a vote, it will be possible that bad candidates will be elected. Such opportunistic behavior by candidates due to asymmetric information may lead to electoral market failures. In other words, bad-quality candidates may drive good-quality candidates out of the electoral market.

We consider the case of adverse selection or information asymmetry in which an informed individual's decision depends on his unobservable characteristics in a way that adversely affects the uninformed people in the market. In this environment, informed individuals will find an incentive to signal information about their unobservable characteristics (their *quality type*) through observable actions (campaign *advertising activity*). We apply this situation in the electoral context.

In an electoral market, candidates inform voters of their private information by sending a signal that may reveal information relating to their quality type. Then, the uninformed voters observe this signal and try to interpret this by using an interpretative scheme known as Bayesian updating mechanism. Thus, voters can infer the quality of candidates by using this mechanism which helps voters distinguish between good and bad candidates. This seems plausible because both voters and high-quality candidates have incentives to try to achieve this objective during the election. We call this 'electoral signaling mechanism'. The basic idea of this is that high-quality candidates may have credible actions, rather than pure words, in order to distinguish themselves from their low-quality counterparts.

In our election context, we suppose that candidates with unobservable information try to reveal the information they have through signal. To reveal information, candidates require a 'credible signal' to

send. Signaling works only if the signal action entails different costs to candidates with different quality.[2]

The general principle governing such situations in which information between candidates and voters differs is that 'actions speak louder than words' in the presence of asymmetric information. The voters should watch *what candidates do*, not what they say (i.e., cheap talk). Thus, knowing that voters will interpret actions of candidates in this way, a candidate will try either to manipulate his actions for voters' information content or to signal quality information through campaign expenditures. In our context, we suppose that a candidate can 'make his actions speak louder than words'. In other words, campaign advertisement and expenditures will serve to speak louder than campaign propaganda or verbal promises.

When candidates play an election game, they may have unobservable information, such as high quality, that is 'good' for themselves in the sense that if voters knew this information, they would alter their decisions in a way that would increase candidates' expected votes gained in the election. On the other hand, candidates may have 'bad information', which would cause voters to act in a way that would hurt candidates. Candidates know that voters will infer information on candidate's quality from the credible actions candidate take. Therefore, each candidate will attempt to take actions that will induce voters to believe that the information a candidate sends is good. Such actions are called signals, and the strategy of using them is referred to as 'signaling'.

In reality, candidate's personal attributes are dominating the policy characteristics of the candidate or party. Because of voter's rational ignorance or policy illusion, voters are likely to focus on candidate's quality attributes rather than policy characteristics. Thus, we focus on the quality attributes. We can call this phenomenon the electoral lemon problem. By sending signals via campaign advertising, good candidates (with high quality) might be able to ameliorate this problem.[3]

Now, we can classify candidates into good and bad quality. First, if we take only policy characteristics into account, then good candidate is the one with proposing more credible and implementable policy (i.e. we call them *electoral good candidate*), whereas bad candidate is the one proposing populist and short-term policy (i.e. we call them *electoral bad candidate*). On the other hand, if we take only quality characteristics into consideration, then good candidate is the one with high quality, while bad candidate is the one with low quality, where "quality" indicates such characteristics as honesty, reliability, or competence, etc.

We attempt to apply a signaling model in an electoral market. The idea is that by spending on his election campaign, an informed candidate can signal his qualities to uninformed voters in a way that influences his votes. In particular, we define good candidates in terms of personal quality, incumbency status and competence. Imagine that there are two types of qualities that candidates espouse during the election: good-quality and bad-quality candidates. In particular, we will call bad quality candidates electoral lemon candidates. A candidate with good quality might want to signal the better or superior quality related to his personal attributes. He knows that it will not suffice merely to propose it by verbal propaganda, or cheap talk, since competing bad-quality candidate can also use this very same propaganda. Thus, one way to 'put his money where his mouth is' will be for the good candidate to spend more money on campaign activities.

3. A BASIC MODEL

In this section, we describe some assumptions and set up a formal model. First, we make basic assumptions. In a signaling model, the institutional context matters and the order of moves is important. We assume that in an electoral signaling model, the informed candidate moves first to send a signal to uninformed voters who receive signaling information later.

[2] *This is known as the 'single crossing condition'. We will deal with this later section.*
[3] *In a market with uncertain product quality, bad-quality product can drive out good-quality goods. This phenomenon is often called the 'lemon problem'. In addition, candidates in an electoral market are equivalent to products in an economic market.*

There are also voters that will cast votes for the candidate they prefer based on the candidate's quality. We assume that voters are principally concerned with the likely benefits (post-election utility gain) from selecting a high-quality candidate. Thus, voters prefer a high-quality candidate since he can give them more utility.

We focus on the candidate's quality concerned with the personal characteristics, rather than policy attributes.[4] We can justify this assumption on the grounds that candidate's personal (quality) attributes are dominating the policy characteristics of candidate or party. Because of voter's rational ignorance or policy illusion due to policy complexity, voters are likely to focus on candidate's quality attributes rather than policy characteristics.[5] Then, we define two types of candidates based on personal quality: one type is high quality and the other type is low quality.

The key element is that candidates attempt to engage in electoral advertising activity which will increase the voteshare they obtain in the election. Specifically, each candidate chooses a level of advertising activity within the legal limits the election law allows. Advertising activity incurs advertising expenditures or costs. Note that we differentiate advertising activity from advertising expenditures[6], and advertising activity is candidate's choice variable in the present context. This means that for every level of advertising, high-quality candidates can obtain more expected votes than low-quality candidates. However, voters, when they vote for a candidate, are unable to tell whether the candidate is high quality or not. But, they can observe the candidate's advertising level, and thereby they learn how much advertising activity candidates are engaging in during the election period. Hence, they can make voting decision contingent on the advertising level that the candidate made in the election.

Campaign advertising will be effective or informative if it reduces the 'election illusion' and 'quality illusion' associated with the candidate quality, and alters the voters' perception on the candidate's quality. Campaign advertising will also be credible if it reveals the correct information on candidate's quality type. Moreover, signaling costs, or advertising costs, must differ between candidate's quality types for signaling to be useful: that is, single crossing condition should be met.

The function of advertising activity may be twofold. First, advertising the candidate's quality can serve to reduce the 'election illusion' that voters have in relation to the candidates.[7] Second, candidates of high quality may have an incentive to execute more advertising and spend more money on advertising than low-quality candidates, because uninformed voters are more likely to vote for high advertising and thus high-quality candidates. Therefore, for high-quality candidates, advertising can be served as a signal of their superior quality.

As an alternative to advertising expenditures, candidates could use brand names as a signal of quality: for instance, name recognition, popularity, or celebrity status. Thus, candidates use a brand name to enable voters to identify their high quality. In addition, some candidates provide the record of holding previous elected office (i.e. the incumbency or ministerial status) as signals to convince voters that they are of high quality, or have experience and competence. But, in our electoral model, we restrict attention to the case where candidates engage in campaign advertising activity. Finally, we assume that advertising serves only for signaling which reveals candidate's quality type.

Based on these assumptions, we now turn to describe the basic model. To keep things simple, suppose that candidates j are of two types with regard to the quality: H (high-quality) and L (low-quality): $j \in [H, L]$. Potential voters are willing to vote more for a high-quality candidate, and less for a low-quality candidate. But, since voters cannot directly observe any particular candidate's quality type,

[4] *In the electoral context, we suppose that the candidate's quality is experience goods in the sense that a candidate must be elected by voters before his quality can be revealed.*
[5] *Alternatively, if we divide candidates based on the policy, then bad-quality candidate means populist candidate or candidates proposing short-term policy, or unimplementable policy, and good-quality candidate indicates candidates proposing long-term or implementable and credible policy, or quality-oriented candidate.*
[6] *In what follows, we assume that advertising is equivalent to advertising activity or level, and advertising expenditures and advertising costs are interchangeable.*
[7] *Of course, advertising can serve to transmit information in relation to the candidate's policy platforms.*

they have to rely on other credible means to distinguish between high-quality and low-quality candidates.

Suppose a candidate may be either of high quality (type H or q^H) or of low quality (type L or q^L). The candidate knows his quality, but voters do not. However, the candidate can attempt to signal his quality by his campaign advertising and expenditures.[8] This relationship becomes interesting because voters have an incentive to *infer* the candidate's type from such a signal while the candidate may have an incentive to *inform* voters of their quality types.[9]

Then, candidates use campaign advertising which incurs campaign expenditures for the signaling. But, each quality type has a different incentive to engage in campaign advertising. If candidates spend money for their campaign advertisements, then their campaign expenditures can be credible evidence of their quality. Suppose the candidate types differ in their ability to spend campaign expenditures: high and low spending (or high ability and low ability to spend).

The timing of the game is as follows.

(1) Nature selects the candidate's quality type - whether a candidate is of high or low quality. The candidate knows his quality type, but voters do not. Nature draws quality q^j for the candidate from a set of feasible types $Q = \{q^H, q^L\}$ according to a probability distribution $p(q^j)$, where $p(q^j) > 0$ for every quality type j and $p(q^H) + p(q^L) = 1$. The probability that $q = q^H$ is p and $q = q^L$ is $(1 - p)$.
(2) Contingent on his quality type, the candidate j chooses campaign advertising level $a_j (a_j \geq 0 \text{ for } j = [H, L])$ from a set of feasible messages $A = \{a_H, a_L\}$, where a_H denotes high advertising (HA) and a_L means low advertising (*LA*).
(3) Voters observe campaign advertising a_j (but cannot the candidates' quality q^j) and then make voting decisions. That is, conditional on the *observed* advertising level of the candidate, voters cast their votes: choosing voting action V_i from a set of feasible vote actions $V = [V_H, V_L]$, where V_H denotes 'vote for high-quality candidate' and V_L is 'vote for low-quality candidate'.

In a signaling game, a pure strategy for the candidate is a function $a_j(q^j)$ specifying which advertising message a_j will be chosen for each quality type q^j that nature draws, and a pure strategy for the voter is a function $V_i(a_j)$ specifying which voting action V_i will be chosen for each advertising message a_j that the candidate might send.[10] Since the set of feasible advertising message depends on the quality type that nature draws, we call this quality-dependent advertising message, $a_j(q^j)$. On the other hand, because the set of feasible voting choice depends on the advertising message level that the candidate chooses, we refer to this as advertising-dependent voting decision, $V_i(a_j)$.

Now, we turn to describe players' payoffs. First, we consider voters' payoff. We assume that there are uninformed voters i. To maximize his expected payoff, voter i will cast his vote equal to the expected utility obtained from a candidate with advertising level a_j, given his belief about the candidate's quality after observing advertising level a_j:

$$V_i(a_j) = \mu(q^H|a_H) \cdot q^H + [1 - \mu(q^H|a_H)] \cdot q^L \tag{1}$$

where $\mu(q^H|a_H)$ is the voter's assessment of the probability that the candidate's quality is q^H after observing advertising level a_H. Thus, the right-hand side represents the expected utility (EU_i) of voters i.

[8] *Alternatively, candidates can attempt to signal his quality through his incumbency status.*
[9] *We ignore the possibility that the candidate have an incentive to mislead or manipulate voters.*
[10] *Recall that a player's strategy is a complete plan of action: a strategy specifies a feasible action in every contingency in which the player might be called upon to act.*

We assume that after observing advertising choice a_j, voters hold the same belief about the candidate's quality, denoted by $\mu(q^H|a_H)$. Voters must hold a common belief that is either on the equilibrium path or off the equilibrium path after observing a choice of advertising a_j. Given this assumption, it follows that in any perfect Bayesian equilibrium, the voters cast the vote $V_i(a_j)$ given in equation (1).

Second, candidate's payoff is described as follows. Now, letting $EV_j(V_i, a_j|q^j)$ denote the expected vote of a candidate with quality type q^j who chooses advertising level a_j and receives vote V_i, we can define $EV_j(V_i, a_j|q^j)$ as being equal his vote V_i gained less any advertising expenditures $e_j(\cdot)$ incurred during the election. Thus, the candidate's payoff is defined as:

$$EV_j(V_i, a_j|q^j) = V_i(a_j) - e_j(q^j, a_j) \tag{2}$$

where $V_i'(a_j) > 0$ and $V_i''(a_j) < 0$. In the analysis that follows, we shall see that this costly advertising may serve as a signal of unobservable candidate quality. In particular, equilibria emerge in which high-quality candidates choose to have more advertising than low-quality candidates, and voters correctly take differences in advertising levels as a signal of quality.

4. EQUILIBRIUM CONCEPT: PERFECT BAYESIAN EQUILIBRIUM

4.1 No-Mimicking and Single Crossing Conditions

Before introducing equilibrium concept, we examine two basic conditions for the equilibrium. First, we start with the no-mimicking condition. We assume that low-quality candidates do not mimic high-quality candidates. Because of private information on candidate's quality, there is a possibility that low-quality candidate could try to mimic as high-quality candidate. To rule out this possibility, we assume that the costs facing low-quality candidates pretending to be of high quality exceed the benefits, and thus they have no incentive to mimic high-quality candidates. In other words, it is too expensive for low-quality candidate to engage in high advertising, even if doing so would trick the voters into believing that the candidate has 'high quality' and so cause them to cast high votes. Then, this no-mimicking condition can be given as:

$$V_L^*(q^L) - e[q^L, a^*(q^L)] > V_L^*(\mathbf{q}_L^H) - e[q^L, a^*(\mathbf{q}_L^H)]$$

where bold character $\mathbf{q}_L^H$ in the parenthesis of the right-hand side denotes the case in which a low-quality candidate pretends to be high-quality candidate, $a_j^*(\mathbf{q}_L^H)$ and obtains higher vote, $V_i^*(\mathbf{q}_L^H)$.[11]

Second, we examine the single-crossing condition and property that is implicit in all signaling models. Candidates want to obtain more votes, but they also dislike advertising activities which need to incur time and monetary costs. Low-quality candidates dislike advertising activity more than do high-quality candidates. That is, both types of candidates dislike advertising activity, but low-quality candidates dislike advertising relatively more (measured in terms of vote compensation). This assumption is crucial for what follows because it implies that a high-quality candidate finds it relatively cheaper (in terms of expected votes) to obtain a higher level of advertising, which can be used to distinguish high-quality candidates from those of low quality. This assumption is known as the *single-crossing property*.[12]

[11] *In a model with more than two values of the candidate's quality, the no-mimicking case can arise if each possible value of quality is sufficiently different from the adjacent possible values. On the other hand, if quality is a continuous variable, then the mimicking case can apply.*
[12] *This condition is referred to as a Spence-Mirrlees condition or sorting condition.*

The monetary cost, or advertising expenditure, of engaging in advertising activity a_j for candidate's quality type q^j is given by the twice continuously differentiable expenditure function $e_j(a_j, q^j)$. We will ignore the time costs that candidates incur and invest in advertising activity. Thus, the time costs are independent of expenditure e_j, so the advertising cost function $e_j(a_j, q^j)$ measures only monetary costs. For the case of a candidate, advertising expenditure function can be represented as[13]:

$$
\begin{aligned}
&e(a, q) \\
&\text{(i) } e(0, q) = 0,\ e_a(a, q) > 0,\ e_{aa}(a, q) > 0 \\
&\text{(ii) } e_q(a, q) < 0\ \forall\ a > 0 \\
&\text{(iii) } e_{aq}(a, q) < 0\ \text{(i.e., } \partial^2 e/\partial a \cdot \partial q < 0)
\end{aligned}
$$

where subscripts denote partial derivatives, and $e_a(a, q)$ represents the marginal cost of campaign advertisement for candidate's quality $q \in [q^L, q^H]$ at the level of advertising a_j: $e_a \equiv \partial e/\partial a$. Note that candidate's quality does not depend on his advertising activity. That is, q^j is determined by nature.

This advertising cost or expenditure function indicates that both the average cost and the marginal cost of advertising are assumed to be lower for high-quality candidates. For example, the advertising might be easier for a high-quality candidate. Or having an advertising activity costs a candidate more when he is low quality. In particular, the last assumption (condition (iii)) on the cross-derivative says that advertising activity can only serve as a signal, but does not increase the quality of candidate. Recall that the quality q of candidates is their private information which is unobservable to voters, but advertising levels a are publicly observed by voters. Thus, the cross-derivative condition implies that voters could *sort* candidates with unobservable quality by looking at their observable advertising levels. Thus, this is referred to as *sorting condition*.

The crucial assumption in our model, as in Spence's model, is that low-quality candidates find signaling more costly than do high-quality candidates. The reasons for this are, for instance, that voters are unlikely to recognize low-quality candidates, or they have less donation from contributors. In other words, the marginal cost of campaign advertising activity is higher for low-quality than for high-quality candidates. Thus, the single-crossing condition is now represented as:

$$e_a(q^L, a) > e_a(q^H, a) \text{ for every } a,\ \text{where } e_a \equiv \partial e/\partial a$$

or

$$\left[\frac{\partial e}{\partial a}\right]^{q^L} > \left[\frac{\partial e}{\partial a}\right]^{q^H}$$

This implies that low-quality candidates will find it more difficult to spend more money and also more difficult to obtain high votes from voters. In other words, high-quality candidates will find it more easy to spend more money and also more easy to obtain high votes.[14]

Second, we examine the vote compensation mechanism by voters: that is, how do voters respond to and compensate a candidate for his increase in advertising activity? In other words, how much of an increase in votes will be necessary to compensate this candidate for a given increase in expenditure? The answer depends on the candidate's quality: low-quality candidates find it more difficult to acquire the extra expenditure and so require a larger increase in votes to compensate them for it. That is, to

[13] *This is the case of a single candidate and thus, we can drop the subscript denoting candidate j.*
[14] *Alternatively, we can explain the single crossing property by using indifference curve. This assumption also implies that low-quality candidates have steeper indifference curves than do high-quality candidates. This indicates that the indifference curves of the two quality types cross only once: known as single-crossing condition. In other words, the indifference curve of the high-quality candidate has a flatter slope.*

compensate a candidate for a given increase in advertising requires a greater increase in votes for a low-quality candidate than for a high-quality candidate.

Voters will compensate a candidate by casting more votes as his advertising expenditure increases. However, the increase will depend on the quality type of candidates. That is, low-quality candidate will get more votes from his increase in advertisement due to the single-crossing property. This implies that for the given increase in advertising, low-quality candidate can obtain more votes than high-quality one. Or, for the given increase in vote, the high-quality candidate is able to engage in more advertisement.

4.2 Voter's Belief: Bayesian Reasoning Mechanism

In our signaling model, we assume that voters have *beliefs* updated by Bayes' rule: Bayesian belief. We explain the mechanism known as Bayesian updating. Bayesian mechanism indicates how voters use new information revealed by the observation of advertising activity and expenditures in order to update their beliefs about the quality of candidates.[15] Electoral advertising can influence the perception of uninformed voters on the candidate's quality through Bayesian reasoning.

First, we describe the Bayes' rule. Suppose the quality events q^H (high quality) and q^L (low quality) are mutually exclusive, and each has nonzero probability $p: p \geq 0$. Suppose that the advertising event a_H (high advertising) and a_L (low advertising) have a nonzero value: $a_j \geq 0$. Then, for quality event q^H and advertising activity a_H, for instance, we can formulate the following Bayes' rule:

$$\mu(q^H|a_H) = \frac{P(a_H|q^H) \cdot P(q^H)}{P(a_H|q^H) \cdot P(q^H) + P(a_H|q^L) \cdot P(q^L)} \tag{3}$$

Bayes' rule allows voters to reassess the probability of the quality event q^H after learning that advertising event a_H has occurred using both the conditional probability $(P(a_H|q^H))$ that a_H will occur given quality q^H and the unconditional probability $(P(q^H))$ of q^H. The unconditional probability $P(q^H)$ is called the prior probability of q^H, since it represents the voter's beliefs before learning that the advertising event a_H has occurred. In turn, the probability $\mu(q^H|a_H)$ is the posterior probability of high quality q^H, since it represents the voter's beliefs after observing about candidate's advertising activity a_H. Thus, Bayesian updating of voters consists of replacing the prior probability with its posterior probability after observing the advertising level of candidates. Voters want to know the posterior probability $(\mu(q^H|a_H))$[16] from using the knowledge of both the prior probability $(P(q^H))$ of high quality and the conditional probability $(P(a_H|q^H))$. Similarly, Bayes' rule for $\mu(q^L|a_L)$ can be derived.

4.3 Perfect Bayesian Equilibrium

In this section, we characterize perfect Bayesian equilibrium (*PBE*) for signaling game in an electoral competition. The *PBE* is the equilibrium concept in the signaling game that must be performed to update player's information on the basis of observed actions. This requires players to update their information by observing actions along the equilibrium path. In the equilibrium of an electoral game with imperfect information, candidates and voters must not only use their best actions given their information, but also voters must draw correct inferences (update their information) by observing the actions of candidates. This type of equilibrium is known as a *perfect Bayesian equilibrium*. The outcome of such a game may entail pooling or separating equilibrium.

The perfect Bayesian equilibrium requires that first, at each stage, the player acting there takes the best action in light of the available information, and second, players draw the correct inferences from their observations, as specified by Bayes' rule for drawing inferences from observations. These requirements constitute a perfect Bayesian equilibrium. While the equilibrium of signaling games can be quite subtle and complex, the basic idea of the role of signaling to send necessary information is

[15] *For the way that advertising influences voters' perception, see Nelson [26].*
[16] *Recall that $\mu(q^H|a_H)$ represents the probability that the candidate is high quality given high advertising activity.*

simple. Candidates of different types, with possessing different information about their own quality characteristics, should find it optimal to take different actions, so their actions must reveal their types truthfully.

A perfect Bayesian equilibrium (*PBE*) is one in which the informed candidate send the profitable or credible signals, the uninformed voters cast their votes after correctly processing the signal, and the signals are correctly processed by the uninformed voters. A separating *PBE* is one in which different candidate types send different signals and hence the initially uninformed voter is fully informed by the time he takes his action. A pooling *PBE* is one in which the signals are identical and thus non-informative.

Now, we specify the notion of perfect Bayesian equilibrium as follows: a set of strategies for candidates and voters, and a belief function $\mu(q^H|a_H) \in [0,1]$, which gives the voters' common probability assessment that the candidate is of high quality after observing advertising level a_H. Thus, a perfect Bayesian equilibrium[17] is defined if the followings are met:

(1) Candidate's advertising strategy is optimal given the voter's strategies.
(2) Voters' vote decision is optimal given that the probability that the candidate is of high quality is $\mu(q^H|a_H)$.
(3) Voter's belief $\mu(q^H|a_H)$ is derived from the candidate's strategy a_H using Bayes' rule.

Based on this notion, we first describe perfect Bayesian equilibrium informally by taking a simple signaling electoral game. The following strategies of candidates and voters, and voter's beliefs constitute a perfect Bayesian equilibrium:

(1) Candidate's Strategy ('advertising decision'): A candidate's strategy specifies the action to make for each of his two quality types. A pure strategy of a candidate is represented by a pair of advertising actions. For each quality type, candidate's advertising decision maximizes the candidate's expected votes given voter's strategy. Thus, a candidate does engage in low advertising activity when he is a low-quality type, and does engage in high advertising when he is a high-quality type.
(2) Voter's Strategy ('voting decision'): The voter's strategy depends only on the candidate's advertising decision, not on his unobservable quality type.[18] For each advertising, a voter's voting decision maximizes voter's expected utility given his updated belief and candidate's advertising strategy. Thus, a voter casts a vote for the candidate if and only if he is a high advertiser, and does not if he is a low advertiser.
(3) Voter's Belief: A voter's updated belief can be derived from the candidate's equilibrium strategy using Bayesian rule to infer the quality type of candidates. Thus, a voter believes that a candidate is a high-quality type when he engages in high advertising activity, and believes that a candidate is a low-quality type when he does in low advertising.

The collection of probability assessments for each information set is called the voter's belief profile. A voter's beliefs can be represented as: $[HQ{:}\,\mu,\, LQ{:}\,(1-\mu)]$. This means that the voter believes that the chance of the candidate being a high-quality type is μ and the chance of him being a low-quality type is $1-\mu$. Thus, a belief profile is represented as: $[HA{:}\,(HQ=1),$ *LA*$:\,(LQ=1)]$.

Then, if we apply this requirements to our simple electoral signaling game, we can find a perfect Bayesian equilibrium as follows: (i) the strategy profile of the candidate is: $(HQ{:}\,HA, LQ{:}\,LA)$, (ii) the strategy profile of the voter is: $(HA{:}\,V, LA{:}\,NV)$, and (iii) the belief profile of the voter is : $[HA{:}\,(HQ=1),$ *LA*$:\,(LQ=1)]$.

[17] *This notion of a perfect Bayesian equilibrium is equivalent to the sequential equilibrium concept.*
[18] *The game-theoretic meaning is that the voter can determine his strategy after observing the candidate's action without knowing the state of the world. That is, the voter can determine his optimal choice at the information set with having to guess which node within the information set he has reached. In general, the voter's optimal choice at an information set will depend on his assessment of the probability of reaching each of the decision nodes within that information set.*

Second, we examine formally perfect Bayesian equilibrium based on the basic model described above. A perfect Bayesian equilibrium in pure strategies consists of a vector of strategies (a_H^*, a_L^*, V_i^*) and a system of belief $\mu^*(q^H|a_H)$ such that:

(1) Candidate's Advertising Strategy: Each candidate j chooses the level of advertising a_j^* by expecting the vote V_i^* that will receive from voters i in the electoral market:

$$\max_{a_j} [V_i^*(a_j) - e(q^j, a_j)] \tag{4}$$

(2) Voters' Voting Strategy: we first define the voters' expected utility obtained from voting the candidate as[19]:

$$EU_i = \mu(q^H|a_H) \cdot q^H + [1 - \mu(q^H|a_H)] \cdot q^L$$

Then, each voter i casts a vote V_i to choose a candidate with an advertising a_j. In any pure PBE, voter i's equilibrium vote choice V_i^* equals the expected utility they obtain:

$$V_i^*(a_j) = \mu(q^H|a_H) \cdot q^H + [1 - \mu(q^H|a_H)] \cdot q^L \tag{5}$$

where $\mu(q^H|a_H)$ represents the probability that the candidate is of high quality q^H after observing high spending a_H. Note that the right-hand side represents the expected utility (EU_i) of voters i.

(3) Voter's Belief: The voters' beliefs $\mu^*(q^j|a_j)$ are consistent with the strategies a_j^* of candidates. There are two cases we can imagine: separating and pooling cases.

(Case 1: separating case) If $a_L^* \neq a_H^*$:

$$\mu^*(q^H|a_H) = \begin{bmatrix} 1 \text{ if } a_j = a_H^* \\ 0 \text{ if } a_j = a_L^* \end{bmatrix} \tag{6}$$

(Case 2: pooling case) If $a_L^* = a_H^*$:

$$\mu^*(q^H|a_H) = [p \text{ if } a_j = a_L^* = a_H^*] \tag{7}$$

where p denotes a prior probability. Note that in both cases, there can be any fraction if a is neither a_H nor a_L.

Then, we turn to verify a separating perfect Bayesian equilibrium. That is, we can verify that these strategies and belief profiles satisfy the conditions for a perfect Bayesian equilibrium.

First, we will start with voter's beliefs. The equation (6) says the following: if voters expect to receive 'different signals', that is, if $a_H \neq a_L$, then upon receiving a_H, he knows he is facing a type q^H candidate. That is, if a candidate is a high advertiser and he employs the proposed equilibrium strategy, then the conditional probability that he is a high-quality type must be satisfied by using Bayes' rule:

$$\mu^*(q^H|a_H) = 1$$

[19] *Alternatively, we can define the expected quality that the candidate produces in exchange for votes that voters cast. In other words, the expected quality that the candidate produces is equivalent to the expected utility that the voters receive from voting the candidate.*

where $\mu^*(q^H|a_H)$ is derived by using Bayes' rule (see equation (3)). Conversely, upon receiving a signal of a_L, he knows he is faced with a type q^L candidate. Thus, a voter's belief, when the candidate is a low-quality type, is given by $\mu^*(q^L|a_L) = 1$ $(\text{or } \mu^*(q^H|a_H) = 0)$. [20] On the other hand, considering the equation (7), if he expects to receive the 'same signal', that is, if $a_H = a_L$, then he concludes nothing from getting this signal: that is, $\mu(q^H|a_H) = p$. What is he to do when he receives a signal that he did not expect, that is, if the signal is neither a_H nor a_L? Then, he might think that it was a mistake and thus, candidates meant to send either a_H or a_L. Or he might think that candidates changed his mind. Since there are multiple explanations, we can be agnostic, and thus, any justification is acceptable, or any revision is correct.

Secondly, with this belief, we can verify that the voter's strategy is optimal and rational. A candidate will engage in high advertising activity only if he is a high-quality type. Then, voters maximize the expected utility given his updated beliefs and candidate's advertising strategy. Then, voter's proposed strategy is optimal. Therefore, it is rational for a voter to vote for the candidate with high advertising activity. The equation (5) indicates that, based on the correct estimate of the two quality types, the uninformed voters must choose each one of his voting actions in order to maximize his expected payoffs (i.e. expected utility). In particular, it requires that he play best responses within the consequent complete information games if he learns candidate's quality type.

Third, we verify candidate's optimality. In order to do so, let's look at the candidate's strategy. If he is a high-quality type, then high advertising activity will be optimal and rational. On the other hand, if he is a low-quality type, then low advertising activity will be optimal and rational. Thus, equation (4) shows a standard best-response condition for the informed candidate of two types. Thus, candidate's strategy, voter's strategy and voter's beliefs are all self-confirming in a separating perfect Bayesian equilibrium.

Finally, we can see certain circularity in the reasoning behind a Bayesian equilibrium. That is, on the one hand, the optimal strategy of the voter depends on the evolution of his belief about the candidate's quality type during the course of the game. On the other hand, his belief depends on candidate's strategy via Bayes' rule. Candidates and voters are connected through Bayesian updating mechanism in the advertising signaling game.

4.4 Separating Equilibria

We now focus on analyzing candidate's equilibrium strategy for advertising. The candidate's equilibrium strategy, his choice of an advertising level, is contingent on his quality type. We determine the equilibrium advertising choices for the two types of candidates. It is useful to consider separately two different types of perfect Bayesian equilibria that might arise: separating equilibria, in which the two types of candidates choose different advertising levels, and pooling equilibria, in which the two types choose the same advertising level. Here, we analyze the separating equilibria which are of more interest.

To analyze separating equilibria, let $a_j^*(q^j)$ be the candidate j's equilibrium advertising choice as a function of his quality type q^j, and let $V_i^*(a_j)$ be the voters' equilibrium vote choice as a function of the candidate's advertising level a_j. We establish the following candidate's equilibrium strategies.

Candidate Equilibrium 1: In any separating perfect Bayesian equilibrium, $V_i^*(a^*(q^H)) = q^H$ and $V_i^*(a^*(q^L)) = q^L$: that is, each candidate-quality type receives votes equal to his quality level.

Remark: In any perfect Bayesian equilibrium, beliefs on the equilibrium path must be correctly derived from the equilibrium strategies using Bayes' rule. This implies that upon observing advertising level $a_j^*(q^H)$, voters must assign probability one to the candidate being type q^H: $\mu(q^H|a_H) = 1$. Likewise, upon observing advertising level $a_j^*(q^L)$, voters must assign probability one to the candidate being type q^L: $\mu(q^L|a_L) = 1$. Then, the resulting votes are exactly q^L and q^H, respectively.

[20] *Note that Bayes' theorem places no restrictions on voter's belief off-the-equilibrium path.*

In a separating equilibrium, low-quality candidate chooses an advertising level a_L^*, and high-quality candidate chooses an advertising level a_H^* which is higher than a_L^*: $a_H^* > a_L^*$. Thus, voters can *infer* the candidate's quality by observing his advertising level.

Candidate Equilibrium 2: In any separating perfect Bayesian equilibrium, there exists $a_j^*(q^L) = 0$: that is, low-quality candidate chooses no-advertising strategy.

Remark: Low-quality candidate receives votes equal to q^L, so his costly advertising (e.g., even low advertising) is of no use to him. Therefore, he chooses not to advertise at all: $a_L^* = a^*(q^L) = 0$. On the other hand, high-quality candidate who chooses $a_H^* > 0$ receives votes equal to q^H. For this to be an equilibrium, low-quality candidate must not mimic high-quality candidate's advertising strategy. We now employ no-mimicking assumption described earlier. In order for this equilibrium to be held, the following no-mimicking condition should be met:

$$V_L(q^L) - e(0, q^L) \geq V_L(\mathbf{q}_L^H) - e(\mathbf{a}_H^*, q^L)$$

or

$$V_L(q^L) \geq V_L(\mathbf{q}_L^H) - e(\mathbf{a}_H^*, q^L)$$

where $e(0, q^L) \equiv e(a_L^* = 0, q^L) = 0$. Symmetrically, high-quality candidate should not envy the advertising strategy of low-quality candidate, so we should have:

$$V_H(q^H) - e(a_H^*, q^H) \geq V_H(\mathbf{q}_H^L) - e(0, q^H)$$

or

$$V_H(q^H) - e(a_H^*, q^H) \geq V_H(\mathbf{q}_H^L)$$

where $e(0, q^H) \equiv e(a_L^* = 0, q^H) = 0$. Note that bold character means 'mimicking case'. For example, q_L^H represents the case that q^L candidate imitates to be q^H candidate. Similarly, $\boldsymbol{q}_H^L$ represents the case that $\boldsymbol{q}^H$ candidate imitates to be q^L candidate. In these separating equilibria, high-quality candidates are willing to have costly advertising simply because it allows them to distinguish themselves from low-quality candidates and to receive higher votes. The fundamental reason that advertising can serve as a signal is that the marginal cost of advertising depends on a candidate's quality type. Because the marginal cost of advertising is higher for a low-quality candidate (i.e. since $e_{aq}(a, q) < 0$), high-quality candidate may find it worthwhile or profitable to have some positive level of advertising $a_H > 0$ to increase his vote, whereas low-quality candidate may be unwilling to have positive advertising. As a result, voters can reasonably or credibly regard advertising level as a signal of candidate quality.

5. LITERATURE REVIEW

One of the well-known facts about US congressional elections is that incumbents almost always win. What accounts for the electoral success of incumbents? The typical answer involves 'incumbent advantages'. Among these are high name recognition, opportunities for constituency favors and the franking privilege. Above all, incumbents possess the ability to raise and spend large sums of money on their reelection campaigns. However, there is some question about whether these outspended resources are the advantage they appear to be or whether these lavish expenditures are productive or inefficient.

The notion of 'candidate quality' has a broad meaning. It is generally recognized that some candidates are better than others. For instance, Jacobson [22]) referred to 'strong' and 'attractive' candidates compared to weak or unattractive ones. But, most of literatures defined the quality notion in a narrow manner, focusing on the case of challenger's quality. Jacobson and Kernell [31]) used the term 'challenger quality', rather than general candidates or incumbents, to describe well-funded, politically experienced challengers. Bond, Covington and Fleisher [32]) measured 'challenger quality' as a combination of challenger personal attributes and campaign spending. Green and Krasno [33]) regarded 'challenger political quality' as the personal characteristics of the challenger that contribute to the strength of his candidacy. They defined candidate's political quality as the sum of two attributes: attractiveness and political skill. Then, they constructed challenger's political quality based on the backgrounds of challengers and developed a point scale system which attributes point values to various background characteristics. Based on the point scores, they distinguished high-quality from low-quality challengers.

Instead, we can use the quality term on a different but still narrow context by focusing the *incumbent's* quality, rather than challenger's. We can measure candidate quality as a dummy variable based on the incumbency status. That is, the candidate quality is determined by incumbency status which is either at the party or at the candidate level. We can distinguish candidates *with* incumbency from ones *without* incumbency. We then consider the candidate with incumbency as the experienced or 'high-quality candidate' and refer to the candidate without incumbency as the inexperienced or 'low-quality candidate'. We view the incumbency and experience in elective or political office as the most important factor in the electoral competition. Incumbency status is often considered by voters to be an impressive qualification for congressional or parliamentary candidates. In addition, it reflects not only the acquisition of political skills, including campaign experience, but also provides candidates with the political connections which are important to campaigning.

The spending is *less* productive as candidates are high quality: we refer to this as the *inefficient vote outcome*. As high quality candidates spend more money, the vote productivity is likely to decrease. That is, quality signaling may be effective, but vote outcome is inefficient. Alternatively, spending will more productive as candidates are low qualities. As low quality candidates spend more money, the vote productivity is shown to increase.

Over the last two decades, political scientists and empirical economists have examined the electoral advantages conferred by incumbency both at the federal and at the state level in US, and proved to considerably affect U.S. legislative elections. The incumbency advantage has been increased considerably in US House elections. Cox and Katz [34] examined the cause of the incumbency advantage. Much of the literature focused on explaining why the incumbency advantage in U.S. House elections grew so substantially. The two explanations have been dominated in the literature: one focuses on *resources* of various kinds and opportunities to perform constituency services, and the other emphasizes the partisan de-alignment. Instead, Cox and Katz [34] suggest three causes of incumbency advantage which are different from the existing literature. They decompose the incumbency advantage into resources, scare-off and quality effects. In particular, the quality effect reflects how much electoral advantage a party accrues when it has an experienced candidate, rather than an inexperienced one. Thus, the quality effect indicates that the incumbent advantage will be increased if there is a quality differential between candidates. Thus, the incumbent advantage depends on the candidate quality in determining votes. Then, Cox and Katz estimate the size of the resources, scare-off and quality effects for U.S. House elections from 1946 until 1990 period, and showed that most of the increases in the incumbency advantage are caused by increase in the quality effect. They suggest from their empirical evidence that much of the growth in the incumbency advantage at the federal level in U.S. cannot be accounted for by resource growth but by quality effect. They show that growth in the incumbency advantage stemmed primarily from growth in the quality effect of candidates. This explains the reason why a high-quality experienced candidate is becoming more important in obtaining votes.

It is crucial to understand that the incumbency status both at the candidate and at the party level become more and more important in predicting voteshares. There are various factors affecting the incumbency such as resources or campaign expenditures each candidate spends during the election,

or candidate incumbency characteristics. Lee [27] concludes that the 'incumbency' of candidates is closely related to their 'quality'. As a result, incumbency status (i.e. high quality) will not only affect directly votes, but influence indirectly (by quality signaling effect) votes through high spending. In general, the term 'quality' refers to anything about both candidates themselves and their party or policy platforms that enable them to garner votes. Thus, other things being equal, high-quality candidates will outperform low-quality candidates in vote gaining.

Although empirical works abound in the literature, there are *theoretically* very little previous works that applies the signal framework to analyze the candidate quality. The closest works to ours are Caselli and Morelli [35], and Poutvaara and Takalo [36]. First, Caselli and Morelli [35] present a simple theory of the quality of elected officials, and propose that 'low-quality candidates' have a comparative advantage in seeking elective office. Second, Poutvaara and Takalo [36] analyze how the compensation of elected politicians affects citizens choosing to run in a citizen-candidate model with ability differences and informative campaigning, and suggest that increasing the reward may lower the average candidate quality when the campaigning costs are very high. Instead, in our model, we propose that high-quality candidates can be elected if they send signals effectively through campaign advertising expenditures.

6. CONCLUDING REMARKS

In an electoral market, if voters cannot distinguish between good-quality and bad-quality candidates before voting, bad-quality candidates may drive good-quality ones out of the election market: this is known as electoral lemon problem. That is, good-quality candidates may not win the election against bad-quality populist ones. This electoral lemon problem due to adverse selection can be eliminated or reduced by the screening by voters or by the signaling by high-quality candidates. Voters can screen candidate quality, or candidates may send signal to voters. We have examined the signaling model by candidates to inform voters that they are of high quality through campaign advertising and its expenditures. Alternatively, candidates can signal through established brand names, such as incumbency and ministerial status.

We examined a signaling model to explain the existing empirical results in which incumbent candidates have substantial positive effect on votes and also inefficient outcome from higher spending. We started with the idea that costly advertising by candidates will serve as a signal of unobservable candidate quality. In particular, equilibria emerge in which high-quality candidates choose to have more advertising than low-quality candidates, and voters correctly take differences in advertising levels as a signal of quality.

We obtain three implications from studying a signaling model. First, high-quality candidates are often adversely affected by the presence of low-quality candidates, and thus, the high-quality candidates are pooled in with low-quality candidates or they must invest in signals beyond the point that they would if there were no informational asymmetry to distinguish themselves from their low-quality counterparts.

Second, information asymmetries may be costly to resolve, and external effects may arise as a result of the resolution process. When campaign expenses are used for signaling, high-quality candidates bear the cost to separate them from the low-quality ones. This is the cost incurred due to the information asymmetry. It would not exist if a candidate type is could be directly and objectively observed. Nor would it exist if the candidates consisted solely of high quality. The high-quality candidates have to bear this cost because there are some low-quality candidates run for the election, from whom high-quality candidates seek to distinguish themselves. Thus, this is a negative external effect inflicted by the low-quality candidates on the high-quality candidates.

Third, the main methods for solving adverse selection problems in an electoral game are to restrict opportunistic behavior by introducing public financing of election expenditures or expenditure limiting system, and to equalize information, such as election campaign law. Finally, the welfare effects of signaling activities are generally ambiguous. On the one hand, by revealing information about candidate quality types, signaling may lead to a more efficient vote allocation of candidates to voters.

On the other hand, because signaling activity is costly, candidate's welfare may be reduced if they are competing to engage in a high level of signaling activity to distinguish themselves.

The ability of advertising activity to allow a candidate to credibly reveal the private information about his quality makes it rational for the candidate to engage in this otherwise seemingly wasteful behavior. Candidates are engaging in the expensive campaign advertising to send a credible signal to voters that they are high-quality candidates. But quality signaling is often unproductive and thus results in the inefficient outcome. Inefficiency of signaling can be reduced by restricting signaling: for instance, limiting campaign expenditure or financing election expenditures by the public fund.

There have been many empirical studies estimating the relationship between the campaign advertising expenditures and the electoral outcome, resulting in the significantly positive relation. Furthermore, candidate's incumbency status is the most important factor in influencing the votes in the election. But, the incumbency effect includes the resource advantage effect and the quality advantage effect as well. It is a very difficult task to clearly distinguish each effect. In addition, many empirical results showed that incumbent candidates might engage in an inefficient campaigning activity when they attempt to reveal their good quality to voters. It will be an important empirical problem to examine the puzzle relating to such an inefficient quality signaling. The variable representing the candidate quality is not directly observable and thus immeasurable. In the absence of a good measure of candidate quality, attempts to estimate its effect will suffer from biased estimates. Because of this, further research should be focused on the development of estimation technique to measure *candidate quality*.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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A Descriptive Study on Data Profiling: Focusing on Attribute Value Quality Index

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ABSTRACT

In the era of the Fourth Industrial Revolution, companies are focusing on securing artificial intelligence (AI) technology to enhance their competitiveness via machine learning, which is the core technology of AI, and to allow computers to acquire a high level of quality data through self-learning. Securing good-quality big data is becoming a very important asset for companies to enhance their competitiveness. The volume of digital information is expected to grow rapidly around the world, reaching 90 zettabytes (ZB) by 2020. It is very meaningful to present the value quality index on each data attribute as it may be desirable to evaluate the data quality for a user with regard to whether the data is suitable for use from the user's point of view. As a result, this allows the user to determine whether they would take the data or not based on the data quality index. In this study, we propose a quality index calculation model with structured and unstructured data, as well as a calculation method for the attribute value quality index (AVQI) and the structured data value quality index (SDVQI). SDVQI was calculated using the attribute value quality index (AVQI). As unstructured data are increasing, it is expected that the calculation of the unstructured data quality index will be helpful to determine the usefulness of unstructured data. In the future, we plan on completing the data profiling model using neural network and statistical analysis (DPNS).

Keywords: Attribute value quality index; data profiling; data quality; data value quality index; feature scaling.

1. INTRODUCTION

In the era of the Fourth Industrial Revolution, more and more people and things are connected to the internet, and big data are being produced explosively [1]. In order for industries to improve the competitiveness of products and services, big data are explosively being produced and utilized, and the government also encourages the creation of new job openings throughout the open and private sectors, as well as the utilization of public data [2]. Dobre and Xhafa [3] report that every day the world produces around 2.5 quintillion bytes of data (i.e. *1 exabyte equals 1 quintillion bytes or 1 exabyte equals 1 billion gigabytes*), with 90% of these data generated in the world being unstructured [4]. The amount of digital information produced and circulated globally is expected to be 90 zettabytes in 2020 [1], and digital information in Korea is expected to increase by an annual average of 57% [5,6]. Digital information can be classified into unstructured data, such as image and voice, and structured data. Unstructured data account for an overwhelming proportion of 92% of the total amount of information, and structured data account for 8% [5]. Appropriate data processing and management could expose new knowledge, and facilitate in responding to emerging opportunities and challenges in a timely manner [7]. Companies are focusing on enhancing the competitiveness of products and services using artificial intelligence (AI) technology, and machine learning, which is a core technology of artificial intelligence (AI), is a way for computers to acquire high-level characteristics through self-

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learning data. Securing high-quality big data is becoming an important asset to enhance corporate competitiveness. Also, with the advancement of data technology, the value of data utilization becomes higher; thus, systematic quality control is required. Until now, the quality control of data concentrated on structured data, with a very weak demonstration for unstructured data. Therefore, it can be said that a systematic study is needed to calculate the quality index of structured and unstructured data. Examples for data based Machine Learning (ML)- and Aritificial Intelligence (AI) innovation projects aiming for a triple bottom line include Social Assistive Robots for Elderly Care (SAR) and Sensor Enabled Affective Computing for Enhancing Medical Care (SENSECARE) [8-11].

Major companies around the world are focusing on securing artificial intelligence (AI) technology, which is a core technology of the Fourth Industrial Revolution, to enhance competitiveness. Global information technology (IT) companies such as Google, Facebook, Microsoft, and IBM are releasing AI algorithms. The volume of digital information is rapidly increasing worldwide, data technology is being developed further, and the value of using stereotyped and unstructured data is getting higher. Companies are focusing on securing artificial intelligence to enhance their competitiveness. Machine learning, which is a core technology of artificial intelligence technology, requires high-quality data in a way that enables computers to acquire high-level characteristics through self-learning of data. Big data that artificial intelligence can learn are exploding, but research on data profiling for securing reliable and high-quality data is very lacking. In particular, it is very important to develop a data quality index for evaluating data quality in digital information [5]. In this paper, we propose a research model for calculating the quality index of fixed and unstructured data, and we derive attributes for data quality diagnosis, calculate the data attribute value quality index, and calculate the data value quality index.

2. MATERIALS AND METHODS

2.1 Structured Data Quality Factors

Data quality is defined as a level that can provide useful value to users by securing data accuracy, interconnection, and up-to-date data [1,12]. In addition, it is defined as a level that can be continuously satisfied for various purposes or for the satisfaction of users who utilize data [13,14]. Data quality management refers to a series of activities performed to maximize user satisfaction by continuously maintaining and improving the quality of data [15,12]. The data quality error rate is calculated by applying the weight by area according to the importance of the value (70%), structure (20%), and standard (10%) of the data in the public data quality management manual [15]. This study provides seven big data quality indexes to measure the quality level of public institution data and 24 detailed indexes which reflect the detailed characteristics by index [15,16]. The seven indexes are readiness, completeness, consistency, accuracy, security, timeliness, and usability. Readiness is an index related to the preparation of policies, organizations, and procedures for quality control of data and it measures whether the data are faithfully managed with the latest contents. As a logical and physical structure in establishing a database, completeness is an index that measures whether data are stored in accordance with business requirements. Consistency is an index that measures whether data that have the same meaning conform to the standard with a consistent name and format and whether data sharing and linking remain consistent. Accuracy is an index that measures whether the stored data are in a range and format of values that fit the defined criteria and whether the data reflect the most recent value. Security is an index that measures whether data generation management subjects are managed and whether the security measures such as data access management level, authority of data, and encryption of important data are performed. Timeliness is an index that measures whether procedures for collection, processing, and provision according to data requirements are managed based on the level of response time, as well as on data requirements for the level being satisfied. Usability is an index that measures the level of data that users are satisfied with, the level of their convenience when accessing data, and whether they are working to improve the convenience of data usage. In a study on the quality factor of big data, it was suggested that it is desirable to determine the quality of data according to whether it is suitable for the purpose of use from the viewpoint of the user based on big data processing technology [17]. In terms of users, data types are classified into intrinsic, accessibility, contextual, and representational quality [18]. In order to

secure data quality, it is said that the quality factors should be defined in consideration of data values, business rules, data standards, data hierarchy, and characteristics of industrial sites, and that continuous management is required through data quality management infrastructure (tool/system), quality management policy, and organization [18]. This study aims to find the quality index centered with a data value which is relatively important for big data quality measurement, which is rapidly increasing.

2.2 Unstructured Data Quality Factors

Quality standards for unstructured data should be applied somewhat differently from quality standards for structured data [5]. The types of unstructured target data refer to metadata, texts, images, sounds, videos, three-dimensional (3D) data, geographic information system (GIS) data, aerial photographs, weather satellite images, and cartographic satellite images, and the cases for classifying the contents in terms of establishing a database are shown in Table 1 [5].

Table 1. Example of content classification

Target Data Type		Contents
Metadata		DB form constructed from data having various information about contents
Text	Direct input method	DB type constructed by direct input of text
	OCR conversion method	DB form constructed by OCR conversion of characters
	Chinese character data	DB form constructed by inputting the data written only in Chinese characters such as old documents and old books
Image		DB form constructed through scanning or camera shooting
Sound		DB form built by editing recording or holding tape
Video		DB form built by editing shooting or holding data (reel tape, beta tape, video tape)
3D		DB forms constructed from 3D data through image-based modeling and rendering methods and 3D scanning for building images from digital filming into 3D data
GIS		DB format constructed by inputting scanning and attribute information of a map that was already produced
Aerial photograph		DB format constructed by recording filming information and spatial information on film and photo data and aerial photos stored
Weather		DB form constructed by converting past satellite raw data and earth observation satellite binary data into standard format
Cartographic satellite pictures		DB type constructed with numerical orthophotographic image data by inputting attribute information to satellite photographs

The quality measurement for unstructured text was firstly considered for the target and scope of quality measurement, and the selection of measurement criteria for quality measurement, as well as the corresponding measurement items and contents, was arranged using a checklist [5,19]. It was used directly for quality measurement by checking the measurement contents recorded in the checklist of quality measurement [5]. The definition of quality criteria for unstructured text can be defined and used according to the purpose of use by the organization, company, or institution [5]. The scope of selection of quality measurement standards can be different based on the quality control policy and direction, and a clear direction should be defined according to the long-term vision and purpose when establishing the quality diagnosis plan, allowing the measurement criteria to be selected [5]. The method of defining the weights among the measurement criteria by calculating the importance of the unstructured text quality measurements may be done using a predefined method or an ad hoc method. The predefined method selects importance based on the matching measurement standard considering the object, the purpose of use, and the purpose of diagnosis to be diagnosed. The ad hoc method quantitatively calculates a weight between measurement standards through a statistical analysis method, so as to calculate a separate importance factor as it is not predefined.

2.3 Data Quality Diagnosis

Profiling is the estimation of potential error data through the analysis of data statistics and patterns [15,20,21]. Data profiling techniques are largely classified into column profiling, single-table profiling, and cross-table profiling techniques [15]. This study mainly uses column and single-table profiling techniques. Data profiling is a core function of data quality diagnosis and allows performing technical analysis of data values and structure. The profiling function includes analysis functions such as column analysis, date analysis, code analysis, referential integrity analysis, and pattern analysis [15,22–24]. The scope of the profiling defines the detailed functions in consideration of the type of data, the level of data quality control, and the goals [25]. The quality diagnosis method is divided into profiling, checklist (interview or questionnaire), business rule diagnosis, and unstructured survey, and Table 2 shows the methods of quality diagnosis of data value and unstructured data [15].

Table 2. Quality diagnosis methods

Quality Diagnosis Method	Method Explanation
Value diagnostic profiling	○ The method to analyze the data value error itself, such as the validity and accuracy of the data value - Diagnosis centered on the accuracy of data values through column analysis, date analysis, pattern analysis, and code analysis
Unstructured survey	○ The method to diagnose the error of unstructured data, such as documents, images, or videos, through a human's manual confirmation (actual measurement) - Views information directly or manually checks the document without separate tools

As big data are increasing explosively, it is hard for humans to diagnose data quality directly through actual measurement. This study focuses on the improvement of data value diagnostic profiling and the unstructured test method.

2.3.1 Calculation of data quality errors

The value which diagnoses the quality level of the database is diagnosed from the viewpoint of data value, structure, and standardization, and the result is formulated and quantified as the data quality error rate [15]. Equation (1) is a calculation formula that applies a weight to the data value, structure, and standardization, which are quality factors of the data quality error rate [15].

$$Quality\ error\ rate = \sum_{i=1}^{n}(E_i \times W_i), \tag{1}$$

where E is the error rate per quality factor, and W is the weight per quality factor. Value (accuracy) error rate (E_1) refers to error level for the value of data. Structure (completeness) error rate (E_2) refers to the degree that the structure of a database is not faithful. Normalization (consistency) error rate (E_3) refers to the degree to which the conformity to a database standard is insufficient. The weight of value (W_1), weight of structure (W_2), and weight of normalization (W_3) are 0.7, 0.1, and 0.2, respectively [15].

$$Value\ (accuracy)\ error\ rate\ (\%) = E_1 = \frac{\sum_{i=1}^{n} e_i}{\sum_{i=1}^{n} s_i} \times 100, \tag{2}$$

where i is a value diagnostic item, s is the number of total data, and e is the number of error data.

$$Structure\ (completeness)\ error\ rate\ (\%) = E_2 = \frac{1}{n} \times \sum_{i=1}^{n} e_i, \tag{1}$$

where n is the number of structural diagnosis items, i is the structural diagnosis item, and e is the error rate of each structural diagnosis item.

$$Normalization\ (consistency)\ error\ rate\ (\%) = E_3 = \frac{1}{n} \times \sum_{i=1}^{n} e_i, \quad (4)$$

where n is the number of standard diagnostic items, i is the standard diagnostic item, and e is the error rate per standard diagnostic item. Equations (2)–(4) show the calculation formulas of the value, structure, and normalization error rates (%). The calculation standard of the database quality diagnosis error data for structured data is defined; however, the target attribute in principle performs data quality diagnosis for all attributes. Also, for unstructured data, the performer should carry out data value quality diagnosis through actual measurement. The value (accuracy) error rate calculation method is an inefficient method for massive data profiling.

2.3.2 Attribute extraction using geometric mean

In order to extract the attributes for big data quality diagnosis, it was confirmed that attribute extraction can be performed using a more scientific method, rather than using the subjective judgment of the performer, in a study featuring the attribute extraction model with the geometric mean [1].

$$Attribute\ extraction\ model = \sqrt[n]{\prod_{a_i \in S}^{n} (a_{iw} + a_{ic})}, \quad (5)$$

where $S \ni \{a_1, a_2, \ldots, a_n\}$, n is the number of attribute selected among S' set, a_i is *i*-th attribute, a_{iw} is ith attribute weight, and a_{ic} is ith attribute correction value. However, for data attribute extraction, this study performed data profiling by targeting the attributes of numerical, categorical, and date types of structured data. The standard for data attribute extraction is shown in Table 3 [1].

Table 3. Attribute weight extraction criteria. NA—not available

Data type	Weight applying criteria	Weight
All data types	Missing value (NA) > 0	0.1
Integer or numeric	Near-zero variance (0)	0.1
Integer or numeric	Standard deviation (SD) ≥ 100	0.1
Integer or numeric	Outlier Bonferroni $p < 0.05$	0.1
Factor	Space > 0	0.1
Date	(Last date − first date) > (current date − first date)	0.1

The attribute correction value extraction criteria for data attribute extraction are shown in Table 4 [1,26,27].

Table 4. Attribute correction value extraction criteria

Data type	Criteria applying attribute correction value	Correction value
All data types	The number of missing values (NA) is more than 1%	0.1
Integer or numeric	Outlier Bonferroni $p \leq 0.00001$	0.1

This study confirmed that the attribute extraction method using geometric mean is superior to the value (accuracy) error rate method [1]. Only the attribute extraction method for data quality diagnosis is suggested, and the attribute value quality index and the value quality index of the data profiling target table cannot be presented. This study proposes a method to calculate the quality index of the structured data attribute value quality index and the target table.

2.3.3 Data quality diagnostic comparison

The calculation method of data quality error performs data profiling on all tables of the database and all attributes of each table in order to calculate a data quality error rate (quality error rate) of the database. The attribute extraction method using the geometric mean extracts an attribute with error

possibility and performs data profiling targeting the extracted attribute. Table 5 shows a comparison of data quality diagnostic methods when targeting a single table.

Table 5. Comparison of data quality diagnostic methods

Division	Data Quality Error Calculation	Attribute Extraction Using Geometric Means
Quality diagnosis method	In principle, data profiling is performed for all attributes, and, in some cases, target attributes are selected according to the subjective judgment of the person who performs data profiling.	Data profiling is performed targeting the attributes derived from the attribute extraction model.
Advantages	By performing data profiling targeting all attributes, you can explore the data value characteristics of each attribute.	This can be done for attributes that possibly have errors, and only those attributes that possibly have errors can be selected depending on attribute weights.
Disadvantages	It is inefficient because it takes a long time when there is a lot of data as it is performed for all attributes. Depending on the subjective judgment of the performer, the data quality diagnosis result may be different.	Using the attribute extraction model, it is possible to select an attribute with a high probability of error according to the attribute weight, but it cannot determine the degree of data value quality for each attribute.

As can be seen from Table 5, the extraction method using geometric mean is more scientific and shows better performance [1]. However, attribute extraction using the geometric mean has a disadvantage in that it is not possible to determine the degree of data value quality for each attribute. Thus, it was judged that, if this method was complemented, it could be helpful to perform data profiling more promptly.

2.4 Feature Scaling

Feature scaling means normalizing the distribution of variable values [28,29]. Normalization involves subtracting the average of the data from the variable or dividing the variable by the standard deviation of the total data, so that the average of the values is zero and the degree of distribution of the values is also constant. The *Z*-score was used for data normalization, where *Z*-score is defined as the distance of standard deviation (*s*) from the average ($\bar{x}$) [30], as shown in Equation (6).

$$Z_i = \frac{x_i - \bar{x}}{s}, \tag{6}$$

where Z_i is *i*-th *Z*-score, and x_i is *i*-th variable value. This study uses the scale () function provided in R package for *Z*-score calculation [31,28].

3. RESEARCH MODEL

3.1 Research Model for Data Quality Index Calculation

This study used the numerical, date, and categorical data attributes for structured data, and text data for unstructured data in order to calculate the data quality index. In order to calculate the value quality index of the structured data, this study analyzed descriptive statistics, missing values, and outliers, and used the term frequency inverse document frequency (TF-IDF) and neural network technique Word2vec to calculate the quality index of the unstructured data. The data profiling model using a neural network and statistical analysis (DPNS), which can calculate the data quality index, is presented in Fig. 1.

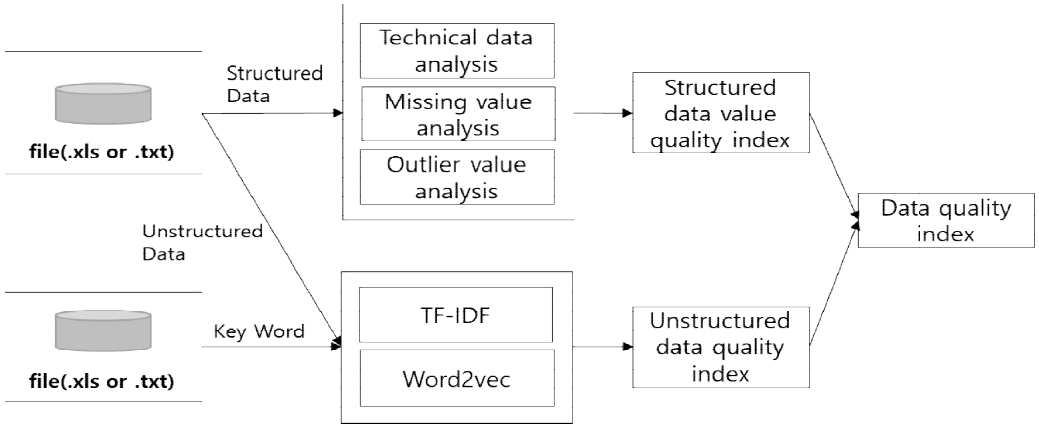

Fig. 1. Data profiling model using a neural network and statistical analysis (DPNS)

In this study, a structured data attribute value quality index was calculated, and a data profiling target attribute was derived using the calculated attribute value quality index. In addition, the value quality index of structured data using the data attribute value quality index was calculated.

3.2 Data Analysis Methods for Model Development

The data analysis methodology includes Knowledge Discovery in Database (KDD) and CRISP-DM (CRSS Industrial Standard Process for Data Mining) [32]. In this study, the existing methodology was customized. The big data analysis methodology of Korea Data Agency (KDA) is a hierarchical process model with three phases: Phase, Task, and step. The top level consists of analysis planning, data preparation, data analysis, system implementation, evaluation, and deployment [33]. Analysis planning is a step in understanding the business, identifying the problems of the domain, and determining the scope of the project. Data preparation is the step of preparing the datasets necessary for data analysis to develop models that reflect business requirements. Data analysis is the step of analyzing the data to achieve the goals established in the analysis planning stage using the fixed and unstructured data. System implementation is the step of implementing the results of exploratory data analysis or data analysis model as a system. The evaluation and deployment steps assess whether the objectives of the analysis planning phase are met, and they end the big data analysis project. KDD is a data mining methodology for discovering knowledge in a database. It is composed of data selection, data preprocessing, transformation, data mining, and interpreting/evaluation [34]. CRISP-DM is a hierarchical data mining methodology developed by many companies including Teradata, NCR, SPSS, and Daimler AG, which started in 1996 in the European Union ESPRIT project [35]. CRISP-DM consists of business understanding, data understanding, data preparation, modeling, evaluation, and deployment stages. Currently, many companies implement big data analysis methodology. The methodology applied to this study was customized to suit the data profiling of the big data analysis methodology, KDD, and CRISP-DM methodology of KDA. The methodology consisted of data preparation, data refining, modeling, and model evaluation, as shown in Fig. 2.

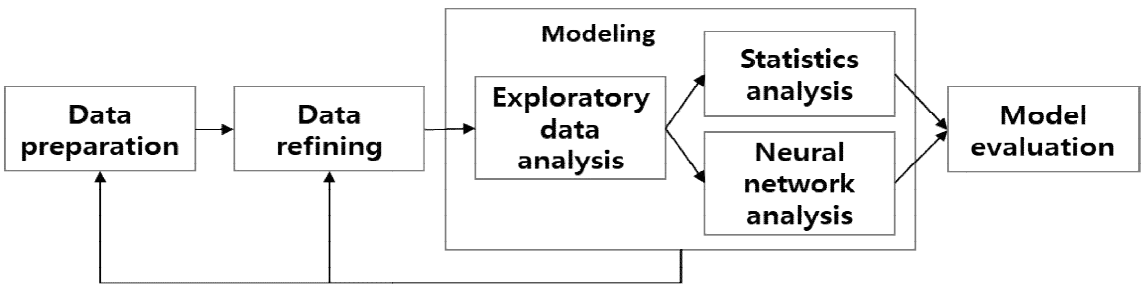

Fig. 2. Analysis method for DPNS mode

3.3 Data Value Quality Index Calculation Model

Outlier refers to a value apart from other observation values [33,36], and, in the case of ± 3 standard deviations, it is regarded as an extreme value [37]. This study used it to diagnose the data quality of numerical, date, and categorical data types. A flowchart for extracting attributes of the data value quality diagnosis target is shown in Fig. 3.

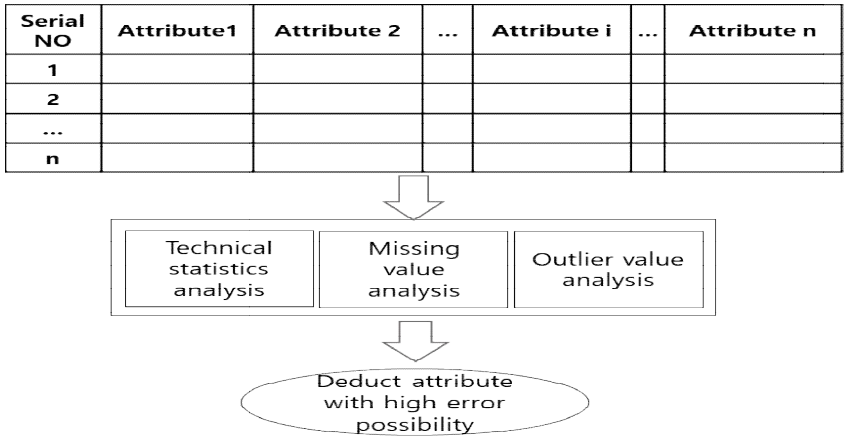

Fig. 3. Data value quality diagnosis target attribute extraction flowchart

The attribute quality index calculation standard is shown below.

Table 6. Calculation criteria of attribute quality index

Data Type	Measurement Item (k)	Attribute Quality Index Applying Criteria (β)	Weight (α)
Numeric, date, categorical date	Missing value	Missing value = 0	0.0
		0 < Missing value ≤ 5%	1.2
		5% < Number of missing values ≤ 15%	1.5
		Number of missing values > 15%	2.0
Number, number categorical	Outlier	*Z*-score ≤ | 2 |	0.0
		| 2 | < *Z*-score ≤ | 3 |	1.2
		| 3 | < *Z*-score ≤ | 4 |	1.5
		Z-score > | 4 |	2.0

The calculation formula of the attribute value quality index (AVQI) of the *i*-th attribute in the data table is expressed by Equation (7).

$$AVQI_i = \left|1 - \frac{\sum_{k=1}^{n} X_k}{\sum_{k=1}^{n} Y_k}\right|, \tag{7}$$

where *i* is *i*-th attribute of the data table, *k* is a measurement item, *n* is the number of measurement items, X_k is the value multiplied by weight (α) corresponding to the standard for applying the attribute quality index of the *k*-th measurement item, and Y_k is the number of records whose weight (α) of measurement item (*k*) is more than 0.0 (but, the AVQI of the attribute is 0.0, in the case of not having the number of records falling on the standard for applying an attribute quality index other than whose weight is 0.0).

$$X_k = \sum_{\beta=1}^{n}(number\ of\ data\ extracted\ by\ \beta\ criteria\ \times \alpha), \tag{8}$$

where β is the attribute quality index applying standard falling on the measurement item, and α is the weight of the attribute quality index application criteria.

$$Y_k = \sum_{\beta=1}^{n}(\, number\ of\ data\ extracted\ \beta\ criteria\,), \tag{9}$$

where β standard record number is the record number in which the weight (α) of the attribute quality index applying standard (β) is other than 0.0. The attribute value quality index (AVQI) becomes lower in error as it approaches 0. The calculation formula for the structured data value quality index (SDVI) is shown in Equation (10).

$$SDVQI = \left|1 - \frac{\sum_{i=1}^{n} B_i}{\sum_{i=1}^{n} A_i}\right|, \tag{1}$$

where *i* is the *i*-th attribute of the value quality index calculation target, *n* is the number of attributes for calculating the value quality index, B_i is the value multiplied by weight (α) falling on the attribute quality index applying standard (β) of the *i*-th attribute, and A_i is the number of records falling on the attribute quality index applying standard (β) of the *i*-th attribute. The structured data value quality index (SDVQI) becomes lower in error as it approaches 0.

4. RESULTS

4.1 Data Collection and Analysis Method

For the performance evaluation, this study used the Delhi Weather dataset registered in Kaggle [38].

The Delhi Weather dataset includes a total of 20 attributes and uses the entire data (number of records = 100,990). If you remove the datetime_utc attribute by separating the datetime_utc attribute into date (_date) and time (_time) attributes, a total of 21 attributes remain. Based on the data types classified in Table 7, the attributes of _conds, _heatindexm, _precipm, _wdire, _wqustm, and _windchillm were excluded from the empirical study. For the empirical study, this study used R, a data analysis tool.

Table 7. Collection data attributes

Attribute description		Attribute description	
date_time_utc	String	_heatindexm	String
_conds	String	_hum	Numeric
_dewptm	Numeric	_precipm	String
_fog	Numeric	_pressurem	Numeric
_hail	Numeric	_rain	Numeric
_snow	Numeric	_wdird	Numeric
_tempm	Numeric	_wdire	String
_thunder	Numeric	_wgustm	String
_tornado	Numeric	_windchillm	String
_vism	Numeric	_wspdm	Numeric

4.2 Performance Evaluation Method

This study used the AVQI value derived from the attribute value quality index (AVQI) calculation formula presented in the research model for performance evaluation and compared the attribute results obtained using the attribute extraction method with the geometric mean. For the performance comparison, the data quality efficiency measurement value (DQEM) was used, calculated as follows [1]:

$$DQEM(\%) = \left(1 - \frac{m}{s}\right) \times 100 \tag{2}$$

where S is the multiplication of the total number of attributes and the number of records, and m is the multiplication of the number of attributes and the number of records derived from the research model.

The value of data quality efficiency measurement was excellent in terms of function as it was close to 100% [1]. For the performance evaluation, this study assumed the preconditions shown in Table 8.

Table 8. Performance evaluation prerequisites

Division	Precondition
Target data type	Number, date, and attributes of categorical data type (15 target attributes)
Attribute extraction using geometric mean	All data attributes extracted by the attribute extraction model
Data value quality index calculation model	All data attributes with over 0 data attribute value quality index (AVQI)

4.3 Results of Data Attribute Derivation Experiment

Experimental results obtained by the attribute extraction model using geometric mean are shown in Table 9.

Table 9. Attribute extraction experiment result using geometric mean

List of extracted data attributes	Experimental result value
_dewpm, _fog, _hail, _humure, _pressurem, _rain, _snow, _tempm, _thunder, _tornado, _vism, _wdird, _wspdm	0.297

A total of 13 attribute lists were extracted using Equation (5), without extracted _date and _time attributes. In the result calculated by the data value quality index calculation model, there were 13 attributes with AVQI values greater than 0.0, as shown in Table 10.

Table 10. Attribute extraction test results using data attribute value quality index (AVQI)

List of extracted data attributes
_dewpm, _fog, _hail, _humure, _pressurem, _rain, _snow, _tempm, _thunder, _tornado, _vism, _wdird, _wspdm

The data value quality index (AVQI) calculation results using the data value quality index calculation model are shown in Table 11.

Using the data attribute value quality index (AVQI), the structured data value quality index (SDVQI) was calculated as follows:

$$SDVQI = \left|1 - \frac{5\ 7\ 19\ 0}{396\ 8\ 2}\right| = 0.441. \quad (12)$$

The SDVQI of the Delhi Weather dataset used in the empirical study was 0.441, which indicates that the degree of data value quality was not good (SDVQI is less likely to have errors as it approaches 0). The data quality efficiency measurement value (DQEM) are shown in Table 12.

Table 11. Attribute data quality index (AVQI) experiment result

Division	Attribute quality index applying criteria (β)	Weight (α)	_Dewptm	_Fog	_Hail	_Hum	_Pressurem	_Rain	_Snow	_Tempm	_Thunder	_Tornado	_Vism	_Wdird	_Wspdm	_Date	_Time
Missing value	Missing value = 0	0															
	0 < Missing value ≤ 5%	1.2	621			757	232			673			4428		2358		
	5% < Number of missing value ≤ 15%	1.5												14,755			
	Number of missing value > 15%	2															
Outlier	Z-core ≤ | 2 |	0															
	| 2 | < Z-Score ≤ | 3 |	1.2	826			780				3080			9		294		
	| 3 | < Z-Score ≤ | 4 |	1.5	26	7038		1								1	34		
	Z-Score > | 4 |	2	5		13	2	1	2652	1	4	952	2	1	3	133		
AVQI			0.208	0.5	1	0.201	0.203	1	1	0.201	1	1	0.2	0.5	0.241	0	0

Table 12. Data quality efficiency measurement results

Division	Data quality efficiency measurement value (%)
Value (accuracy) error rate	$\left(1-\frac{15\ \times 100{,}990}{15\ \times 100{,}990}\right)\times 100=0.0$
Attribute extraction using geometric mean	$\boldsymbol{\left(1-\frac{13\ \times 100{,}990}{15\ \times 100{,}990}\right)\times 100=13.333}$
Data value quality index calculation model	$\boldsymbol{\left(1-\frac{13\ \times 100{,}990}{15\ \times 100{,}990}\right)\times 100=13.333}$

The DQEM for each data quality diagnostic model was calculated for 15 attributes from the Delhi Weather dataset using Table 6 criteria. The model of the value (accuracy) error rate performed data quality diagnosis for as many data records as possible per 15 attributes. This resulted in low-efficiency measurements when there were a large number of datasets or records. On the other hand, the attribute extraction model using geometric mean and the data value quality index calculation model had the same value of DQEM at 13.333%.

5. CONCLUSION

Digital information volume is growing at a rapid pace, and companies are focusing on securing artificial intelligence (AI) technology to enhance competitiveness. Machine learning, a key technology in artificial intelligence, is a method via which computers acquire high-dimensional characteristics through self-learning of data. This requires continuous high-quality big data in order to raise accuracy. It is proven that securing high-quality big data is an important asset in enhancing corporate competitiveness. This study presented a structured/unstructured data quality index calculation model (DPNS). The quality index for each data attribute was calculated using the attribute value quality index (AVQI). When the AVQI value was 0.0 or more, it was considered that the probability of error was high, shown as 13.333% from the experimental result of attribution using geometric mean and the data value quality index calculation model (Table 12).

However, as can be seen in Table 9, from the attribute extraction experiment results using the geometric mean, the experimental result value calculated using the attribute list with error possibility and the attribute extraction model was 0.297 (weight value ≥ 0.1). As can be seen from the experimental results, the degree of data value quality of each attribute could not be evaluated (Table 11). As can be seen from the experimental results of the attribute data value index (AVQI), it is helpful for quickly data profiling the data value quality index for each attribute. It is possible to evaluate its data quality using data attributes extracted from the experimental result value (as the experimental data value approaches 1, the quality of data worsens). It is important for data quality to evaluate whether it is suitable for the purpose of use from the user's perspective. Therefore, it is very meaningful to present the attribute value quality index (AVQI) for this. In addition, it is expected to confirm the data quality of a single table using the structured data value index (SDVQI) with the attribute value quality index (AVQI).

In this study, the SDVQI was calculated using the attribute value quality index (AVQI). As unstructured data are increasing, it is expected that the calculation of the unstructured data quality index will be helpful to determine the usefulness of unstructured data. In the future, we plan on completing the data profiling model using neural network and statistical analysis (DPNS).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Assessing the National Directorate of Employment (NDE) Strategy in Poverty Reduction in Nigeria

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ABSTRACT

In the past and in recent times, studies have shown government schemes in combating poverty in developing countries but such efforts have yielded little or no positive results. Consequently, poverty has been on the increase in such countries. In Nigeria, one of such schemes is NDE that was set up to address the problem of unemployment and poverty. In several years of its operation, studies have shown that the problem of poverty is yet to be adequately taken care of. Given this, the present study intends to assess its activities using data from a secondary source and content analysis as its methodology. Hence, the paper discusses its objectives, mandates and strategies. It also looks at some of the achievements of the agency and several challenges hindering her effectiveness. The paper argues that NDE is a good strategy which can be used to reduce poverty in Nigeria but the main challenge lies in what could be referred to as the 'Nigerian factors' which means negative attitudes of many Nigerians to achieving national development.

Keywords: Assessing; NDE; strategy; poverty; reduction.

1. INTRODUCTION

The seriousness of poverty among mankind has been illustrated in several academic literature [1]. Its negative effects on the ten per cent of the global population have been a major concern to all and sundry, most especially the United Organisations [2]. Certainly, the figure accounts for almost one billion persons who are living below the benchmark of $1.90 per day set aside to determine its prevalence [1]. However, studies have shown that most of such persons are found in developing countries where poverty is considered one of the greatest challenges to people's progress and national development [3].

This is not to say developed nations are exonerated from the scourge of poverty, the point lies in its rate of escalation which is lower in such countries but higher in developing countries [3-4]. Nigeria is one of such countries in Sub-Saharan. Dwelling on the report of the National Bureau of Statistics, between September 2018 and October 2019 forty per cent of Nigeria live below the poverty line [5].

The irony is that Nigeria is endowed with several natural resources than many developed nations, but experience and studies, over the years, have shown little or no correlation between her abundant natural resources and development [6]. Going by human thinking, such endowments could have been used to ensure rapid development. Or they could have been considered added advantage in the sense that their existence in large quantities and in quality could have been used to complement human assets for actualising rapid development but the reverse has been the case as countries that lack natural endowments have rapidly developed more than Nigeria.

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Thus, the case of Nigeria and other African countries has become a concern to The United Nations Organisation and leaders of many multilateral organisations and it became more serious with their inability to meet the Millennium Development Goals deadline of 2015 UNO, [2]. This is not to say that African leaders are not taking steps in addressing the menace of poverty, the challenge lies in their insincerity in properly implementing the programmes intuited to address poverty.

In Nigeria, NDE is one of such programmes. Its origin could be traced to the outcome of the survey conducted by the National Manpower Board in 1986 on youth unemployment which stood at ten per cent of the entire population (2 million) [7]. The outcome propelled the inauguration of Chukwuma Committee to set up strategies to address mass unemployment among the youth population which some authors have found to be a strong predictor of criminality and abject poverty [7]. In order to effectively actualise its mandate, the directorate launched four cardinal programmes out of which agriculture features prominently [8].

Prior to the discovery of the oil on Sunday, January 15th 1956 at Oloibiri, Niger Delta, by Shell Darcy, presently known as Shell Petroleum Development Company of Nigeria (SPDC), agriculture was regarded as the pillar of the Nigerian economy. Being the first discovery of profitable oil in Nigeria, it may not be out of point to reason that the discovery was historic, most especially as the breakthrough was recorded after fifty years of unsuccessful oil exploration. Apart from that it presented the great opportunity of flinging Nigeria into the publicity of the Petro-State globally [9]. However, instead of employing the proceeds from oil to upgrade and develop subsistence agriculture to extensive and intensive farming like that of Denmark, Ministry of Environment and Food of Denmark [10]; invest in quality education Like South-east Asia to spur advancement in science and technology, the Nigeria elite squandered the resources and plunged the nation into poverty [11].

Though several authors have described poverty as a complex concept because it does not mean the same thing to many people. However, if the term primary poverty, which affects common man that represents the largest population in Nigeria [5] is to be considered poverty in this context, then it could be described as the inability to meet the basic requirements for a successful living, per day. The United Nations calls this 'living below the poverty line' [1]. To show the severity of such in Nigeria, forty per cent of the population is negatively affected [5].

In order to reduce that figure, NDE was set up to provide employment opportunities via various strategies which this article intend to discuss in the later part of this discourse. But instead of alleviating poverty among Nigerians, the problem is escalating to the extent that Nigeria is now considered one of the poorest countries in the world [12]. It is on this note that this paper intends to assess NDE as a strategy in elevating poverty among Nigerians in order to discover problems hindering her effectiveness.

This article is subdivided into three major sections- introduction, literature review and concluding remarks.

2. LITERATURE REVIEW

2.1 National Directorate of Employment: An Overview

National Directorate of Employment is one of the agencies created by the Ibrahim Babangida administration to address the problem of unemployment in Nigeria in 1986 [7]. It was mandated statutorily by number 24, decree of the year 1989 National Directorate Annual Report, [13]. As argued by [13], the menace of unemployment has been with mankind right from several decades and how to manage it successfully has always been the major apprehension of successive government [14]. The concern for the NDE could be observed from the importance attached to the agency in addressing the high rate of unemployment.

Consequently, the agency was given legal backing upon the expiration of the military rule in 1999 by extending its existence through its enabling ACT, CAP250 of the laws of the Federal Government

NDE, (1999) cited in [15]. Besides, the financial support for the agency was increased. For instance, in the 2016 budget, 5.9 billion was allotted to NDE Federal Republic of Nigeria (2016) cited in [15]. Despite these, the problem of unemployment keeps rising as indicated in Tables 1 and 2.

Table 1. The rate of unemployment in Nigeria between 1985 and 2011

SN	Year	Rate
1	1985	8.5%
2	2005	12.7%
3	2008	14.9%
4	2009	19.7%
5	2010	21.4%
6	2011	23.9%

Source: [15]

Further to the above, the World Bank, (2016) submits that the rate of unemployment increased among Nigerians from 15 years to 24 as indicated in Table 2.

Table 2. The rate of unemployment among Nigerians between 15 and 24 years, from 2011 to 2014

SN	Year	Rate
1	2011	13.8%
2	2012	13.7%
3	2013	13.6%
4	2014	13.6%

Source: [16]

Previous studies have shown a serious correlation between unemployment and poverty. Thus, the more unemployment is increasing, the more the rate of poverty will be increasing.

The data in Tables 1 and 2 are not indications that NDE has failed in all ramifications; some of its contributions to National development are discussed briefly in the later part of this discourse.

3. OBJECTIVES, MANDATE AND STRATEGIES OF THE NDE

According to [15], NDE was to address the following objectives:

a. To set up plans on how to carry out programmes to arrest the escalation of mass unemployment
b. Suggest policies which are capable of developing employment programmes via labour intensive capacities;
c. To get and sustain information on employment and joblessness for the purpose of acting as a clear house to connect job seekers with openings in partnership with other state agencies; and
d. To carry out other policies which may be set up by the Board that established NDE under sections of the enabling ACT.

In order to realise its mandate [8], argues that NDE introduced the following programmes in the areas stated below in 1987:

a. Youth employment at the national level;
b. Graduate employment and small-scale entrepreneurs;
c. Special works; and
d. Agricultural activities.

Based on the study of [17], the above-stated programmes were strongly supported via administration, monitoring exercise and provision of adequate personnel but due to its inability to reduce

unemployment as argued by [18], the main job creation drive of the NDE was re-organised into other programmes in the following areas:

a. Skill development in vocational areas;
b. Businesses or enterprises in small-scale activities;
c. Public jobs in special areas; and
d. Promotion of employment in rural areas

Despite its re-organisation, NDE has not been able to adequately tackle the problem of unemployment and poverty among farmers due to several problems highlighted in the literature which we intend to discuss in the next section of this paper.

4. SOME OF THE CONTRIBUTIONS OF THE NDE TO NATIONAL DEVELOPMENT

Evidence from some empirical studies conducted on the activities of the NDE have shown some positive contributions. These include, the study of [18] that revealed a correlation in the socio-demographic features of farmers with the severity of poverty. The study shows that farmers who did not benefit from the NDE had the highest vulnerability to poverty than their counterparts who benefited in Ekiti State, Southwest Nigeria with their poverty index of 0.94 compared to 0.11 of the beneficiaries respectively.

In addition to that, the work of Adebisi & Oni (2012) cited in [15] investigated the operations of the NDE and the usefulness of its training scheme in Southwest Nigeria. The outcome unveiled eleven schemes of operations and thirty employment categories. The findings also showed that NDE training programmes were able to meet the needs of 99.2% trainees while 98.3% confessed attaining their desirable skills which they are using in their vocations through the agency.

Furthermore, the work of [19], conducted in the southeast Nigeria delved with the influence of the NDE skill acquisition programmes. The findings show that 16.67% of the recipients sampled acquired vocational skills which enable them to create thirty job opportunities while those trained under the special public works were able to create fifty-four employments. For beneficiaries under agriculture and SME, eighty-two and seventeen jobs were created respectively.

Moreover, the study of [20] conducted in the north central evaluated the influence of the NDE programmes on graduate employment in Kaduna State. The result shows the positive effect of NDE activities in generating employments among graduates.

5. FACTORS AFFECTING THE SUCCESS OF NATIONAL DIRECTORATE OF EMPLOYMENT

The review of relevant literature has shown that several problems are hindering NDE effectiveness. These include poor funding of programmes, policy distortion, corruption and managerial problem Odeh and Okoye, (2004) cited in [7]. Others according to [17], include lack of effective and efficient state-of-the-art facilities (the public address system, cameras, walking talking, computer, etc), unnecessary delay in the payment of trainees' stipends, poor repayment of loans disbursed to beneficiaries, inadequate monitoring, loan diversion and other forms of corruption etc.

Of all these challenges, corruption is the major obstacle. Apart from seeing the appointment of key office holders as compensation for patronage or support, it is often perceived as an opportunity to siphon funds meant for national development. Thus, most contracts awarded do not reflect the real value, as the sum is usually jacked up to benefit top government officials. In the same manner, most of the employees usually indulge in the same to amass wealth in their various offices and locations [21].

Apart from the above, the posture and attitudes of many Nigerians to federal government's works or projects are on the negative. Such include lateness to work, laziness, selfishness, poor maintenance

culture [22]. Poor maintenance culture could be viewed as people's failure to develop and maintain positive values in thinking, discernment, conduct, handling or using facilities that are necessary for work etc. When such are actively displayed in any nation, the attainment of national development may be practically impossible. Other negative attitudes of many Nigerians could be found in their sayings- 'nothing concerns me', it is not my father's business' so 'if it can spoil let it spoil'. These could be regarded as unpatriotic, selfishness and parochial interest. With such actively been displayed by many Nigerians, NDE may not achieve the objectives of reducing poverty.

6. CONCLUDING REMARKS

This paper was written to assess NDE in its bid to reduce poverty among Nigerians. It looked at its origin, objectives and mandates. It also discussed the achievements and challenges hindering its effectiveness and argues that NDE could be a plausible scheme which can be used to reduce poverty but the major challenge lies in Nigerians negative attitudes and disposition to national development. The paper argues that unless such negative attitudes are replaced with positive attitudes, NDE may not achieve its objectives. These negative attitudes could be eradicated once government policies become people oriented and responsive to welfare of the entire citizenry. This could be achieved when policies are formulated to initiate from grass root while making the citizens proffer solutions to identified challenges. It's established that people disassociate themselves or develop apathy to issues they perceive alien to them. Hence, NDE should enunciate policies that conform with the factor endowments and peculiarities of immediate societal demands. This will go a long way in refocusing the minds of people and change their negative attitude towards national development and set the pace for a genuine approach to poverty reduction.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Assessment of Human Capital Management, Organizational Climate, Commitment and Performance in Latin America

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ABSTRACT

The purpose of the research was to confirm the validity of an analytical model originally proposed by Kopelman, Brief and Guzzo [1] in 4 countries of the Latin American region. Cincel, a top organizational research institution from Colombia, adapted the original model and coordinated this research. The objectives of the research included to make various comparisons and relationships among some productive sectors and countries of the region. Cincel's analytical model implies that the Human Capital Management Practices (HCMP) can predict the Perceived Organizational Performance (POP), but also that this relationship is moderated by the variables Organizational Climate (OC) and, at minimum, 3 types of commitment of the staff: Affective Commitment (AC), Continuity Commitment (CC) and Normative Commitment (NC). The research includes a total sample of 4491 participants from Chile (CL), N = 799, Colombia (CO), N = 2083, Mexico (MX), N = 874, and the Dominican Republic (DO), N = 735. The productive sectors included were Industry, Services and Education. The instruments for the data gathering were supplied by Cincel. The questionnaires were administered via Internet by Cincel. The moderation analysis was done with the regression procedure of the SPSS. In general, the moderation analysis validated the model, with important differences for the included sectors. HCMP and OC were effective in predicting POP in every sector. AC was a good predictor of POP in the Services and Education sectors, while CC could only predict POP in the Education sector and the NC was a good predictor of POP only in the Industry sector. The interaction between OC and CN was able to predict POP in both the Industry and Services sectors. Furthermore, we found significant differences, confirmed by analysis of variances (ANOVA), among the evaluations in the different countries. CO performed better in the evaluations in almost every factor for each sector. DO was second in the evaluations of the Industry and Services sectors. MX was second in the Education sector, and CL was third in the Services sector. The human capital managers from each country should take in account the fact that the predictors of performance and the staff commitment are different for each country and for the different productive sectors. More research is needed to determine the reasons for these idiosyncratic differences among the countries. The other main contribution of this research was to establish the fact that the importance of the different factors was very diverse for each participant country. Human Capital managers should verify in each country the importance of the factors affecting performance to maximize their effectivity.

Keywords: Human capital management practices; organizational climate; organizational commitment; perceived organizational performance; human capital in Latin America.

1. INTRODUCTION

This research is part of an international study coordinated by the Center for Research in Organizational Behavior (CINCEL), a leader on organizational research from Medellin, CO. It is directed to confirm, for several countries in Latin America, an Analytical Model based on the model of Climate, Culture and Productivity by Kopelman, Brief & Guzzo [1].

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The research included participants from large organizations from CL, CO, MX and the DO. These organizations came from the Industry, Services and Education sectors. In this paper, we try to integrate the results from the different sectors. The detailed results from each sector are published elsewhere [2,3,4].

HCMPs have been strongly and positively related to organizational performance, but this relationship is moderated by the type of measure used and the specific type of HCMP [5]. Numerous studies of competence and knowledge management have been carried out, but the practices of this area are still not very well known [6,7]. The relationship appears stronger when performance is measured by indicators of operational performance (for example, satisfaction with customer service or innovation), as opposed to measures of overall performance (for example, return on assets or returns in sales) [8].

In recent years, scholars and practitioners have increasingly recognized the importance of effective human capital management for the performance of the organization [9]. Practices that improve employee engagement and attitudes, improve indeed many financial performance indicators at work. Based on a study of learning orientation and market orientation, Mavondo, Chimhanzi, & Stewart [10] suggest that HR practices and Innovation are important mechanisms for transmitting the benefit of Learning Orientation and Market Orientation into performance outcomes [11].

Several works by Toro [12,13] showed that the CO is a condition that produces significant effects on commitment. Toro [14] also suggests that culture in general, and administrative practices in particular, decisively affect the climate of work teams and organizations.

According to the analytical model established by CINCEL as the basis for this study, the human capital or personnel management practices would provoke different perceptions of the reality of work and organization, producing different levels of organizational commitment to the work. In addition, the climate would be a moderator between such practices and commitment, but this commitment would be the most influential element on the organization's productivity. These relationships are depicted in Fig. 1 which shows a summary diagram of the relationships between the dimensions of the model, since some of them have, in turn, several components. For example, HCMP can be divided into two sub-dimensions: Performance Orientation (PO) and Personnel Conservation Orientation (PCO). In the same way, different types of commitment have been proposed, the AC, the CC and the NC among them. We describe these components in the subsection 3.2.

The validity of this general model in different Latin American countries would imply structural similarities between them, which would agree with Hofstede's [15] position. This researcher in the field of culture of the organization has reported great affinities in different regions of the world, including Latin America (LA), regarding administrative and management environments of productive organizations in each region.

However, especially in LA, the different countries have had their own political and economic histories, as well as very different customs and habits, which would allow finding particularities in the internal dynamics and the performance of their respective organizations.

2. OBJECTIVES

2.1 Validation of the Analytical Model

To validate the Analytical Model proposed by CINCEL by determining the weight of its different dimensions when influencing one another.

2.2 Similarities and Differences among Countries

We also tried to verify the similarities and differences among the participating countries, with respect to the evaluations of the dimensions of the Model.

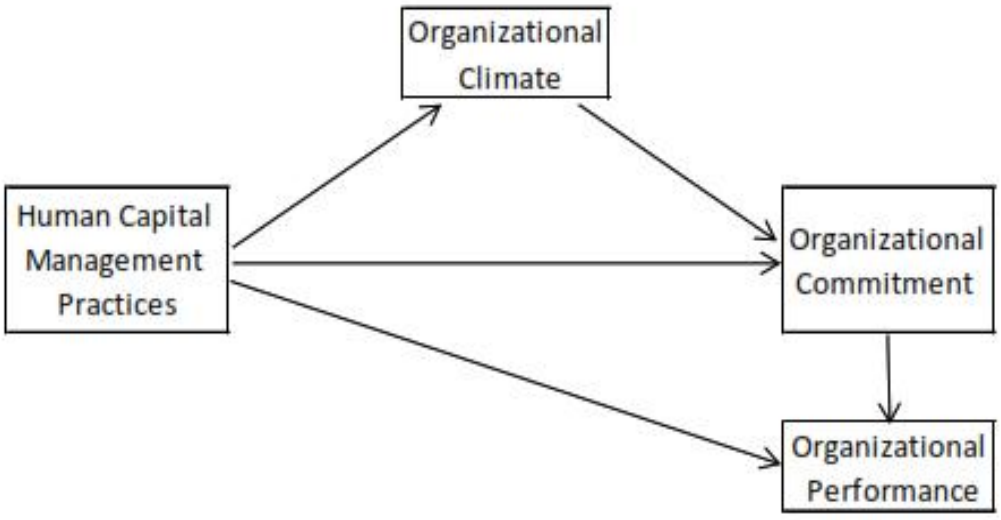

Fig. 1. Analytical Model proposed by CINCEL, Source: CINCEL [16]

3. METHOD

3.1 Participants

Table 1 shows the number of participants in the research by country and productive sector.

Table 1. Participants by country and productive sector

Countries	Productive Sectors			
	Industry	Services	Education	Totals
Chile	39	628	132	799
Colombia	503	830	749	2082
Mexico	488	137	249	874
Dominican Republic	293	220	222	735
Totals	1323	1815	1352	4490

We selected our sample by availability. The participants were selected randomly, but keeping their stratification according to the proportions of employee category, education, gender, department and seniority in their respective organizations. From CL we had 1 industry, 3 services companies and 1 university. From CO, 4 industries, 5 services companies and 4 universities. From MX, 2 industries, 2 services companies and 3 universities. From DO we had 2 industries, 2 services companies and 1 university. As can be seen on Table 1, the total sample was 4490 participants.

3.2 Instruments and Variables

CINCEL provided all the measurement instruments. To measure HCMP we use an adaptation of the scale used by Gong, Law, Chang & Xin [17]. Items were answered on a 4-point Likert-type scales described as: (1) Strongly Disagree, (2) Disagree, (3) Agree, and (4) Strongly Agree. A value of (0) was added for the option Neither Agree, Neither Disagree. The midpoint of the scale was eliminated to avoid the central tendency error. The psychometric indicators of the scale can be found in Toro, Sanín and Guevara [18].

This scale included perceptions of performance evaluation, training, and personnel selection, which make up the PO sub-dimension. We also evaluated stability in employment, reduction of status

differences, participation in decision making and compensation contingent with performance. These factors compose the SCO subdimension. The average of all these measures constituted the HCMP dimension.

The OC is understood as the perception or representation of the realities of the work, not as the opinion about those realities or as the attitude toward them or as the satisfaction with them. The OC is a way of seeing the reality shared by the people of a company [19]. To measure OC we used the Reduced ECO IV scale, built and validated by Toro [20]. This scale includes 9 factors:

Stability, Interpersonal Relationships, Sense of Belonging, Coherence, Team-work, Organizational Clarity, Availability of Resources, Boss Support and Retribution.

Organizational Commitment is the degree to which an employee identifies himself with an organization and its goals, and wishes to maintain this relationship. There is quite a consensus with the model of Meyer and Allen [21] that raises three dimensions of commitment:

1) AC. This is the emotional attachment of the employee with the company and is acquired if the organization meets the needs and expectations of the worker.
2) CC. This occurs as a result of the time and effort that the person has invested on his stay in the company and would lose if he leaves his position.
3) NC. This comes from the moral duty or gratitude felt by the worker when he believes that he must respond reciprocally to the company as a result of the benefits obtained (treatment, training, labor improvements, etc.).

The POP was registered with measures of operational performance through items that asked the participant to compare the company in the last 3 years in relation to how product quality was perceived, the development of new products, the acquisition and retention of qualified employees, customer satisfaction and relationships between employees and supervisors.

3.3 Procedure

The surveys were administered directly by CINCEL through the Internet and also in person. CINCEL then provided the databases to researchers in each country so that they could present the results to participating companies.

In each company, authorization was requested from human management personnel to allow staff participation. Additionally, each person was asked for their informed consent. CINCEL's Scientific Committee endorsed the research after reviewing the technical, methodological and ethical aspects.

3.4 Data Analysis

The theoretical model of CINCEL was put to the test with a moderation analysis, which simultaneously compares the influence of independent variables and their interactions, on the dependent variable. To run the analysis we used the regression procedures from the SPSS, version 22.

The POP was placed as a dependent variable. The HCMP was included as an independent variable, as well as the others that would be also moderators: OC, CA, CC and CN.

The following interactions were included as moderating variables: OC * CA, OC * CC and OC * CN.
As the sub-dimensions of HCMP, PO and SCO, contribute to this dimension, they were not included in this moderation analysis to avoid problems of collinearity.

Nevertheless, we included the sub-dimensions of HCMP, PO and SCO, in the analysis of the differences between the countries, as in the analysis of variance (ANOVA) the collinearity is not an issue. With the SPSS we run 8 ANOVAs, one for each dimension and sub-dimensions of the model as dependent variables. For theses ANOVAs the independent variable was always the country: CL, CO, MX and DO.

4. RESULTS

4.1 Validation of the Proposed Analytical Model

On Table 2 we show a summary of the moderation analysis for the sectors included in the research. The first column in Table 2 includes the number of the model computed in the regression. On the second column we find the constants and independent and moderator variables for the 2 regression models. The next three columns contain the statistics for the Industry sector on each factor: the standardized Beta coefficients (β), the *t* test and its statistical significance (*p*). The next six columns show the same statistics for the Services and Education sectors.

4.1.1 Predictors of POP in the industry sector

In the Industry sector, model 1 without moderating variables, explains almost 55% of the variance of the DOP (Adjusted R^2 = .546) and model 2, which includes the moderating variables, explains only a little more of that variance (Adjusted R^2 = .547). Thus, the change implied by the inclusion of these moderating variables was minimal and not significant (R^2 Change = .003, p = .073).

Table 2. Summary of the moderation analysis for the industry, services and education sectors

Model		Productive Sectors								
	Factors*	Industry			Services			Education		
		Beta	t	Sig.	Beta	t	Sig.	Beta	t	Sig.
1	(Constant)		0.048	0.962		.301	0.763		.249	.803
	Zscore: HCMP	0.373	11.092	.000	0.327	11.535	.000	.252	7.327	.000
	Zscore: OC	0.316	9.094	.000	0.212	6.818	.000	.315	8.703	.000
	Zscore: AC	-0.038	-1.545	0.123	0.225	6.805	.000	.164	4.751	.000
	Zscore: CC	-0.021	-0.92	0.358	-0.01	-.454	0.65	.051	2.242	.025
	Zscore: NC	0.193	7.943	.000	0.038	1.315	0.189	.035	1.140	.255
2	(Constant)		0.283	0.777		-1.111	0.267		-.980	.327
	Zscore: HCMP	0.371	10.949	.000	0.314	11.063	.000	.256	7.457	.000
	Zscore: OC	0.315	8.945	.000	0.221	7.105	.000	.310	8.582	.000
	Zscore: AC	-0.036	-1.417	0.157	0.248	7.124	.000	.181	4.851	.000
	Zscore: CC	-0.025	-1.061	0.289	-0.02	-.872	0.383	.043	1.853	.064
	Zscore: NC	0.187	7.656	.000	0.041	1.412	0.158	.041	1.328	.184
	Moderator OC*AC	0.032	1.118	0.264	-0.06	-1.409	0.159	-.026	-.664	.507
	Moderator OC*CC	0.042	1.56	0.119	0.037	1.528	0.127	.035	1.380	.168
	Moderator OC*NC	-0.083	-2.615	0.009	0.091	2.350	0.019	.060	1.602	.109

*Note: *Dependent Variable: POP*

The analysis of variance for model 1 showed high significance, *F* (5, 1240) = 300.46, *p* = .000, as for model 2, *F* (8, 1237) = 189.26, *p* = .000. In both cases the effect size was enormous (f^2 = 1.22) and the power perfect (1 – β = 1).

In Table 2 for the Industry sector we see that, both in the regression model 1 and in model 2, the HCMP, the OC and the NC significantly influenced the POP. According to the β coefficients, in model 2, a change of one deviation in the HCMP would produce a change of .371 deviations in the POP. Also in model 2, a change of one deviation in the OC would produce a change of .315 deviations in the POP. The influence of the NC is practically half of the above because a change of one deviation on the NC would produce only a change of .187 deviations in the POP.

As a moderating variable, the interaction between OC and NC shows an inverse relationship with the POP since the value of β is negative and, although small, it is statistically significant.

4.1.2 Predictors of POP in the services sector

In the Services sector, the importance of the 2 computed regression models was almost as high as in the Industry sector, as both of them explained more than half of the POP variance. Model 1 showed an Adjusted R^2 = .515 and model 2, with the moderator variables interactions, showed an Adjusted R^2 = .519. Nonetheless, although the inclusion of the moderator variables produced just a slight change, this was statistically significant (R^2 Change = .005, p = .000) and we had to accept the greater predictive power of model 2.

The ANOVA for model 2 had a high statistical significance, F (8, 1718) = 233.697, p = .000, a very large effect size (f^2 = 1.079) and a perfect power (1 – β = 1).

In Table 2 for the Services sector, according to the β coefficients, in both models 1 and 2 the best predictors for the POP were, in that order, HCMP, AC, and OC. Model 2 gives a better prediction of the POP because it includes the OC by NC interaction. As shown on the β coefficients in model 2, a change of one deviation on HCMP will produce a change of .314 deviations on the POP. The same change on AC will produce a change of .248 deviations on the POP. Consequently, if the OC changes one deviation the POP will change in .221 deviations. The inclusion of the OC by NC interaction in model 2 showed a small, but significant, predictive influence on the POP (β = .091, p = .019).

4.1.3 Predictors of POP in the education sector

In the Education sector, the importance of the 2 regression models was as important as in the two other sectors, explaining more than half of the POP variance.

Model 1 had an Adjusted R2 = .51 and model 2 had an Adjusted R2 = .513. The change produced by the inclusion of the moderator variables in model 2 was small (R2 Change = .004) but statistically significant (Sig. F Change = .012).

The ANOVA for model 2 also had a high statistical significance, F (8, 1279) = 170.236, p = .000, with a very high effect size (f2 = 1.07) and a perfect power (1). According to the β coefficients in Table 2 for the Education sector, in both models 1 and 2, the best predictor for the POP was OC, then HCMP, and AC. In model 2 a change of one deviation in OC would produce a change of .31 deviations on POP. The same amount of change in HCMP will change POP in .256 deviations. A change of one deviation on AC would change POP in .181 deviations.

Although CC was a significant predictor for POP in model 1, it did not reach statistical significance in model 2. The interactions among the moderating variables showed no significant predictions of the POP.

4.2 Differences among Countries

4.2.1 Differences in the industry sector

The differences among the countries showed the relative importance of the factors for each one of them. All factors obtained different evaluations in almost all the included countries. In Table 3 we can find the summary of the ANOVAs results for the Industry sector.

In the first column on Table 3, we can find the factors included in the research, the second column shows the F statistic for each factor, as its statistical significance in the third column. The fourth column contains the effect size (f) of each of the differences found for each factor, which were all large except for CC, which was medium. In the fifth column we can see the power of each analysis, which was always very high. The last column shows the results of the post hoc multiple comparisons, which confirmed the differences among the countries at least at the .05 level of significance, using the Tamhane correction.

Table 3. Summary of the ANOVAs for the Industry sector among the countries

Factors	Industry sector				
	F	Sig.	Effect size (f)	Power	Multiple comparisons
POP	96.231	.000	0.43	0.95	DO > CO > MX > CL
HCMP	76.176	.000	0.39	0.95	CO = DO > MX > CL
PO	76.506	.000	0.39	0.96	CO = DO > MX > CL
SCO	70.148	.000	0.37	0.96	CO = DO > MX > CL
OC	63.815	.000	0.36	0.95	CO = DO > MX > CL
NC	59.306	.000	0.35	0.95	DO > CO > MX > CL
AC	51.632	.000	0.33	0.95	CO > MX > DO > CL
CC	11.718	.000	0.17	0.95	CO = DO > MX > CL

The results in Table 3 were ordered by the size of the effect size. In the Industry sector the highest evaluations were for the POP, followed by the HCMP and the PO. The lowest evaluations were for the commitments: CC, AC, and NC.

In the Industry sector, five of the factors, HCMP, PO, SCO, OC and CC, were best evaluated by CO and DO, followed by MX and CL. DO made the highest evaluations for POP and NC, and CO made the highest evaluations for AC, followed by MX.

4.2.2 Differences in the services sector

In the Services sector the best evaluations were for AC, followed by OC and POP. The lowest evaluations were for CC, SCO and HCMP. All effect sizes were large and the power of the analysis was always perfect.

In this sector, half of the factors, AC, POP, NC and CC, were best evaluated by CO, followed by DO, then CL and then MX. For the other factors, OC, PO, HCMP and SCO, the evaluations by CO and DO were equally high. A summary of these differences can be found in Table 4.

Table 4. Summary of the ANOVAs for the Services sector among the countries

Factors	Services sector				
	F	Sig.	Effect size (f)	Power	Multiple comparisons
AC	132,099	.000	0.44	1	CO > DO > CL > MX
OC	127,385	.000	0.43	1	CO = DO > CL > MX
POP	86,828	.000	0.4	1	CO > DO > CL > MX
NC	100,430	.000	0.39	1	CO > DO > CL > MX
PO	82,649	.000	0.36	1	CO = DO > CL > MX
HCMP	77,437	.000	0.35	1	CO = DO > CL > MX
SCO	65,602	.000	0.32	1	CO = DO > CL > MX
CC	57,994	.000	0.31	1	CO > DO > CL > MX

4.2.3 Differences in the education sector

A summary of the differences in the evaluations of the included factors by the different countries can be found in Table 5.

In the Education sector the best evaluations were for NC, followed by PO and HCMP. The lowest evaluations were for SCO, AC and OC. The effect size for NC and PO were large, and medium for the rest of the factors.

In this sector, most of the factors, PO, HCMP, POP, OC, AC and SCO, were best evaluated by CO, followed by MX and DO, and then CL. For the other two factors, NC and CC, the evaluations by CO and MX were equally high and higher than those by DO, which in turn, were higher than those from CL. The evaluations for CC were the same by DO and CL.

Table 5. Summary of the ANOVAs for the Education sector among the countries

Factors	Education sector				
	F	Sig.	Effect size (f)	Power	Multiple comparisons
NC	56.897	.000	0.35	1	CO = MX > DO > CL
PO	123.4	.000	0.29	1	CO > MX = DO > CL
HCMP	66.186	.000	0.2	0.99	CO > MX = DO > CL
CC	30.329	.000	0.19	0.99	CO = MX > DO = CL
POP	40.49	.000	0.19	0.99	CO > MX = DO > CL
OC	51.498	.000	0.16	0.99	CO > MX = DO > CL
AC	33.47	.000	0.16	0.99	CO > MX = DO > CL
SCO	33.065	.000	0.14	0.99	CO > MX = DO > CL

5. CONCLUSIONS

5.1 Validation of the Analytical Model

We have found limited evidence favoring the Analytical Model proposed by CINCEL. The HCMP and the OC were the first two better predictors of the POP in the three included sectors, although the OC was more important than the HCMP in the Education sector. Therefore, the Human Capital managers in the universities should give more importance to keep the good climate of their institutions than to the HCMP.

Although it was expected that the AC would also be a good predictor of POP, this was only true in the Services and Education sectors. In the Industry sector, this factor was substituted by the NC. This result calls for the Human Capital managers in the industries to pay a greater attention to the affection of their employees and to promote their moral gratitude as a result of the benefits obtained.

The importance of the interaction of the climate and the different types of commitment as moderator variables to predict the POP was not clearly confirmed. Although significant, the interaction between OC and NC was negative in the Industry sector and positive in the Services sector. This result calls for further research.

One of the two main contributions of this research was to differentiate the effectiveness of the Analytical Model used among the different productive sectors, alerting the Human Capital managers to adapt the model to their respective productive sectors.

5.2 Differences in the Evaluations among Countries

The factors included in this research were evaluated very differently by the participants from the different countries and the different productive sectors. In the Industry sector Colombians and Dominicans gave the greatest importance to the human management practices and their different orientations, and the lowest importance to the commitment from continuity, but these factors were always more important for them than for Mexicans and Chileans.

To the Dominicans, the organizational performance and the normative commitment were more important than for the other nationalities, while the Colombians, followed by the Mexicans, considered the affective commitment as more important than all others.

In the Services sector, all the factors were more important for the Colombians than for the other nationalities, except for the climate and the human management practices and their different orientations, which the Dominicans considered as important as the Colombians. Among these nationalities, the Mexicans gave the least importance to all factors.

In the Education sector, Colombians were the first again in considering the importance of all factors. The Mexicans gave the same importance to the normative and continuity commitments than the

Colombians, over the Dominicans and Chileans. Dominicans gave the same importance as the Mexicans to every other factor.

More research is needed to determine the reasons for these idiosyncratic differences among the countries.

The other main contribution of this research was to establish the fact that the importance of the different factors was very diverse for each participant country. Human Capital managers should verify in each country the importance of the factors affecting performance to maximize their effectivity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Monitoring Investor Behavioral Finance: Examining Its Applicability on Egyptian Investors

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ABSTRACT

The behavioral finance takes its fundamental principles from the economic theory. Behavioral finance is a novel approach in the financial markets domain. It originates due to an urgent need to overcome and deal with the outstanding issues that traditional investors face in today's modern finance system. Thus, it is said that certain investors who do not have perfectly sensible elucidation regarding some financial situations and issues can recognize these issues better by means of certain financial models. Likewise, in a number of behavioral finance models, investors are known to be unable to bring an up-to-date of their beliefs in the correct manner. The nature of behavioral models normally has integrated perceptions from psychology with the neoclassical style of economic theory. However, other models show that investors adopt questionable choices in some cases. Thus, this paper introduces the behavioral finance, describes the background and the aims and objectives of the study, and it introduces the standards of the behavioral finance. Investors in Egypt can make use of the findings that show that anchoring match their finance behavior. A period of three consecutive days of stock market past performance is considered as a trigger that shifts the investors' perception regarding market trend.

Keywords: Financial theory; Egyptian investors; stock analysis; anchoring theory; loss aversion.

1. INTRODUCTION

The behavioral finance takes its fundamental principles from the economic theory. Behavioral finance is a relatively new school of thought that deals with the influence of psychology on the behavior of financial practitioners and its subsequent impact on stock markets [1,2]. Thus, it's worth mentioning that Adam Smith declares that "There is insight to the human psychology which is further developed today into behavioral finance". Relatively, there is likeness between both behavioral finance and behavioral economics. This resemblance returns to the strategy that they both apply scientific research on human behavior, social perception, and emotional biases as well. This adoption comes to create creative environment that helps the related parties to be able to make decisions. It also explains the way these decisions and other factors influence market prices and returns and the resources distribution as well. Hence, the aspects of this issue mainly refer to the rationality or deficiency of economic factors. The nature of behavioral models normally has integrated perceptions from psychology with the neoclassical style of economic theory. Recently, more efforts are concentrated on examining the theoretical finance in relation to the efficient market hypothesis and the increasing domain of the behavioral finance. Complementing to Shiller's [3] piece Heukelom [4] provides a comprehensive account of how behavioral economics and finance were founded on the personal level [5]. Thus, the efficient market hypothesis since its progress is considered as a key theory that is widely employed to help in understanding the behavior of various asset markets. However, things have changed in 1970 till 1980. At this period, a large number of studies indicated differences from what is standard when comparing with this theory. In 1990, for instance, the focus mainly was given to the academic discussion; apart from the analysis of these irregularities. In fact, there was an urgent need to explore the efficient market hypothesis through launching in depth

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studies on human behavior that affects the financial markets. This adoption really leads to provide more focuses to the behavioral finance which is a novel domain to the finance that applies principles of psychology, sociology and other social sciences.

2. STUDY MODEL AND OBJECTIVES

2.1 Study Model

The model of this study represents the relationship between the dependent and independent variables where the Investor Behavioral Finance is the independent variable and the Modern Financial Theories are the dependent variables. Presented below (Fig. 1) the Model of study based on previous studies that implemented internationally.

2.2 Objectives of the Study

To test the applicability of behavioral finance theories on Egyptian Investors.

2.2.1 Sub-objectives

1) To study the concept of behavioral finance and various theories associated with it.
2) To prove the loss averse nature of investors.

3. RESEARCH METHODOLOGY

3.1 Research Design

To check the applicability of Behavioral finance, it is essential to conduct a sample survey among the investors. This is to know the investing behavior of the investors. Some brokers and financial institutions are also included with the general investors. A questionnaire has been designed to get information.

3.2 Research Type

Descriptive research—in the form of collection of secondary data.

3.3 Hypothesis

1) For checking the loss averseness of Egyptian Investors, the hypothesis to be tested is:

“There is no difference in investors’ behavior when a stock is losing in the market and when it is gaining in the market.”

2) For checking the validity of Anchoring on Egyptian Investors, the hypothesis to be tested is:

“There is no difference in investors’ perception when the index of a stock market has consequently increased or decreased for three days in a row.”

3.4 Sample Design and Size

The population from which sample is drawn comes from Egypt. The sample size for the consumer survey is 135 and they are drawn randomly.

3.5 Hypothesis Testing

Hypothesis is tested by using Chi-square Analysis, which involves following steps:

1) Calculate the expected frequency of all the given cells, which is worked out as:

$$\text{Expected Frequency of any cell} = \frac{(\text{Row total of the cell}) \times (\text{Column total of the cell})}{(\text{Grand Total})}$$

2) Obtain the difference between observed and expected frequency and find out the difference between such differences i.e., calculate $(O_{ij} - E_{ij})^2$.

3) Divide the quantity $(O_{ij} - E_{ij})^2$ by the corresponding expected frequency to get $(O_{ij} - E_{ij})^2/E_{ij}$ for all the cell frequencies.

4) Find the summation of $(O_{ij} - E_{ij})^2/E_{ij}$ values. This is the required Chi-Square value (x^2).

$$x2 = \frac{\sum (O_{ij} - E_{ij})^2}{E_{ij}}$$

5) The computed value is then compared to a tabular chi-square value. If the compared chi-square value is great then the tabular chi-square value at predetermined level of significance, the hypothesis is rejected, otherwise the hypothesis is accepted.

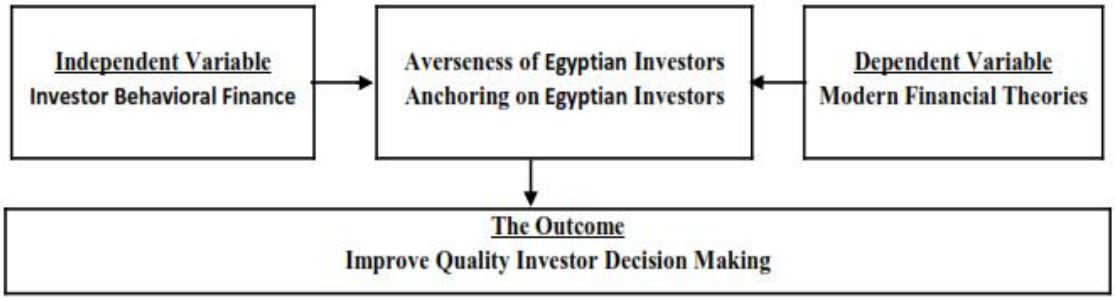

Fig. 1. The model of the study—researcher constructed

4. LITERATURE REVIEW

The Egyptian exchange is one of the oldest stock exchanges in the Middle East. It was established in 1883 in Alexandria. Later, in 1903 the Cairo Stock Exchange was established after twenty years from the establishment of Alexandria Stock Exchange. Thus, Alexandria becomes distinguished with one of the oldest markets in the world in the 1800s. Historically, in 1885, Egypt systematized its local trade. Since then the stock exchange has been emerging and developing. The following are the most significant dates that illustrate chronologically important events regarding the stock exchange in Egypt:

1909—Issuance of the first general regulations for the stock exchanges.

1947—Commencement of the over the counter (OTC) market in Egypt.

1980—Establishment of the Capital Market Authority (CMA).

1994—Shift from an outcry system to an automated order-driven system issuing a law to establish Miser for Cleaning, Settlement and Depository Company.

1996—Unifying the trading between Alexandria Stock Exchange and Cairo Stock Exchange.

1997—Egypt was added to the International Finance Corporation Global and Investable indices.

1998—Launching case 30 which became known later as EGX30 with a base value of 1000 Egyptian pounds.

2000—Establishment of Settlement Guarantee Fund to ensure timely settlement of transactions.

2001—Egypt was added on the Morgan Stanley Capital International (MSCI) Emerging. Markets Free Index (EMF), EMEA and All Country World Index.

2002—EGX started its new price ceiling system that removed 5% ceiling in daily prices. With regard to the most active stocks based on fulfilling specific criteria.

2005—same day trading started.

2007—EGX launched NILEX, the first Mid and Small Cap market in the MENA region.

2009—EGX launched EGX100 Price Index and EGX70 Price Index.

2011—EGX launched EGX 20 Index.

2014—EGX launched NILEX First Index.

The study of Beugelsdijk and Frijns, [6] comes to examine foreign bias. Hence, foreign bias in international asset allocation is examined by using country-level data. This is due to underlie individual fund level data of mutual fund holdings of 26 countries that are considered as the most developed countries in the investment field. These 26 countries are shown in a sample that consists of 48 countries. The other countries are considered as developing markets. These findings were discussed and explored in 1999-2000. The deviations from the optimal portfolio as described by asset pricing theory were calculated in order to measure the foreign bias and to measure the uncertainty avoidance (UAV) and individualism (IND) as well. They also employed Hofstede's scores in order to measure cultural variance. The findings state that "societies that are more uncertainty avoidant invest less in foreign equity and societies that are more individualistic invest more in foreign equity". They then clarify that when there is an increasing cultural distant between two countries, there will be less investment between them. This also will affect the way they decide their investment destination.

Relatively, the study of Konukoglu, [7] in Turkey, demonstrates that from January 1997 to June 2008, foreigners prefer their country as a better place to trade and own shares in the stock market than foreign markets. For them, in spite of this finding, the diversification is considered to be highly profitable. The study explains this finding due to reasons that in some aspects refer to their lack of knowledge of these markets. As a result, this rather traps them to sell at lower prices. This also forced them to move towards finding larger and more liquid stocks that are enriched with less foreign exchange risk and more levels of financial data as well. What's more, information asymmetry is considered as another conceivable clarification regarding the trading behavior in the market. This is defined as the alterations amongst investor's collection and processing of information on international investments. Hence, many studies argued that investors with greater information compared to other traders can better get advantage of this data in their trading and then leads to gain better profits.

In the context of international equity investments, previous studies from various markets show that domestic investors are better informed than their foreign counterparts as, on average, local investors are better informed on the payoff structure of local securities than foreign investors.

Another study by Jay R. Ritter [8] introduces brief summary on the behavioral finance. The study says that behavioral finance includes studies that exclude the traditional norms of anticipated value

extension with rational investors in the developed markets. However, the main two basis of behavioral finance mentioned in the article are cognitive psychology that clarify how people think; while the other is the limits to arbitrage that clarify when markets will be inefficient.

Relatively, the study of Meir Statman, [9] emphasis on the fact that market efficiency arises from behavioral finance, standard finance, in addition to the value of investment professionals. Remarkably, the study defines the concept market efficiency in two different ways. Firstly, it defines market efficiency as the ability of investors of dealing with the market systematically. The other definition states that security prices are rational which reflects only applied features such as risk, not value-expressive characteristics and sentiment. Hence, behavioral finance demonstrates that value-expressive features affect equally investor choices and asset prices as well.

Another study by Richard Fairchild, [10] explains the relation between both behavioral finance and capital budgeting models and clarifies their concept. What's more, the study emphasizes on the effects of managerial unreasonableness in relation to capital budgeting. Thus, the study examines three behavioral influences as following: A. The mutual relation that is distinguished with trust between the investors and the managers. B. The effect of framing behavior initiates by unreasonable acceptance to a risk that must be rejected. C. The effect of framing behavior accompanied with managerial exceeded assurance which leads to massive levels of effort.

Another authentic reference is The Wall Street Journal, [11]. It states that the majority of investors are rational; whereas others are irrational. Hence, behavioral finance helps in telling us when we are thinking rationally; and when we think emotionally. It adds that there is instability of our thinking and mood which affects our behavior from time to another. For instance, Albert Phung, Invest opedia clarifies that" According to conventional financial theory, the world and its participants are, for the most part, rational "wealth maximizes". Doubtlessly, it becomes a fact to say that behavioral finance is a novel domain that combines both conventional economics and finance with behavioral and cognitive psychological principle in order to deliver reasons that explains why people make financial decisions irrationally.

5. RESULTS AND DISCUSSION

5.1 Loss Averseness of Egyptian Investors

It is worth mentioning that sensitivity to losses is less than gains loss aversion. This fact is justified due to the tendency of investors to stop manufacturing stocks when loss occurred and selling attractive stocks early. There is unevenness regarding the values that investors put on gains and losses. A questionnaire shows that 86 investors prefer to hold stocks if losses occurred. In contrast, it shows that 49 will sell theirs. However, 90 chose to sell the stocks when if the market is prosperous which states that 45 will hold stocks. Chi-Square Analysis illustrates the aforementioned finding in details.

There is no difference in investors' behavior when a stock is losing in the market and when it is gaining in the market "See Table 1".

The expected frequency of all the given cells is worked out as: "see Table 2" and "see Table 3".

$$\text{Expected Frequency of a cell} = \frac{(\text{Row total of the cell}) \times (\text{Column total of the cell})}{(\text{Grand Total})}$$

$$\text{Chi-Square value}(x2) = \frac{\sum (O_{ij} - E_{ij})^2}{Ei_j} = 24.926$$

The degree of freedom is {(r-1)*(c-1)}, where r equals to row involved, and c is the no. of columns, so degree of freedom is {(2-1)*(2-1)} or 1. The level of significance chosen is 0.05. On this basis tabular x^2 (Chi-Square) is 3.84.

Table 1. Observed frequency (O_{ij})

	Sell Stock Now	Hold Stock for a month	Total
Loosing Stock	49	86	135
Gaining Stock	90	45	135
Total	139	131	270

Table 2. Expected frequency (E_{ij})

	Sell Stock Now	Hold Stock for a month	Total
Loosing Stock	69.50	65.50	135
Gaining Stock	69.50	65.50	135
Total	139	131	270

Table 3. Calculation of Chi Square

Cell (i,j)	Oij	Eij	(Oij – Eij)	(Oij – Eij)2	(Oij – Eij)2/ Eij
(1,1)	49	69.50	- 20.50	420.25	6.047
(1,2)	86	65.50	20.50	420.25	6.416
(2,1)	90	69.50	20.50	420.25	6.047
(2,2)	45	65.50	- 20.50	420.25	6.416

Since, the computed x^2 (Chi-Square) value is 24.926, the hypothesis is rejected. Thus, there is a difference in investors' behavior when a stock is losing in the market and when it is gaining in the market.

The risk aversion in gains causes investors to sell too quickly into rising stock prices, thereby depressing prices relative to fundamentals. Conversely, risk seeking in losses causes them to hold on too long when prices decline, thereby causing the prices of stocks with negative momentum to overstate fundamental values.

5.2 Relevance of Anchoring in Respect to Egyptian Investors

Anchoring is employed to refer to the manner individuals focus on current conduct and pay less attention to longer tendencies. Thus, anchoring is considered to be the greatest remembered price. Therefore, investors lean toward using anchoring so as to put into effect similar stock prices from a day to the other. Likewise, a questionnaire shows that 51 respondents think rationally where they argue that it's difficult to predict the market. However, in an upward, market tendency of three days, for instance, 37 investors assumed that it is possible to find a related tendency, though 47 assumed that it will reverse. In contrast, in a downtrend, there were 51 rational respondents who believe that it's impossible to predict the market. Further, 27 respondents came out with a related trend; whereas 57 thought in reverse trend. Thus, the propensity of prior prices will function as anchors which will clarify the detected propensity of trends in the reversed individual stocks prices.

The validity of Anchoring is checked by the Chi-Square Test.

There is no difference in investors' perception when the index of a stock market has consequently increased or decreased for three days in a row "See Table 4".

The expected frequency of all the given cells is worked out as: "see Table 5" and "see Table 6".

Table 4. Observed frequency (O_{ij})

Market Trend	Increase*	Decrease*	Total
Increase for three days	37	47	84
Decrease for three days	57	27	84
Total	94	74	168

**Indicates the market trend on the fourth consecutive day*

Table 5. Expected frequency (E_{ij})

	Sell Stock Now	Hold Stock for a month	Total
Loosing Stock	47	37	84
Gaining Stock	47	37	84
Total	94	74	168

Table 6. Calculation of chi-square

Cell (i,j)	Oij	Eij	(Oij – Eij)	(Oij – Eij)2	(Oij – Eij)2/ Eij
(1,1)	37	47	- 10	100	2.128
(1,2)	47	37	10	100	2.703
(2,1)	57	47	10	100	2.128
(2,2)	27	37	- 10	100	2.703
Cell (i,j)	**Oij**	**Eij**	**(Oij – Eij)**	**(Oij – Eij)2**	**(Oij – Eij)2/ Eij**

$$\text{Expected Frequency of a cell} = \frac{(\text{Row total of the cell}) \times (\text{Column total of the cell})}{(\text{Grand Total})}$$

$$\text{Chi-Square value}(x2) = \frac{\sum (O_{ij} - E_{ij})^2}{E_{ij}} = 9.662$$

The degree of freedom is {(r-1)*(c-1)}, where r equals to row involved, and c is the no. of columns, so degree of freedom is {(2-1)*(2-1)} or 1. The level of significance chosen is 0.05. On this basis tabular x^2 (Chi-Square) is 3.84. Since, the computed x^2 (Chi-Square) value is 9.662, the hypothesis is rejected.

Thus, there is a difference in investors' perception when the index of a stock market has consequently increased or decreased for three days in a row, which shows that the anchoring theory is relevant in case of Indian Investors.

6. CONCLUSIONS AND SUGGESTIONS

6.1 Conclusions

The following conclusions may be drawn on the basis of study findings:

1) Stable returns are preferred by the majority of investors notwithstanding the fact that they possibly be lower.
2) The data provided from companies, on the first hand, is considered as a very essential item for the majority of respondents in their investment. It is considered as a foundation stone for the purpose of analysis fundamentals. On the second hand, the process of making decision of investments requires taking into account the importance of employing forecasts of Historical Performance and Professional due to its importance in this regard.

3) Gamble and hold on are preferred by investors over loosing stock as they expect the prices will get better. Hence, the tendency of investors leans towards being tolerant in accepting risk when threatened with losses.
4) Selling a winning stock early might become the investor's choice which expose that they tend to avoid risk in gains.
5) A large number of respondents adopt rational decision that is to sell a losing stock so as to invest in a gaining one.
6) There are an increasing number of investors who show their tendency towards expecting that at whatever time the Sensex bullish or bearish for three days in a row, market won't indicate a similar trend or alter its trend.
7) In Egypt, investor's behavior shows their tendency towards Loss Averse; in which their losses and gains show differences in their behavioral tendency.
8) Investors in Egypt can make use of the findings that show that anchoring match their finance behavior. A period of three consecutive days of stock market past performance is considered as a trigger that shifts the investors' perception regarding market trend.

6.2 Recommendations

The following recommendations are made on the basis of finding of the study to avoid mistakes in financial investments decisions by applying behavioral finance:

1) It's important to understand the marked in different aspects especially its psychological mood as foundation stone afore establishing or thinking of starting any investment. Thus, investors mustn't depend only on fundamental analysis because this may lead to incorrect assumptions.
2) It's important to assure that your source of information is confidential and trusted one. Also, the company's announcements must be adjusted in portfolios.
3) It is highly recommended that losing stocks must be disposed in a case of negative news occurrence.
4) The quality of anchored figure is considered insufficient and it must be examined. Hence, anchoring to an expectation is founded reasonable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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The Development of Multiperspective of Business to Business E-commerce Maturity Application

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ABSTRACT

The majority firms worldwide are Small Medium Enterprise (SMEs), and they play a significant role in economy. It is known that SMEs are the main players in generating domestic-led investment and stimulate economic expansion. They are vital for economic growth and innovation, poverty reduction, local employment and development, and social cohesion. However, in the current digitally-connected trading economy, SMEs have face many new challenges that change the way SMEs business-to-business (B2B) trading operates. Among these challenges are the level of B2B e-commerce implementation and utilization that able to facilitate B2B trading process. However, the implementation of B2B e-commerce is being categorized as a system with high degree of difficulty since it involves complexity of the multiple relationships and interactions between trading partners. The interactions are not just complicated by their volume and variation in processes, but also by the complexity inherent in the dependencies exist between different trading parties. Based on this, for SMEs to partake in the B2B e-commerce activities, they need to have attained some reasonable level of maturity or readiness measurement in order to participate in B2B e-commerce initiatives. To overcome this, the robust multiperspective B2B e-commerce maturity application to assess the e-readiness level is needed. This paper describes the development of B2B e-Commerce Maturity Application (BeMA) which involves several distinct sequential exploratory stages. In order to ensure its validity and practicality, the application was evaluated by 35 selected SMEs. Based on the evaluation results, all respondents were agreed on the model usefulness and its practicality. The research believes that the model will provide practical guidance for SMEs to clearly define appropriate method of measuring e-readiness and the recommendation approaches to improve their B2B e-commerce maturity level. The research proved that the theory and findings have thus supported the B2B e-commerce maturity model. With the adoption of the proposed B2B e-commerce maturity model, SME is hoped to be better prepared to manage B2B business transaction in a more efficient way.

Keywords: B2B e-commerce; e-readiness; small medium enterprises; maturity assessment application; maturity level.

1. INTRODUCTION

Small and Medium- Sized Enterprises (SMEs) have historically been the main player in domestic economic activities, especially as a large provider of employment opportunities, and a generator of primary or secondary sources of income for many households. They are vital for the development and innovation of dynamic economies, poverty reduction, employment, and social cohesion. Internationally, there is a growing impetus for the development of strong SMEs sectors as a catalyst for the economic growth and development [1,2]. Despite the fact that most of the enterprises in every economy are SMEs [3], the shift of scholarly and practitioner interest from large to small and medium

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sized companies gained pace only within the last three decades [4]. Their substantial contributions of 80% to global economic growth make the SME sector as a major growing force in terms of contribution to GDP, scale of assets, diversification of products, and the creation of employment [2,5]. In Malaysia, SMEs have historically been the main player in domestic economic activities, especially as a large provider of employment opportunities, and a generator of primary or secondary sources of income for many households. According to SME Annual Report 2009/10, there are more than half a million SMEs in the country, constituting about 99.2% or 548, 267 of total business establishments with almost 80% in the form of micro enterprises. SMEs are a major source of employment, providing jobs for over 3.0 million workers and accounting for 56% of total employment. However, to ensure the continous success and sustainability of SMEs to be the engine of economy growth, it is important for SMEs to remain competitive and be adaptive in the use of B2B e-commerce technology [6,7]. Small and medium enterprises (SMEs) are a noteworthy driver of economic development [8], being vital to most economies across the world, particularly in developing and emerging nations [9, 10]. Nowadays, compared to other business models, the B2B e-commerce is considered as the most significant in terms of growth, financial contribution and the economic impact [6,7,11,12,13]. Considering the fact that B2B e-commerce is the most significant source of growth of business on the internet, and the prediction on the ultimate size of B2B e-commerce is enormous, the unsuccessfulness and slow adoption of the B2B e-commerce might have a significance effect on SME in general [14]. The lagging of SME sector in preparing itself to embrace e–commerce, could hinder their resilience and competitiveness, since B2B e-commerce application is able to enhance the effectiveness of upstream and downstream business transactions as well as facilitate trading over regional and geographic boundaries at low costs [6].

However, considering the various constrains of SMEs compared to large organizations in terms of expert, financial and technological resources, failures of such a complex and expensive B2B e-commerce project might affect their businesses. In fact, over the years there are many failure stories in B2B e-commerce project developments that range from insufficient resources in terms of technology, employees, operational, financial to the lack of solid management tools for forecasting, monitoring and evaluating the e-commerce adoption process [15-17]. Many organizations are not achieving even minimal levels of B2B e-commerce adoption, raising concerns as to why e-commerce adoption initiatives, including projects led by government, are not more successful [18,19]. This highlights the importance for SMEs to know the prerequisite factors before adopting the technology since B2B e-commerce involves high level of implementation risks to the organizations as well as to the trading partners. Understanding the growing process of B2B e-commerce implementation also enhances the ability of organizations to ready, plan and develop their application strategy [6,18]. Thus, there is a need for an e-readiness model that can determine the B2B e-commerce maturity level and its requirements on SMEs.

2. A REVIEW OF E-READINESS ASSESSMENT MODEL

B2B e-commerce may help an organization to gain competitive advantage over their competitors. However, since some e-commerce related implementations ended in disastrous failures especially among, SMEs therefore need to know their maturity level and every aspect needed to improve themselves before implementing the systems SMEs [17]. Organizations also need to consider their strengths and weaknesses before making decisions to explore new online channels without weakening the existing channels. However, according to [20-22], most e-readiness models would require re-designing in order for them to be comprehensive e-readiness assessment tools. The missing robust model of e- readiness that focuses specifically on SMEs also, has attracted a lot of researchers including Pal et al., Mutula & Brakel, Molla and Licker and Huang et al. [23,24,25,12]. Their e-readiness tools can be considered as a generic by many as one e- readiness tool assessments that are applicable to a country level and the industrial level. However, since the studies are not focus on B2B e-commerce, the tool cannot be used effectively for B2B e-commerce readiness assessment. The models also do not put into consideration the barriers that inhibit the implementation of technology in organizations. Specific indices of barriers under each e-readiness dimension are able to give clearer theoretical foundation of e-readiness level.

Another study by [26] produced a tool to measure mobile CRM readiness in the nationwide distribution company. The study adopted the VERDICT model of Ruikar [27], to assess the e-commerce readiness in B2C relationships. However, since the focus is mostly on large companies, the measurement might not be compatible with the needs of SMEs. Another study by Zakaria & Janom (2011) and Fathian et al. [28-29], added further insight in understanding the widespread adoption of e-commerce in SMEs in developing countries. Even though both studies provide views on multiple perspectives of e-commerce adoption at industrial level, the limitations of organizational and environmental indicators is not sufficient enough to understand technology adoption among SMEs in developing countries.

In short, the existing literature review with regard to e-readiness in developing countries, showed the positive and negative aspects of such measures. Even though most e-readiness models provide a useful overview of the significant factors of e-readiness, they do not completely provide meaningful multiperspective measures that are specific for SMEs in developing countries. Another limitation of existing research is related to the research scope which mostly focuses on large companies indicators which has limited power in explaining how and what level of infrastructure development affects the SME's decision to adopt B2B e-commerce. The formulation of e-commerce readiness models also have so far been mainly addressed from either the perspective of the individual firm or the perspectives of a whole industry or the perspectives of country e-readiness. This seems to be a serious shortcoming since SMEs need proper e-readiness assessment tool to identify the real issues and drivers of B2B e-commerce and its success. Therefore, it is necessary to make an attempt to develop model that able to measure the B2B e-commerce maturity assessment specific from SMEs perspective.

3. DEVELOPMENT OF B2B E-COMMERCE MATURITY ASSESSMENT APPLICATION

Currently most of the e-readiness tools use different definitions and different techniques of measurement that lead to different concepts and ideas as well as their practical applications and implications in e- readiness areas [30]. The definition of e-readiness is very much depends on purpose and scope of research in order to make sure the variables measure what they are supposed to measure. Thus, in this study e-readiness or e-maturity is defined as the degree to which an organization is prepared to participate in the digital B2B transactions through considering various e-readiness success factors and challenges. Since the words readiness and maturity are believed to portray the same meaning, both will be used interchangeably in this paper.

In the development of B2B e-commerce readiness assessment application, sequential exploratory design involving qualitative and quantitative approaches was used. Using this method, theories can be developed qualitatively and tested quantitatively [27]. A systematic two-stage approach was also adopted in the development process. The first stage involved the development of the B2B e-commerce readiness dimensions and indicators which were later operationalized into the B2B e-commerce readiness assesssment application. The second stage involved development and evaluation of a prototype application. The stages are explained below.

3.1 The Development of B2B E-commerce Maturity Dimensions

As e-commerce is a multi-disciplines area of research, the discussions of e-commerce had been viewed from several perspectives using different models which are designed to examine different aspect of e-commerce. For example, some models examine the external environment of firms [29, 31], some are focus on technology aspect [30,32], other studies focus on social and behavioural aspects [33-38], some focus on organizational factors [14,39-43], and the others used the combination on any of these perspectives [44-49,16]. Thus, considering the importance to identify variables and factors that are able to provide multiperspective insights on B2B e-commerce readiness, it is critical for researcher to identify e-readiness indicators that cover the internal and external organization factors.

Through extensive literature review analysis on various publications in related to B2B e-commerce area, appropriate theory and model to support and enforce a competitive e-readiness approach have

been identified. However, according to Amit & Zott (2001) [50], as cited by Mansfield & Fouries (2004) [51], since each theoretical framework and model has its own limitations when applied in a context of highly interconnected electronic markets, the exploitation and integration of different theoretical views approach are normally used. Theories and frameworks also probably need to be tailored to the type of technology and its adoption context since it is difficult to develop a unifying, one-size-fits-all theory related to technology adoption. Considering the perspective of this research, the integration of different theoretical views consists of resources based view (RBV), Technology-Organization-Environment (TOE) model, Technology acceptance model (TAM), Technology Readiness Index (TRI) and Diffusion of innovations (DOI) have been employed.

The theories are used to investigate the factors that determine the e- readiness and its stages. Even though each theory and model is focusing on different aims and objectives, there are some commonalties which exist among the theories that can assist in enriching the B2B e-commerce readiness model developed in this study. Each of the principle themes contributes in some way to further explain and justify research strategies related to e-readiness assessment in SMEs. Based on the theories, an extensive literature review of more than thirty publications related to B2B e-commerce are gathered which are used to build e-readiness assessment indicators model. From the review, analysis and classification of related factors in these publications, three dimensions emerged as critical to the B2B e-commerce readiness which is individual, organizational and environmental dimensions. Under these three dimensions, eight aspects are initially identified and operationally defined. Each aspect contains their own critical success factors and issues. The conceptual definitions and quantity measured under each aspect are being discussed below.

Table 1. Conceptual and quantity measured

Conceptual definition	Quantity measured
Personal traits: Personal traits address the motivation, personality and characteristics of owner/ top management regarding the adoption of B2B EC.	Does the top management have positive attitudes towards B2B e-commerce (EC)? Do the issues related to personal traits retard the B2B EC of the company?
Organizational features: This is based on availability of organization to fulfill the requirements of B2B EC in terms of technology affordability, policies, procedures, innovation culture, strategies and visions, governance as well top management commitment.	Does the organization have set up a suitable and effective goals and strategies on B2B EC? Does the governance model emphasize on the effective management of B2B EC? Do the policies and procedures are sufficient to meet B2B EC? Does the top management provide sufficient support for B2B EC development? Does the organization culture encourage technology innovation? Do the issues related to organizational readiness retard the B2B EC readiness of the company?
Competency: This considers the social and cultural aspects encompasses of competencies, relationships, exposure and skills of employees in organization with regards to B2B EC technology	Do the employees are capable to adopt and manage B2B EC technology? Does the organization have internal B2B EC expertise? Does the organization provide training and initiatives related to B2B EC? Do the issues related to competencies retard the B2B EC readiness of the company?
Technology: The variables include the availability of technology infrastructure, the flexibility and the capability of existing organizational system.	Does the available internal technology meet the requirements of B2B EC? Does internal technology meet the security requirements of B2B EC? Does the organization have B2B system that emphasis on e-service quality?

Conceptual definition	Quantity measured
	Do the issues related to technology retard the B2B EC readiness of the company?
Business Process: This cover the practices, actions, business process, the flexibility, working rules, collaborations and communications, procedures that compliment and accommodate activities within and between organizations.	Does the existing process need a comprehensive change? Do the communications and integration within and between organizations enough to support and regulate B2B EC? Does the barrier related to business process retard the B2B EC readiness of the company?
Market forces: This construct includes the e- readiness assessment on related suppliers and competitors with regards to B2B EC. The constructs include the integration, collaboration and cooperative norms among trading partners.	Do the company's initiatives fit well with industry's development? Does the company's value chain fits with the B2B EC initiative? Does company impose agreement and programs to enhance relationships with trading partners? What are the initiatives and efforts taken to get participation from trading partners? Do the issues related to market forces retard the B2B EC readiness of the company?
Supporting industries: The attributes involve the support of industries on the availability of telecommunications, financial, trust enablers, IT industry and consultant services.	Does telecommunication industry provide appropriate service and support? Does financial industry provide appropriate service and support? Do courier and logistic industries provide appropriate service and support? Does industry legal expertise able to manage B2B EC related issues? Do the issues related to supporting industries retard the B2B EC readiness of the company?
Government: This involves the conduciveness of the B2B EC climate, economic, financial support, national infrastructure conditions and e-government initiatives.	Does B2B EC readiness is a national priority? How effective the national laws and policies related to B2B EC? What are the available initiatives to foster B2B EC development? Do the issues related to government readiness retard the B2B EC readiness of the company?

For the sake of completeness and to ensure the validity of the B2B e-commerce readiness integration scale, expert evaluation is used. The subject matter expert should provide feedback in relevance to the significance and weight age of each critical factor indicator of B2B e-commerce readiness. Thus, in order to ensure expert is able to provide an overview and insight of B2B e-commerce from different perspectives. the selection of the experts is based on three criteria such as: (1) involve in the strategic planning, development, monitoring and the marketing of B2B e-commerce application (2) knowledgeable and have experience related to SMEs (3) willingness to participate in the research. Based on these criteria, six management executives from six different organizations were selected and interviewed using purposive sampling. The management executives included CEO, CIOs, Vice President, Project Directors and senior executive who are in charge of B2B e-commerce projects in SMEs. The reviews from experts have provided tentative evidence of the reliability and validity of the B2B e-commerce readiness constructs and indicators. In addition, in order to identify specific weight for each indicator, the Analytical Hierarchy Process (AHP) was used. According to AHP, the more important is the indicator, the greater the weight age will be. Due to space limitation of the paper, the relative weight for each indicator is not provided but can be refereed in Janom and Zakaria (2010) [52]. Overall there are 59 critical success factors and 30 issues being identified. However, to identify the e- readiness stages, **each dimension value is measured by calculating the scores of the indicators classified under them.** This was done through, **deducting the total AHP score of critical success factors with the total AHP score of issues. Then, the range of score** for each

aspect is obtained by dividing the range of e-readiness scores by four which represent the four level of e-readiness. Table 2 shows the matrix of the range of index score for all B2B e-commerce readiness aspects for each e-readiness stages.

The model was then operationalized into questionnaire form to be embedded into B2B E-commerce Maturity Assessment Application (BeMA).

3.2 B2B E-commerce Maturity Assessment Web Development

The B2B e-commerce Maturity Application (BeMA) is the web- based prototype application that able to assess the B2B e-commerce maturity of SME. The BeMA is designed using System Development Life Cycle (SDLC) method. In designing the navigational structure, several important features have been identified and constructed based on Austin et al. (2008) and Arshad et al. (2008) [53-54]. Table 3 shows the listing of 7 important features of BeMA.

Table 2. Range of index score

Indicators/ stages	Stage 1	Stage 2	Stage 3	Stage 4
Personal traits	Below (-2)	(-2.01) - 0	0.01- 2	2.01- 4
Organizational features	Below 4	4.01- 9	9.01- 14	14.01- 19
Competency	Below 2	2.01 – 6	6.01- 10	10.01- 14
Technology	Below 2	2.01 – 6	6.01- 10	10.01- 14
Business process	Below (-2)	(-2.01) -0	0.01- 2	2.01- 4
Market forces	Below (-2)	(-2.01) - 0	0.01- 2	2.01- 4
Supporting industries	Below 0	0.01- 3	3.01 – 6	6.01 - 9
Government	Below (-2)	(-2.01) - 0	0.01 – 2	2.01- 4
Overall	Below 2- 24	2.01 – 24	24.0 – 48	48.01 – 68

Table 3.Important features for BeMA

No	Page classification	Features
1	Home	Introduction - Explain the purpose of the application - Explain the benefits of the e- readiness assessment to the organization - The page also provide link to assess e- readiness
2.	B2B e-commerce maturity dimension	- Provide brief explanation on the B2B e-commerce readiness - Describes all eight readiness dimensions namely personal traits, organizational features, competency, technology, business process, market forces, supporting industries and government.
3.	Maturity levels	- Provide brief description of all four maturity stages from stage 1 to stage 4.
4.	Maturity Assessment	- Enables data capture activities and prompting results and analysis on the assessment - Provides strategic solutions based on the result obtained
6.	Contact us	- Provide researchers name and contact address to establish authority and credibility of the researcher.
7.	Terms and conditions	- Establish respondent confidentiality and privacy

The BeMA home page provides brief explanation on the purpose and benefits of application to the users. On the left hand side of the screen, researcher provides list of menu that user can select. User can click any menu they want and they will be directed to a new page. However, for the first time user, researcher strongly suggest for the respondent to select the first two menu options of **'**B2B e-

commerce Maturity Dimension' and 'Maturity levels' to get a better understanding on the subject matter. The main page also shows the list of link to other pages including B2B e-Commerce Maturity Dimension, Maturity levels and Start assessment.

However, the main body of the application comprises of the B2B e-commerce maturity questionnaire which is distributed over eight pages which one page represents one e-readiness aspect. In order to gauge the B2B e-commerce maturity score, the measurements are obtained through inferences drawn from the various scores of indicators compose under each aspect.

Unlike other models that rely entirely on captured data from the respondents' perceptions that may be rather subjective, this model is different as it weights each factor according to impact on the overall organization. The score reflects the real situations of the organization. The relative weights of all selection criteria were used to calculate the scores for B2B e-commerce maturity of the organization. As shown in Fig. 1, researcher uses a 5 point likert scale of: 1. strongly not agree 2. not agree 3. neutral, 4. agree, and 5. strongly agree. The assessment is based on respondent's agreement on the availability of the e-readiness indicators in the organization which are required for a successful B2B e-commerce implementation. The organization will assess their readiness for each criterion based on the above likert scale and calculated the final score for e-readiness measurement.

On successful completion of the questionnaire, users are presented with a report that summarises their overall maturity level as well as e-readiness stage for each aspect (refer Fig. 2). This allows companies to focus on, and improve on, those specific aspects. This maturity assessment report includes data in textual formats. Once the results of the assessment are shown, users are given a series of recommendations based on their maturity stage levels. The recommendations can help SMEs to progress to the next maturity level. Overall it is advisable for SMEs to focus on seven strategy recommendations as below:

- Develop positive perceptions and attitudes towards B2B e-commerce through providing motivational development programs to develop self-efficacy, motives, needs, capabilities, and expectations on B2B e-commerce among top management and employees.
- Increase top managemnet support through encouraging top management to equip themselves with managerial and technical knowledge on B2B e-commerce business model, concepts, process, policies, procedures and solutions so that the project will have high priority and receives the required financial resources and attention.
- Provide appropriate technical and management training courses which emphasize on acquisition of skill of know-how and know-why to increase knowledge, skill and positive perception on B2B e-commerce technology. The training modules also should reflect differences between types of organization, functional orientation, level of personnel and level of employee's competencies.
- Increase technology resources and set priority. Organization needs to be equipped with the telecommunication networks, backbones, switches, routers, multiplexers, as well as internet with broader bandwidth that include all of its parts.
- Continual improvement on business process and products through thorough understanding of their product transactions and specifications. This will allow companies to better design the B2B e-commerce process and offer greater value to buyers and sellers.
- Mutual beneficial relationships with trading partners, supporting industries and government through encouraging open communication and cooperation between different functional departments which can increase business process effectiveness and efficiency The risk-sharing agreements and strategic alliances between smaller players and industry leaders can also increase prominence in the strategy and able SMEs to compete more effectively with large players.
- Continuous review on B2B e-commerce application and systems. For SMEs that are ready to introduce B2B e-commerce application or those already have B2B e-commerce application in place, it advisable for them to create a more fault-tolerant atmosphere to further encourage success in B2B e-commerce development. They need to continuously review B2B policies, procedures, training modules, and supply chain business operation which is an impediment to the further development of B2B e-commerce.

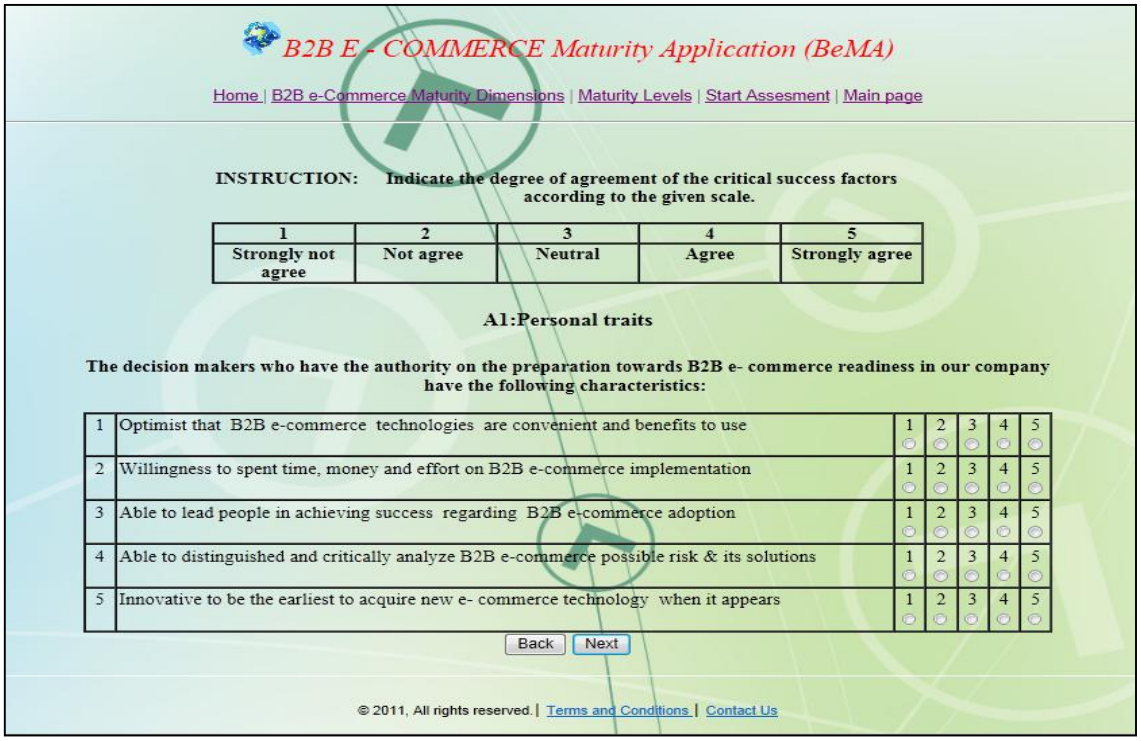

Fig. 1. BeMA Questionnaire using 5 Point Likert Scale

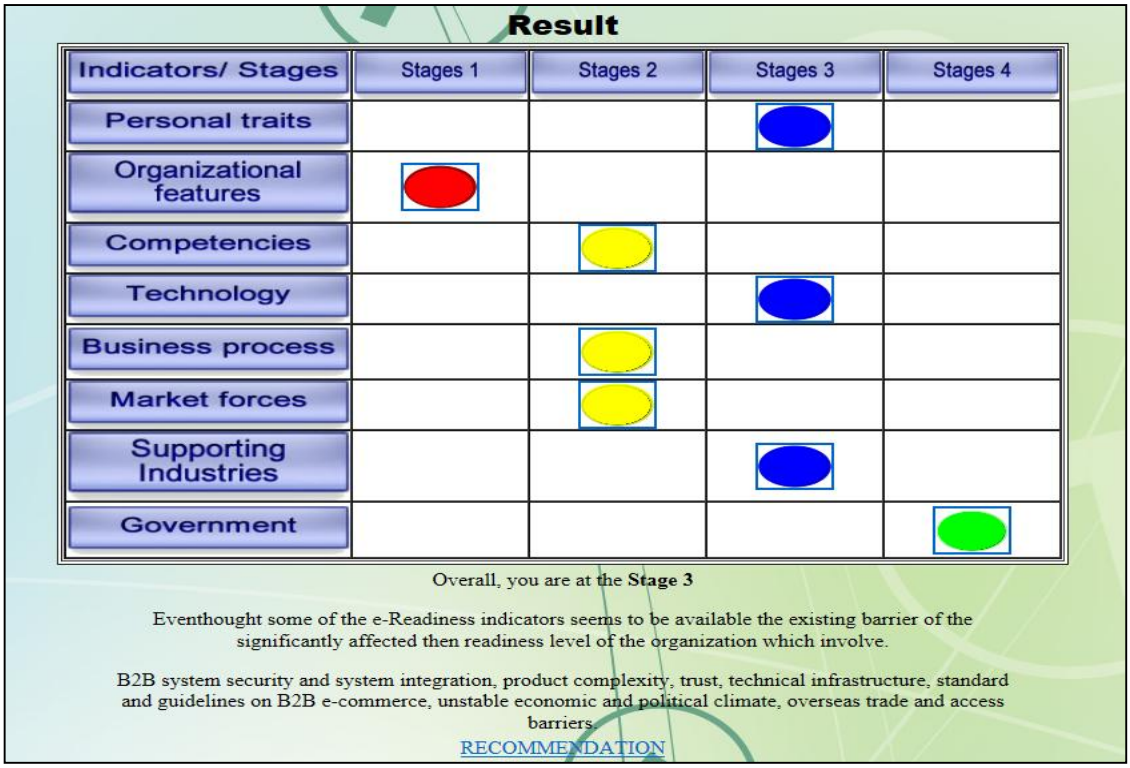

Fig. 2. Result of e-readiness assessment stages

4. BeMA EVALUATION

Even though the application has been derived from solid research base, the application evaluation is needed as it is a proactive measure to ascertain its validity, acceptability, applicability and usability. Thus, in order to ensure the practicality and the usefulness of the application developed, there is a need to verify the model and its feasibility. Taking into account the satisfaction of user requirements, the idea of validating the application is generally taken to prove that it works satisfactorily for SMEs other than those from whose data was derived. In addition, the validation through users should demonstrate the feasibility, practicality and integrity of the application.

To facilitate the evaluation process, thirty - five SMEs from agro-based industry were given hands-on usage of the application prototype developed in this study. SMEs as a potential user of the application were selected through convenience sampling method based on the listing in SME Corp web sites, Members of AgriBazar Portal Malaysia's (both are the latest update listing of June 2010) and Halal Directory 2008. The target group of this application evaluation and validation exercise was either the CEO, owner of the organization, or project manager who is in the best position to relate to the subject matter. As mentioned, the e- readiness assessments are done through the BeMA application, which the users were asked to enter their input regarding B2B e-commerce readiness elements into the questionnaire set in the application. On completion of the assessment and certification exercise, respondents were given a standard questionnaire evaluation form covering areas of functionality, usability, accuracy, attractiveness and benefits of the model. Fig. 3 illustrates the flow of the process.

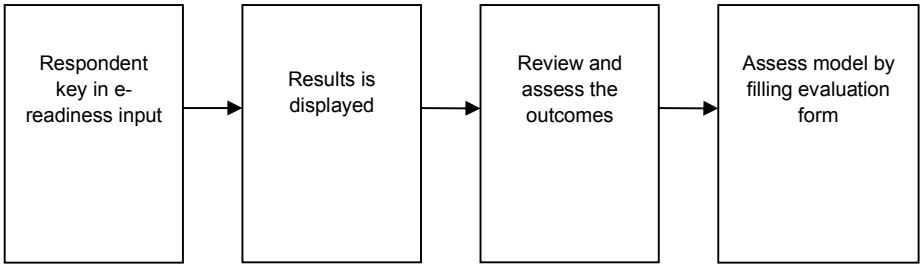

Fig. 3. The flow of the process

Respondents were encouraged to include any additional suggestions to enhance the application. However, if the respondents do not agree with the e-readiness assessment results they may give comment and suggestion in the form provided. The evaluation relies on the judgement of the respondents as to whether or not he/she agrees with the statements in the context of their organizations. By looking at the e-readiness analysis and its solutions provided by the application, users are able to assess whether the application is justified to be the proficient tool to measure B2B e-commerce maturity in SME in the real world environment. The respondents need to ensure that their responses are consistent and reflected throughout.

The extent to which the respondent agrees or disagrees with the statement is graded on a scale of 1 to 5, where 1=Strongly Disagree, 2=Disagree, 3= neither agree/ disagree or no opinion, 4=Agree and 5=Strongly Agree. An average score was calculated for each element. The results from the assessment of the model revealed that in terms of average and standard deviation score, all respondents basically agree on the usability, effectiveness, attractiveness, accuracy and benefits of the application. In terms of frequency analysis about 28 (80%) SMEs agree that the application is usable to assess organization e- readiness. Only one respondent indicated neither agree or disagree on the usability of the model, and the other 6 (17%) strongly agreed on the usability of the model. From the perspective of model effectiveness, about 29 (82%) SMEs agreed on the effectiveness of the model, while 5 (14%) of the respondents strongly agreed that the e- readiness assessment results are easy to understand and effectively highlight the areas of readiness that company need to address. The results also shows that most respondents (70%) are satisfied with the e-readiness analysis results and thought that the e-readiness results accurately reflect the current B2B e-commerce

readiness level in the company. While the other 4 (11%) SMEs, strongly agreed on the accuracy of the e-readiness assessment results. However, about 6 (17%) SMEs neither disagree or agree. The evaluation findings also highlighted that about 29 (83%) of the SMEs agreed that the resolutions suggested in the application are able to improve the maturity level of B2B e-commerce. Only about 1 (3%) of SMEs neither agree or disagree on the resolutions provided to them, while the other 14% strongly agreed that the suggestions are comprehensive and meaningful. In terms of the benefits of the application, majority (80%) of the SMEs agree that the application is beneficial to the SME as it gives a clear result of an organisation's strengths and weaknesses regarding its readiness for B2B e-commerce, about 3 SMEs (9%) strongly agree while the other 4 (11%) neither disagree or agree. The results provided from the assessment, allowed the respondent to do comparisons and to assess whether the application reflects the real B2B e-commerce maturity of their organizations. On the whole, the evaluation results are encouraging and most respondents verify the validity of the application. They are also enthusiastic for future use of BeMA. From the evaluation assessment it can be concluded that:

- The application is usable as it addresses all aspects of B2B e-commerce that SMEs need to consider to achieve e- readiness.
- The application is easy to understand as it provides easy to understand reports and highlight e- readiness aspects that company need to address on.
- The application accurately portrays the current maturity level of the organization which reflect the integrity of the application as a valuable maturity assessment tool.
- The resolutions provided in the application are acceptable to be used as guidelines for organization to achieve a higher maturity level. However, further research on B2B e-commerce readiness best practices from expert advices will add more value to the application.
- The application is also beneficial to SME as it highlight organisations' strengths and weaknesses. Through the application, SME can strategize and plan their resources effectively with respect to B2B e-commerce implementation. In general, the evaluation exercises have demonstrated the practicality and the integrity of the application.

5. CONCLUSION

The research intends to provide maturity model as a practical guidance to other researchers. In order to ensure its successfulness, the systematic research process of the B2B e-commerce maturity model was used. The model was generated in conceptual form, which was subsequently developed through evaluation from subject matter experts in B2B e-commerce. The model has been refined and improved by incorporating the significance e- readiness factors which were measured by the index score. However, to prove that the model provide an accurate and well structured representation of SME's environment, BeMA validation assessment by SME was done. Overall, the evaluation results are encouraging and most respondents verified the validity of the model. They are also enthusiastic for future use of BeMA. Thus, based on the validation and assessment results, it is worth pointing out that the model and the application have proved its practicality in SMEs context.

The research also proved that the theory and findings have thus supported the B2B e-commerce maturity model. With the adoption of the proposed B2B e-commerce maturity model, SME is hoped to be better prepared to manage B2B business transaction in a more efficient way. However, due to the growing complexity of SME business environment, the indicators focused in this research should not be treated as definitive for SME yet. Further analysis of organization capability and their impact on the conditions of the environment are needed in order to increase the granularity of the B2B e-commerce maturity model.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Chapter 10
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Application of a Multimodal, Multicommodity International Freight Simultaneous Transportation Equilibrium Model to Sultanate of Oman

Mohamad K. Hasan[1*]

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ABSTRACT

The prediction of multicommodity freight flows over a multimodal network has attracted much interest in the recent years. An implementation of the International Freight Simultaneous Transportation Equilibrium Model (IFSTEM) that developed in United Nations Economic and Social Commission for Western Asia (ESCWA), to the goods trade through the ports and lands of Sultanate of Oman is presented. The transportation network is usually modeled in a simplistic way (bipartite network) and these models rely to a large extent on the *supply* and *demand* functions of the producers and consumers respectively. Although some socio-economic variables, which are not available, were required for IFSTEM model calibration, some reasonable assumptions were made and it was good enough to draw the following main findings: the proposed alternative enhancement scenarios were four nested scenarios, i.e., each scenario included the previous one plus an additional enhancement. These four enhancement scenarios were analyzed against and compared with scenario (0), i.e., the reference "Do nothing" scenario. The analysis has been achieved in two stages. The first stage involved the prediction of international trade flows (imports, exports and re-exports), times and costs that would result from the application of the 4 alternative enhancement scenarios during the analysis period through the target year of 2040. The prediction results revealed that the estimated international trade flows (imports, exports and re-exports) for Oman were increased by more than 504% by 2040 compared to the present situation of the base year 2012. This increase would represent around 70% compared to the "do nothing" reference scenario by the year 2040 assuming that the average increase of international trade flows in the "do nothing" case would be around 4% annually during the analysis period from 2012 to 2040. The predictions of average total trip time and total cost per ton revealed an estimated decrease, compared to the reference scenario, by around 25% and 20% respectively. These results are internally consistent and represented reasonably significant improvements compared to the "Do nothing" reference scenario.

Keywords: International multimodal multicommodity network; simultaneous transportation network equilibrium model; integrated transport network; integrated transport system; international freight transport; exporters; importers.

1. INTRODUCTION

The prediction of multicommodity freight flows over a multimodal network has attracted much interest in the recent years. In contrast to urban transportation, where the prediction of passenger flows over multimodal networks has been studied extensively and many of the research results have been transferred to practice (Safwat and Walton [1] , Safwat and Hasan [2], Safwat [3] and [4], Safwat and Magnanti [5], Hasan [6], Hasan and Al-Gadhi [7], Hasan and Safwat [8], Florian [9] and [10]), the study of freight flows at the national, regional, or international level, perhaps due to the inherent difficulties and complexities of such problems, received less attention. A good review of freight

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transport modeling may be found in Friez and Harker [11]. Below is a brief review based on Guelat, Florian, and Crainic [12]. The prediction of passenger flows on multimodal urban transportation networks has been studied extensively, and many of the research results have been applied at the practical level [13-17].

The first class of models that was well studied in the past for prediction of interregional freight flows is the *spatial price equilibrium model* and its variants. The model, stated initially by Samuelson [18] and extended by Takayama and Judge [19] and [20] then by Florian and Los [21], Friesz, Tobin and Harker [22], has been used extensively for analyzing interregional commodity flows. This class of models determines simultaneously the flow between the *producing* and *consuming* regions as well as the *selling* and *buying* prices. The transportation network is usually modeled in a simplistic way (bipartite network) and these models rely to a large extent on the *supply* and *demand* functions of the producers and consumers respectively. The calibration of these functions is essential to the application of these models and the transportation costs are unit costs or may be functions of the flow on the network. There have been so far a few multicommodity applications of this class of models, with the majority of applications having been carried out in agricultural and energy sectors in an international or interregional setting. It is not this class of models which is the main topic of our study.

The second class of models which we consider are *freight network equilibrium models* which enable the prediction of multicommodity flows over a multimodal network, where the physical network is modeled at a level of detail appropriate for a nation or a large region, and represents the physical facilities with relatively little abstraction. The demand for the transportation services is exogenous and may originate from an input-output model, if one is available, or from other sources, such as observed demand or scaling of observed past demand (in our proposed model endogenous transportation demand will be considered). The choice of mode or subsets of modes used is exogenous and intermodal shipments are permitted. In this sense, these models may be integrated with econometric demand models as well. The emphasis is on network representation and the proper representation of congestion effects in a static model aimed to serve comparative studies or discrete time multiperiod analyses.

The first significant multimodal predictive freight network model was by Roberts [23] and later extended by Kresge and Roberts [24]. This model became known as the Harvard-Brookings model. Only the behavior of shippers was taken into account. Using constant unit costs, each shipper chooses the shortest path for movements from an origin to a destination. The amount moving between an origin-destination (O-D) pair being determined by a simple distribution submodel. The model resorted to a fairly simple “directed link” representation of the physical network and congestion effects were not considered. The model was applied to the transport network of Columbia.

Later, the Multi-State Transportation Corridor Model (McGinnis et al. [25], Jones and Sharp [26] and Sharp [27]) went a step further in representing an explicit multimodal network, but without any consideration of congestion. The first model that considers congestion effects and shipper-carrier interaction is that of Friesz, Viton and Tobin [28]. A review of shipper-carrier models, both sequential and simultaneous, is given by Friesz and Harker [11]. The first application of a model that considers congestion phenomena in this field is the Freight Network Equilibrium Model (FNEM) (Friesz, Gottfried and Morlok [29]). This is a sequential model which uses two network representations : an aggregate network that is perceived by the users, which serves to determine the *carriers* chosen by the *shippers* and then more detailed separate networks for each carrier, where commodities are transported by minimizing total cost. A generalization of the work of Friesz, Viton and Tobin [28] in which variable demand functions are considered in the shipper’s submodels, is given by Harker and Friesz [30] and [31]. They combine the variable demand modeling approach of spatial equilibrium models with a detailed description of the behavior of shippers and carriers, in mathematical formulations that are yet to be tested in a practical application.

Guelat, Florian and Crainic [12] developed a multimodal multiproduct network assignment model that does not consider shippers and carriers as distinct actors in the decision made for shipping freight. This level of aggregation which is appropriate for strategic planning of freight flows, where origins and

destinations correspond to relatively large geographical areas, leads to the specification of supplies and demands for the products considered, which represent the services provided by all the individual shippers for the same product. Their model assumes that goods are shipped at minimum total generalized cost, which is particularly appropriate when certain products are captive to a mode, or a subset of modes, due to service availability or regulation. In other situations, as in our study, when modes compete for the shipment of products, generalized cost function components which reflect shippers' objective should be included. This generalized cost may be composed of costs, time delays or other relevant factors, keeping in mind that shippers, in this context, are aggregated by origins. The multimodal aspects of their model are accounted for in the network representation chosen and the multiproduct aspects are accounted for in the formulation of the predictive model and are taken advantage of in the solution procedure.

Safwat [32] describes in his dissertation an intercity transportation model, i.e., a Simultaneous Transportation Equilibrium Model (STEM). An application of the STEM model to Egypt included both passenger and freight movement. The generation of trips in a region is incorporated via a specific non-linear functional form including transportation costs (see also Safwat and Magnanti [5]). Thus, Safwat represented producers' and consumers' behavior by this specific trip generation function, collapsing their decision-process into one known functional relationship. In practice, the STEM model was applied to many real-world transportation systems. The most recent applications were on the urban transportation network of Tyler, Texas, U.S.A. (Hasan and Safwat [8]) and of Riyadh, Saudi Arabia (Hasan and Al-Gadhi [7]). Earlier applications included the intercity passenger travel in Egypt (Safwat [3] and [4]) and the urban transportation network of Austin, Texas, U.S.A. (Safwat and Walton [1]). Moavenzadeh et al. [33] included an extended version of the STEM model as a central component of a comprehensive methodology for intercity transportation planning in Egypt [34]. This methodology has been used in several case studies involving multimodal transportation of passengers and freight in Egypt.

Safwat and Hasan [35] further adapted the STEM to International Freight STEM (i.e., IFSTEM) and implemented it to the Integrated Transport System in the Arab Mashreq (ITSAM) through United Nations Economic and Social Commission for Western Asia (UN-ESCWA).

Hasan [36] implemented and adapted the IFSTEM methodology to the international trade flows through Lebanon, Syria and Jordan. Throughout these applications, STEM and IFSTEM predictions consistently outperformed the predictions produced by applying the traditional sequential transport planning approach used worldwide by international consultants.

More recently, Mathisena and Hanssena [37] give a good academic literature on intermodal freight transport. First, they examined the historical development of academic research on intermodal freight transport. Second, they identified the seminal works on the topic.

Duan et al. [38] demonstrate the effect of recognizing heterogeneity in values of time (VOT) on the design of a hub network for freight transportation. By taking the VOT distribution into account, we emphasize shippers' broader logistical, social and economic situation in the network design, and are not limited to commodity types

The IFSTEM-Oman adapted in this paper is essentially based on the above mentioned developments, adaptations and implementations. That is, the IFSTEM–Oman is a simultaneous trip generation, trip distribution, modal split and traffic assignment model that most appropriately illustrates the behavior of exporters and importers of different commodities over the international multimodal network for Oman.

The remainder of this article is structured as follows. In Section 2, we describe the international trade flows prediction model for Oman (IFSTEM–Oman Model). Then, in Section 3, IFSTEM-Oman model application assumptions are presented before predicted international trade flows, times and costs: application results and analysis are presented in Section 4. Finally, conclusions are presented in Section 5.

2. THE INTERNATIONAL TRADE FLOWS PREDICTION MODEL FOR OMAN (IFSTEM–OMAN MODEL)

2.1 IFSTEM Modelling

2.1.1 Network Representation

The physical network infrastructure represented by IFSTEM supports the transportation of several products by several modes. A product is any category of commodity (a collection of similar products), goods or passengers that generates a link flow specifically associated with it. A mode is a means of transportation with particular characteristics, such as vehicle type and capacity, as well as a specific cost function.

A base network consists of physical nodes representing capitals, cities, border points, seaports and airports, as well as the physical links that connect those nodes for different types of modes. Represented as well in the model are various types of administrative and logistical operations (ALOs) at origins, destinations, border points, seaports and airports; these ALOs include export and import procedures, transit-in (entry) transit-out (exit) procedures, re-export-in (entry), re-export-out (exit), pre-import and pre-export procedures (those not performed at the border point itself), and transfer operations. ALOs often involve dummy links that connect some of the physical nodes with fictitious (artificial) nodes.

Since each commodity can be transported by a specific mode or set of modes depending on commodity characteristics, a network for each commodity type has been created under IFSTEM. Each commodity type r has its own network that can be defined by a set of nodes N^r and a set of links A^r for a combination of modes and operations, as follows:

$$A^r = \left[\left(\bigcup_{m(r)} A^{m(r)} \right) \bigcup \left(\bigcup_{o(r)} A^{o(r)} \right) \right] \quad \text{and} \quad N^r = \left[\left(\bigcup_{m(r)} N^{m(r)} \right) \bigcup \left(\bigcup_{o(r)} N^{o(r)} \right) \right] \quad \forall r \in C$$

where

(N, A) = A multimodal multi-commodities network consisting of a set of N nodes and a set of A links where:

$$N = \bigcup_{r \in C} N^r \quad \text{and} \quad A = \bigcup_{r \in C} A^r$$

C = Set of all commodity types

M = Set of all mode types, $M = \bigcup_{r \in C} m(r)$

O = Set of all ALO types, $O = \bigcup_{r \in C} o(r)$

$m(r)$ = a set of mode types possible for commodity type r (combinations of road, rail, air and/or maritime modes),

$o(r)$ = a set of ALO types for commodity type r (combinations of export, import, transit-in, transit-out, re-export-in, re-export-out, pre-export, pre-import and/or transfer operations), and

The creation of operation links for each commodity r depends on the origin and destination of this commodity. The network is thus further decomposed into origin-destination (O-D) combinations; each O-D pair for commodity r has its own multimodal network. Each transport mode has its own network including unique node and link identification numbers. If at any node of any modal network that connects the given O-D pair there is the possibility of transfer to another modal network, this is represented by an artificial transfer link between the two modes. A physical modal origin node is connected to an artificial node by an artificial link that represents the pre-export operation of the given commodity at the given origin. Similarly, any physical modal destination node is connected to an artificial node by an artificial link that represents the pre-import operation of the given commodity at the given destination. All of the artificial modal origin nodes are connected to a super artificial origin node, and all of the artificial modal destination nodes are connected to a super artificial destination node through artificial dummy links that entail no cost (see Fig. 1).

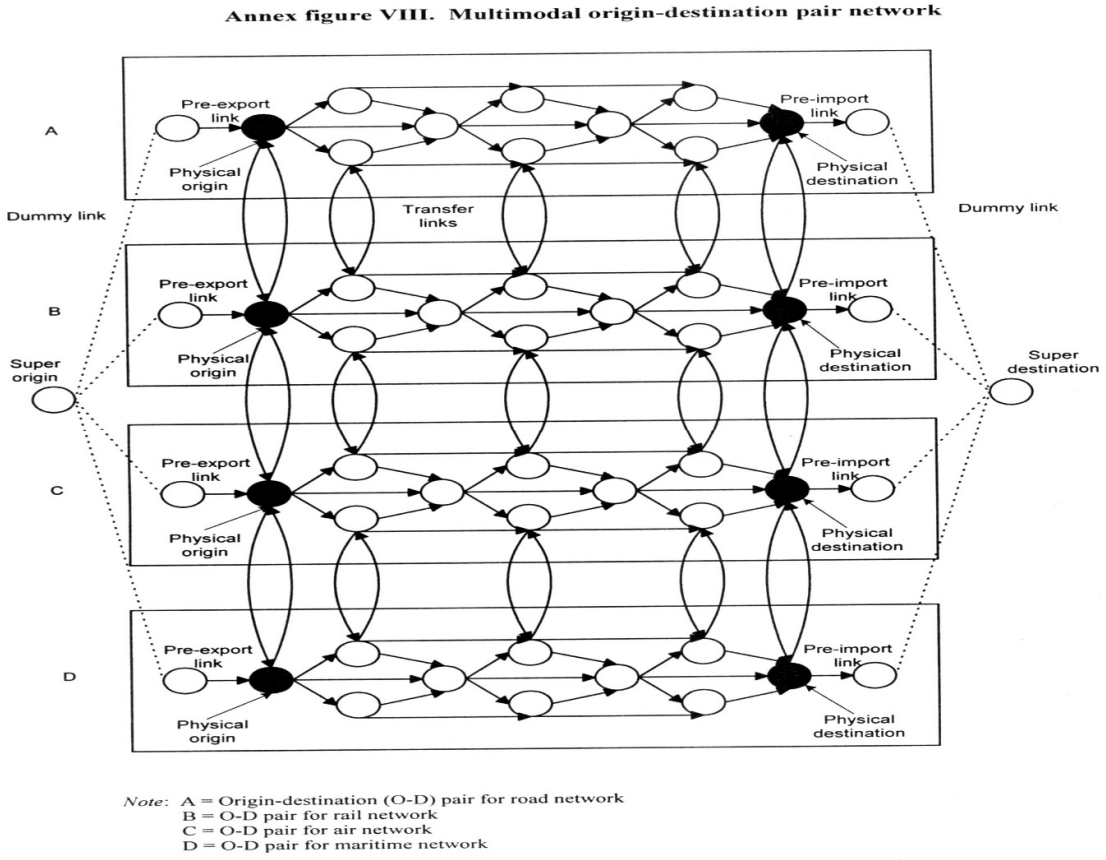


Fig. 1. Multimodal origin-destination pair

According to the representation above, a specific commodity flowing between a given O-D pair can begin from its super artificial origin and move through a multimodal network until it reaches its super artificial destination. The network representations for export, import, transit-in and transit-out ALOs for land border points are shown in Fig. 2. Part (a) of the Figure 2 shows part of a directed road network at a border between country X and country Y, and parts (b) shows ALOs involving node 102 in country X and node 200 in country Y. Part (b) shows a possible directed ALO from country X to country Y based on the creation of the following artificial nodes and links:

1- At node 102, three artificial nodes (10211,10214, and 10220) and three artificial links (102-10211, which represents the export operation, 102-10214, which represents the transit-out operation, and 102-10220 which represents the re-export-out operation were established. Then, three links (10211-

200, 10214-200, and 10220-200) were created; either of these represents the physical link 102-200 in part (a). Since either export or transit-out or re-export-in will occur, the commodity will flow along either the 102-10211-200 or the 102-10214-200 path, or 102-10220-200.

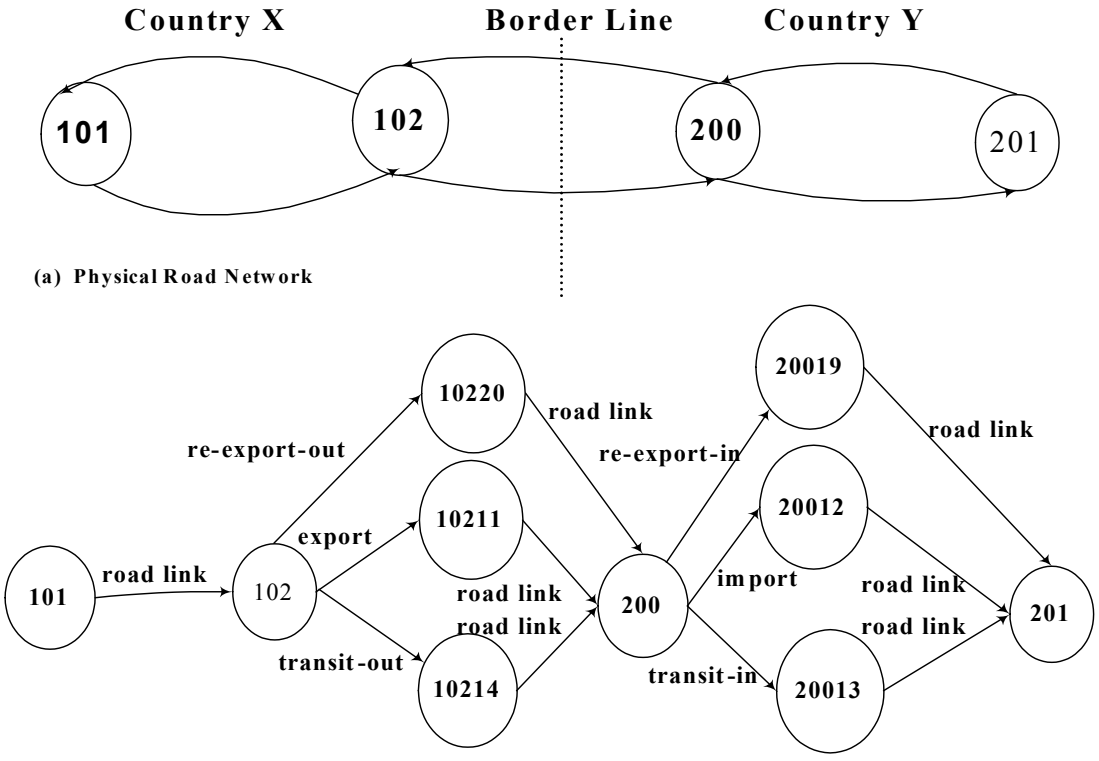
2- At node 200, three artificial nodes (20012, 20013, and 20019) and three artificial links (200-20012, which represents the import operation, and 200-20013, which represents the transit-in operation) and 200-20019, which represents the re-export-in operation) were established. Then, three links (20012-201, 20013-201, and 20019-201) were created, either of these represents the physical link 200-201 in part (a). Since either import or transit-in, or re-export-in will occur, the commodity will flow along either the 200-20012-201 or the 200-20013-201 path, or the 200-20019-201 path.

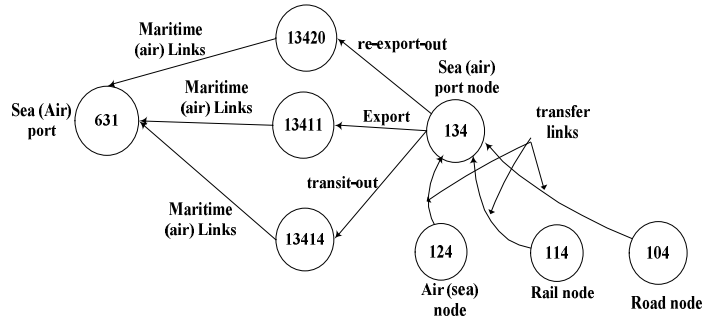
Parts (c) and (d) show similar network representations of export, import, transit-in, transit-out, re-export-in, and re-export-out ALOs for seaports or airports combined with possible other mode transfers were also created.

2.1.2 Model Description and Assumptions

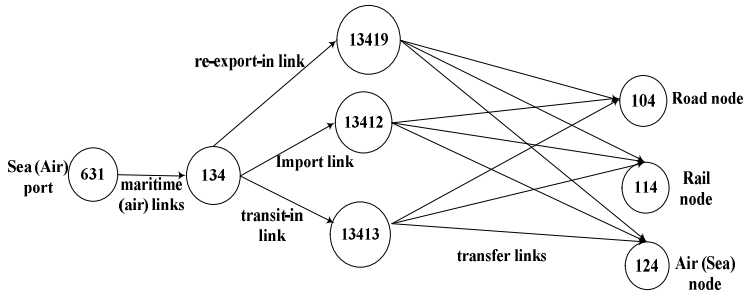
The model selected for this study, following an extensive literature review , is a simultaneous trip-generation, trip-distribution, modal-split and traffic-assignment model that most appropriately illustrates the behaviour of exporters and importers of different commodities over an international multimodal network.

IFSTEM modelling procedures are quite similar to those used for the STEM approach (Safwat [*32*], Safwat and Magnanti [*5*]), largely because the modelling assumptions of the former are essentially based on those of the latter. IFSTEM is constructed in such a way that commodity exporters make decisions about where and how to transport their freight; choices are made regarding destination, mode, trans-shipment and routing.





(c) A possible directed ALO to a seaport (airport) combined with possible node transfers



(d) A possible directed ALO from a seaport (airport) combined with possible node transfers

Fig. 2. ALOs Operations

Notation

I = Set of origin (export) nodes $I = \underset{r \in C}{U} I^r$ and $\mathrm{N}^{\mathrm{r}} \supseteq I^r$

I^r = Set of origin (export) nodes for commodity r

i = An origin (export) node in the set I^r

D_i^r = Set of destination (import) nodes that are feasible for importing commodity r from origin i.

j = A destination (import) node in the set D_i^r

R^r = Set of origin-destination pairs (ij) for commodity r

R = Set of all origin-destination pairs (ij) in the system , where $R = \underset{r \in C}{U} R^r$

p = A simple (i.e., no node repeated) multimodal path (i.e., it may include a combination of links with different modes $m(r)$) for commodity r in the network $\left(N^r, A^r\right)$

$P_{ij}^{m(r)}$ = Set of simple paths that can be used to transport commodity r from origin i to destination j using only $m(r)$ modes of transport.

P^r = Set of simple paths in the network $\left(N^r, A^r\right)$, i.e., $\left(P^r = \bigcup_{ij \in R^r} P_{ij}^{m(r)}\right)$

a = A link in the set A. Each link is identified by (k, l, q), i.e., the link connects node k to node l by mode/operation q.

Delivery cost (price)

It is assumed that the "perceived" delivery cost (price) u_{ij}^r, comprising the cost of commodity r exported from origin i and imported to destination j, is as follows:

$$u_{ij}^r = \gamma^r t_p^r + PC_i^r + ALC_p^r + TR_p^r + TC_p^r$$

Where

γ^r = the value of time of the exporters of commodity r,

t_p^r = the total time (sum of ALO and transport times) on a multimodal path p from origin i to destination j for commodity r,

PC_i^r = the unit price of commodity r at origin i,

ALC_p^r = ALO (export, import, transit-in, transit-out, pre-export, pre-import and/or transfer) costs on a multimodal path p from origin i to destination j for commodity r,

TR_p^r = the tariff cost (at the origin, en route, and at the destination) on a multimodal path p from origin i to destination j for commodity r, and

TC_p^r = the transportation cost on a multimodal path p from origin i to destination j for commodity r.

Utility function

It is assumed that an exporter who wishes to export commodity r from origin i associates a utility v_{ij}^r with each destination j among the destinations that are feasible for importing commodity r from origin i. Since exporters do not usually have perfect information concerning the system and cannot quantify all the factors that influence their utilities, it is assumed here that the exporter's utility function is random and may be decomposed into a measured (observed) utility component plus an additive random (error) term, as follows:

$$v_{ij}^r = V_{ij}^r + \varepsilon_{ij}^r$$

Where

v_{ij}^r = the utility of exporting commodity r from origin i to destination j,

V_{ij}^r = the measured (observed) utility of exporting commodity r from origin i to destination j, and

ε_{ij}^r = the random (unobserved) utility of exporting commodity r from origin i to destination j.

It is further assumed that the measured utility is a function of the socio-economic characteristics of the destination (such as consumption level, commodity deficit, population and selling prices) and the origin (such as the price of the commodity at the origin), as well as the system's performance (including the cost and time of transport and ALO), and can be expressed as follows:

$$V_{ij}^r = -\theta_i^r u_{ij}^r + \sum_{w=1}^{W} \theta_{iw}^r g_w(A_{wj}^r)$$
$$= -\theta_i^r u_{ij}^r + A_j^r$$

Where

A_{wj}^r = the value of the w^{th} socio-economic variable that influences the number of tons of commodity r imported at destination j,

$g_w\left(A_{wj}^r\right)$ = a given function specifying how the w^{th} socio-economic variable A_{wj}^r influences the number of tons of commodity r imported at destination j, and

A_j^r = a composite measure of the effect that socio-economic variables exogenous to the transport system have on the number of tons of commodity r imported at destination j.

The quantities θ_i^r and θ_{iw}^r for $w = 1, 2, ..., W$ are coefficients to be estimated, where $\theta_i^r > 0$.

Exporters are utility maximizers; therefore, within each O-D pair exporters compete with one another for limited transportation facilities while trying to minimize their own delivery costs. A Wardropian user equilibrium among exporters exists when no exporter acting unilaterally can decrease his delivery cost (Wilson [39]). At equilibrium, the delivery costs u_{ij}^r on all used paths are equal to or less than those on unused paths between a given O-D pair.

Link cost functions

This study deals with two major types of links: the first comprises modal (real) links including road, rail, maritime and air links; the second comprises operational (dummy) links including export, import, transit-in, transit-out, re-export-in, re-export-out, pre-import, pre-export and transfer operation links. Each type is given its own cost function that depends upon the flow over the given link.

The modal link cost function can be expressed as follows:

$$C_a^r(F_a^r) = \gamma^r t_a^r(F_a^r) + TC_a^r(F_a^r) \qquad \text{for all modal links } a \tag{1}$$

Where

F_a^r = the flow, in tons, of commodity r on link a,

$C_a^r(F_a^r)$ = the generalized cost per unit of flow of commodity r on link a, using one of the feasible modes for F_a^r,

$t_a^r(F_a^r)$ = a function representing the delay per unit of flow of commodity r, on link a, using one of the feasible modes for F_a^r,

$TC_a^r(F_a^r)$ = a function representing the monetary cost per unit of flow of commodity r, on link a, using one of the feasible modes for F_a^r, and

γ^r = the value of the time as perceived by the exporters of commodity r.

The operational link cost function can be expressed as follows:

$$C_a^r(F_a^r) = \gamma^r \sum_k \text{tproc}_{ka}^r + \sum_k \text{cproc}_{ka}^r + \text{infc}^r(\text{nsig}^r, PC_i^r, F_a^r) + \text{tariffc}^r(PC_i^r, F_a^r) + \beta^r \text{ EDIL}_a^r \quad (2)$$

where

tproc_{ka}^r = the time taken to finish administrative procedure k of operation a for commodity r,

cproc_{ka}^r = the administrative cost of procedure k of operation a for commodity r,

infc^r = the informal cost as a function of the number of signatures, nsig^r; the unit price of commodity r at origin i, PC_i^r; and the flow F_a^r,

tariffc^r = the tariff cost of commodity r as a function of the unit price of commodity r at origin i, PC_i^r, and the flow F_a^r,

EDIL_a^r = the electronic data interchange (EDI) level of implementation used to perform operation a for commodity r; this level ranges from 0 to 5, with 0 representing full implementation of EDI and 5 representing no implementation of EDI, and

β^r = a parameter to be estimated that measures the cost of the limited implementation of EDI for the export of commodity r.

It is assumed that each link cost function depends on the flow over that link and should be continuous and non-decreasing. All the functional forms and parameters of equations (1) and (2) need to be specified and calibrated for the real application of the model to ITSAM.

Model assumptions

Based on the above utility function for exporters and following the STEM model (Safwat and Magnanti [*5*]) development and assumptions, we adapted the accessibility, trip generation, model split, and trip assignment models of STEM model to fright transport application assuming the following:

1- The accessibility is defined as a composite measure of transportation system performance and socio -economic system attractiveness as perceived by a typical exporter of a given commodity from a given origin and it can be measured by the expected maximum utility to be obtained from a particular export choice situation.

2- The trip generation model assumed that the number of tons of a given commodity exported from a given origin is a function of the socio-economic activities at that origin, the socio-economic characteristics of the exporter, and transport system performance.

3- The trip distribution model assumed that the probability that a typical exporter at any given origin will choose to export a specific commodity to any given destination , accessible from that origin, is equal to the probability that the utility of exporting to that destination is equal to or greater than that of exporting to any other destination

4- Each importer will consider competitive alternative delivery costs for each commodity he wishes to import from different exporters at different origins, e.g., if an importer at destination j knows the average selling price of commodity r, SP_j^r, and specifies a profit margin of MP_j^r, he will import commodity r from an exporter at origin i as long as

$$\text{the import criterion} = imc = SP_j^r - u_{ij}^r - MP_j^r \geq 0$$

5- Based on the network representation used in this study and practical considerations for freight transport, it is assumed that commodity r can be transferred from one mode to another as long as this transfer is feasible and reduces the total delivery cost (that is, the cost of transporting commodity from its origin i to destination j). Therefore, it is assumed that each exporter will choose the mode and route combination that minimizes the total cost of delivery to import destination node j from export origin node i .These assumptions on modal split, trip assignment and system performance imply a Wardrop user equilibrium model of (multimodal) path choice. More precisely, if u_{ij}^r is identified as the minimum delivery cost, the perceived delivery costs on all used multimodal paths for any given O-D pair are equal to or less than those on unused multimodal paths

6- The demand for the transport of one commodity is independent of that of another. In other words, the movement of different commodities is assumed to involve independent interaction with the transportation system. For this reason, they can be modelled separately, and IFSTEM may therefore be decomposed by commodity type. Additionally, since capacity issues are generally not a principle concern in regional or international freight transportation planning, it is not necessary to simultaneously assign multi-commodity flows to this international network; a simplified separation of freight into commodity groupings is sufficiently relevant. Each commodity or sector becomes a layer, and together all relevant layers provide an aggregate estimate of all freight traffic volumes at a level of accuracy that is useful for planning.

The IFSTEM Model

Integrating all the modeling components and assumptions described in the previous subsections and following STEM model formulation (Safwat and Magnanti [*5*]) gives the following International Freight Simultaneous Transportation Equilibrium Model (IFSTEM) (for more details see ESCWA [*40*]).

IFSTEM: for each commodity $r \in C$,

$$S_i^r = \max\{\ 0, \ln \sum_{\mathrm{j}\in \mathrm{D_i^r}} \exp\ \ (-\theta_i^r u_{ij}^r + A_j^r)\ \} \qquad \forall\ \mathrm{i} \in \mathrm{I^r}$$

$$G_i^r = \alpha^r S_i^r + E_i^r \qquad \forall\ \mathrm{i} \in \mathrm{I^r}$$

$$T_{ij}^r = \left\{ \begin{array}{ll} G_i^r \dfrac{\exp(-\theta_i^r u_{ij}^r + A_j^r)}{\sum_{k\in D_i^r} \exp(-\theta_i^r u_{ik}^r + A_k^r)} & \text{if } imc \geq 0 \\ 0 & \text{otherwise} \end{array} \right\} \quad \forall ij \in R^r$$

$$C_p^r \quad \left\{ \begin{array}{ll} = u_{ij}^r & \text{if } \ H_p^r > 0 \\ \geq u_{ij}^r & \text{if } \ \mathrm{H_p^r} = 0 \end{array} \right\} \qquad \forall \mathrm{p} \in \mathrm{P_{ij}^{m(r)}}, ij \in R^r$$

where

$$C_p^r = \sum_{a\in A^r} \delta_{ap}^r C_a^r (F_a^r) \quad \forall \mathrm{p} \in \mathrm{P_{ij}^{m(r)}}, ij \in R^r$$

S_i^r = the accessibility of the exporter of commodity *r* at origin i,

G_i^r = the number of tons of commodity *r* exported from origin i,

T_{ij}^r = the number of tons of commodity r exported from origin i to destination j,

H_p^r = the flow of commodity r on multimodal path p,

E_i^r = a composite measure of the effect the socio-economic variables, which are exogenous to the transport system, have on the number of tons of commodity r exported from origin i.

$$E_i^r = \sum_{l=1}^{L} \alpha_l^r q_l (E_{li}^r)$$

E_{li}^r = the value of the l^{th} socio-economic variable that influences the number of tons of commodity r exported from origin i,

$q_l\left(E_{li}^r\right)$ = a given function specifying how the l^{th} socio-economic variable, E_{li}^r, influences the number of tons of commodity r exported from origin i,

C_p^r = the total perceived delivery cost for commodity r transported from export origin node i to import destination node j on any multimodal path $p \in P_{ij}^{m(r)}$

$$\delta_{ap}^r = \left\{ \begin{array}{l} 1 \text{ if link } a \text{ belongs to path } p \\ 0 \text{ otherwise} \end{array} \right\} \text{for all paths}$$

The quantities α^r and α_l^r for $l = 1, 2, ..., L$ are coefficients to be estimated.

The model decision variables for commodity $r \in C$ are S_i^r, T_{ij}^r and H_p^r, which are interrelated through the minimum delivery cost u_{ij}^r These interrelationships allow a simultaneous prediction of trip generation, trip distribution, modal choice and trip assignment.

2.2 Equivalent Optimization Problem (EOP) for IFSTEM

The IFSTEM model can be formulated as the following EOP for each commodity $r \in C$:

$$\text{Minimize} \quad Z(S,T,H) = \sum_{i \in I^r} \frac{1}{\theta_i^r}\left[\frac{\alpha^r}{2}(S_i^r)^2 + \alpha^r S_i^r - (\alpha^r S_i^r + E_i^r)\ln(\alpha^r S_i^r + E_i^r)\right] +$$

$$\sum_{i \in I^r} \frac{1}{\theta_i^r}\left[\sum_{j \in D_i^r}\left[T_{ij}^r \ln T_{ij}^r - A_j^r T_{ij}^r - T_{ij}^r\right]\right] + \sum_{a \in A^r} \int_0^{F_a^r} C_a^r(w)dw$$

Subject to:

$$\sum_{j \in D_i^r} T_{ij}^r = \alpha^r S_i^r + E_i^r \qquad \forall i \in I^r$$

$$\sum_{p \in P_{ij}^r} H_p^r = T_{ij}^r \qquad \forall ij \in R^r$$

$$S_i^r \geq 0 \qquad \forall i \in I^r$$

$$T_{ij}^r \geq 0 \qquad \forall ij \in R^r$$

$$H_p^r \geq 0 \qquad \forall p \in p^r$$

Where

$$F_a^r = \sum_p \delta_{ap}^r H_p^r \qquad \forall p \in p^r$$

2.3 The Solution Procedure for EOP

We need an efficient solution procedure for the EOP that is guaranteed to converge to an existing and unique equilibrium. Safwat and Brademeyer [41] developed a globally convergent efficient algorithm called the Logit Distribution of Trips (LDT) algorithm for predicting equilibrium on the STEM model. We adapted this algorithm to solve our IFSTEM. The algorithm belongs essentially to the class of feasible-direction methods and is known to be globally convergent. For each commodity, at any given iteration, k, the method involves three main steps:

I. determines a direction for improvement,

II. Determines an optimum step size, λ^k, along that direction

III. Updates the current solution, X^k, $X^{k+1} = X^k + \lambda^k d^k$ where the vector X^k is defined by $X^k = (S^k, T^k, F^k)$

As mentioned in the network representation of Safwat and Hasan (2004) and Hasan (2009), each O-D pair for a given commodity will have its own network, therefore the algorithm will deal with each O-D pair network separately and then updates its flows to the commodity network level. The algorithm can be summarized as follows:

Solution Algorithm:

Step 0: ***Initialization.***

Perform all-or-nothing assignment based on $C_a = C_a(0), \in a \in A$ (i.e., free flow cost). This yield $X^1 = (S^1, T^1, F^1)$. Set . $k = 1$.

Step 1: ***Cost Update.***

Set $C_a^k = C_a(F_a^k), \forall a \in A$.

Step 2: ***Direction finding.***

Compute the costs on the shortest paths $u_{ij}^k, \forall ij \in R$ based on C_a^k. Find $d^k = Y^k - X^k$ where the vector $Y^k = (L^k, Q^k, V^k)$ is given by

$$L_i^k = \max\{0, \ln \sum_{j \in D_i} \exp(-\theta_i u_{ij}^k + A_j)\} \qquad \forall \, i \in I$$

$$Q_{ij}^k = \begin{cases} \dfrac{(\alpha L_i^k + E_i)\exp(-\theta_i u_{ij}^k + A_j)}{\sum_{l \in D_i} \exp(-\theta_i u_{il}^k + A_l^k)} & \text{if } imc = SP_j - u_{ij}^k - MP_j \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad \forall ij \in R$$

$$V_a^k = \sum_{ij \in R} \sum_{p \in P_{ij}} \delta_p B_p^k \qquad \forall a \in A$$

Where

$$B_p^k = \begin{cases} Q_{ij}^k & \text{if } p = p^* \in P_{ij} \\ 0 & \text{otherwise} \end{cases} \qquad \forall p \in P_{ij}, \forall ij \in R$$

and p^* is the shortest path between the given O-D pair. Then the feasible direction at iteration k is the vector d^k with the following components:

$$d_i^k = L_i^k - S_i^k \qquad \forall i \in I$$

$$d_{ij}^k = Q_{ij}^k - T_{ij}^k \qquad \forall ij \in R$$

$$d_a^k = V_a^k - F_a^k \qquad \forall a \in A$$

Step 3: ***line search.***

Find λ^k that solve

$$\sum_{i \in I} \frac{\alpha}{\theta_i}\left[(S_i^k + \lambda d_i^k) - \ln((S_i^k + \lambda d_i^k) + E_i)\right]d_i^k + \sum_{ij \in R} \frac{1}{\theta_i}\left[\ln(T_{ij}^k + \lambda d_{ij}^k) - A_j\right]d_{ij}^k$$
$$+ \sum_{a \in A} C_a (F_a^k + \lambda d_a^k) d_a^k = 0$$

Step 4: ***Move.***

Set. $S_i^{k+1} = S_i^k + \lambda^k d_i^k \qquad \forall i \in I$

$$T_{ij}^{k+1} = T_{ij}^k + \lambda^k d_{ij}^k \qquad \forall ij \in R$$

$$F_a^{k+1} = F_a^k + \lambda^k d_a^k \qquad \forall a \in A$$

Step 5: ***Convergence test.***

If a convergence criterion is met, stop (the current solution $\{S_i^{k+1}, T_{ij}^{k+1}, F_a^{k+1}\}$ is the set of equilibrium flow patterns); otherwise, set $k = k+1$ and go to Step 1.

A computer code in C++ was developed to create the multimodal network representation requirements and solve the above Algorithm.

3. IFSTEM-OMAN MODEL APPLICATION ASSUMPTIONS

3.1 Application Assumptions for Demand Models

As can be seen from the description of the IFSTEM Model, it involves two demand models. These are trip generation and trip distribution models. In a typical application of the IFSTEM Model, these demand models would have been calibrated using available socio-economic and transport and logistics cost data. However, because of data limitation on the availability of socio-economic and transport and logistics cost variables, in this application of the IFSTEM-Oman Model, we could not perform typical calibration of these demand models.

Instead, however, we assumed the following assumptions to "calibrate" the trip generation and trip distribution models within the IFSTEM-Oman Model. First, we invoked the following assumptions to estimate the exogenous variables E_i for each origin i from the equation

$$E_i = \sum_{l=1}^{L} \alpha_l q_l(E_{li})$$

1. $l = 1$
2. $q_l(E_{li})$ = $E_{1i} = G_i^o$ (Observed trip generation at origin i)
3. $\alpha_1 = .40$ for all origins

Hence

$$E_i^o = 0.40 G_i^o \qquad \forall \mathrm{i} \in \mathrm{I}$$

That is, the socio-economic variables, which are exogenous to the transport and logistics system, are assumed to account for 40% of the international trade flows that are exported from that origin.
For the attractiveness measure in the trip distribution model,

$$A_j = \sum_{w=1}^{W} \theta_{iw} g_w(A_{wj})$$

We assumed that

$$A_{ij} = \ln T_{ij}^o \qquad \forall ij \in R$$

By this assumption each destination has different attractiveness for different origins. We then assumed that this attractiveness composite measure is the exogenous variable in the exporter observed utility function. That is,

$$V_{ij} = -\theta_i u_{ij} + A_{ij}$$

We further assumed that the exporter at origin i is influenced only by this attractiveness measure and that he would not consider the delivery cost u_{ij} to be a major factor in his choice of the destination.

Hence, the accessibility measure for this behavior will be

$$S_i^o = \ln \sum_{\mathrm{j} \in \mathrm{D_i}} \exp \ (-\theta_i u_{ij} + A_{ij}) \qquad \forall \ \mathrm{i} \in \mathrm{I}$$

$$S_i^o = \ln \sum_{\mathrm{j} \in \mathrm{D_i}} \exp \ (\ln(T_{ij}^o)) \qquad \forall \ \mathrm{i} \in \mathrm{I}$$

$$S_i^o = \ln G_i^o \qquad \forall \ \mathrm{i} \in \mathrm{I}$$

And the trip generation model will be specified as follows:

$$G_i^o = \alpha_i S_i^o + E_i^0 \qquad \forall \mathrm{i} \in \mathrm{I} \quad G_i^o = \alpha_i Ln(G_i^o) + 0.40 G_i^0 \qquad \forall \mathrm{i} \in \mathrm{I}$$

Now we can estimate $\alpha_i \ \forall \mathrm{i} \in \mathrm{I}$ from the observed trip generation as follows:

$$\alpha_i = \frac{0.6 G_i^o}{Ln(G_i^o)} \ \forall i \in I$$

We then estimated the parameters $\theta_i^r = \theta^r$ for all origins of commodity r by solving the IFSTEM-Oman Model for different values for θ^r until we obtain the values θ^r that satisfy the following condition:

$$\frac{\sum_{i \in I} G_i^o}{\sum_{i \in I} G_i^p} \approx 1.60$$

For each commodity

Where G_i^p is the predicted trip generation for origin i for year 2012. This value of θ^r will keep the effect of transport and logistics system (supply), as measured by the delivery cost u_{ij}, on the predicted trip generated from origin i to be 60% on average less than the observed trip generation.

This is consistent with the earlier assumption that 40% of trip generation is influenced by socioeconomic factors, which implies that 60% is influenced by transport and logistics cost factors.

3.2 IFSTEM-Oman Model Supply Side Assumptions

The supply side of IFSTEM-Oman Model is represented by a set of link cost functions for different modes and operations. We assumed the following link cost function

$$C_a(F_a) = (c + vt)F_a$$

Where

F_a = number of tons on link a.
$C_a(F_a)$ = Cost of F_a tons in USD
c = cost per ton in USD
t = time in days
v = the value of time per ton per day

Based on interviews with freight forwarders, we estimated the values of time (see Duan et al. [42]) to be as follows:

For exports 3.5 USD/Tone/Day, for imports 5 USD/Tone/Day, and for Re-exports 7.5 USD/Tone/Day

3.3 Input Data for IFSTEM-Oman Model and Application Assumptions

3.3.1 Major seaports and land border points

According to the available statistics for imports, exports and re-exports for Oman during the base year of 2012, the international trade volumes (available for imports, exports and re-exports) at three major seaports and two major land border points represented around 74% of the total weight in tons of Omani exports, imports and re-exports and around 90% of the total value of these observed international trade statistics for Oman. Hence, in this application we considered these major five points of entry/exit of international trade to/from Oman. These are three major seaports, namely Mina Sultan Qaboos (at Muscat), Mina Sohar and Mina Salalah (see Fig. 3 and two major land border points, namely Al Wajajah and Wadi Jizzi. From these five points we selected the five commodities of the highest volumes of trade with Oman.

3.3.2 Observed international trade data for 2012

We obtained the following Import, Export and Re-Export Data for 2012 from the Omani National Centre for Statistics:

1- Commodity H.S Code (4 Digits)
2- Commodity Type
3- Point of Entry
4- Country of Export
5- Observed Flows (in Kilogram and in Value of Omani Rial (OR))

Fig. 3. Oman major seaports

3.3.3 Estimated documents, times and costs for international trade for 2012

We obtained the following estimates of documents, times and costs of a typical 20-ft container for exports and imports, from the World Bank (WB) Report 2013 on Trading Across Borders (i.e., estimates for the year 2012) for Oman and UAE:

1- Documents to Export (number)
2- Time to Export (days)
3- Cost to Export (USD per 20-ft container)
4- Documents to Import (number)
5- Time to Import (days)
6- Cost to Import (USD per 20-ft container)

We then assumed that the estimates for re-exports of Documents, Times, and Costs are the same as those estimated for Exports according to the WB report indicated above (see Tables A1-1 and A1-2 in Appendix 1). We estimated the Import, Export and Re-Export Times and Costs for Inland Transport and Handling inside Oman and between Oman and the neighboring land connected Arab countries, based on the WB Trading Across Borders Report 2013 (see Tables A1-3 and A1-4 in Appendix 1).

3.3.4 Estimated international maritime transport times and costs for 2012

We obtained estimates for the International Maritime Transport Times (in days) and Costs (in USD per 20-ft container) for 2012 for Mina Sultan Qaboos from an International Freight Forwarder in Oman. We then assumed that these estimates are the same for Mina Sohar and Mina Salalah simply for lack of data and / or reliable estimates (see TableA1-5 in Appendix 1).

We further assumed that the commodities that go through the land border points Wadi Jizzi or Al Wajajah and not exported or imported from/to UAE, Saudi Arabia, Qatar, Bahrain, Kuwait, Jordan, Syria, and Iraq, will exit/enter from/to Jabil Ali Port in the UAE and their International Maritime Transport Times and Costs to/from other countries worldwide, from/to Jebel Ali Port are 20% less than the estimated values from/to Mina Sultan Qaboos.

All other commodities that go through the land border points Wadi Jizzi or Al Wajajah and exported or imported from/to UAE, Saudi Arabia, Qatar, Bahrain, Kuwait, Jordan, Syria, and Iraq are assumed to use only land transportation.

3.3.5 Other application assumptions

Mainly because of lack of appropriate detailed data and actual estimates from the field, we have invoked the previous assumptions and approximate estimates as well as the following general assumptions:

1- All 20-ft containers carry10 tons per TEU (10000 KG), as assumed by WB reports.
2- All Points of Entry/Exit in Oman have the same procedures, costs, and times
3- All Commodities have the same procedures, costs, and times at any Entry/Exit point.
4- Transit and Transhipment trade for Oman are excluded (for lack of data).

3.3.6 Alternative enhancement scenarios

To achieve the main objectives, our focus has been on undertaking effective and efficient actions with particular focus on significantly improving procedures, times and costs of international trade processes and transactions across Omani ports. In view of the above and the estimates of documents, times and costs for Oman imports and exports as indicated in the WB Trading Across Borders country report 2013, we proposed the first two scenarios 1 and 2 involving reductions in number of documents and their associated costs as well as port terminal handing times, as indicated in paragraph 5 below.

Considering that an important objective of enhancing Omani ports is to attract major shipping lines to Omani ports. This would contribute significantly to reducing international maritime transport times and costs, and consequently total international trade trip times and costs per ton. The total volumes of international trade with Oman would be expected to increase significantly as well. Hence, we proposed scenarios 3 and 4 that involve reducing international maritime transport times and costs by 20% and 40% respectively. Scenarios 3 and 4 are also inclusive of scenarios 1 and 2, as indicated in paragraph 5 below.

Based on the estimated GDP growth rate for 2013 (which was approximately 4%) we assumed that the average annual growth rate for prediction purposes in our analysis is 4% annually during the analysis period from 2012 through 2040.

For each scenario we predicted the expected increase in international trade flows of imports, exports and re-exports (in tons), the expected decrease in average total trip time (in days) and the expected decrease in total cost per ton (in USD). The predictions are estimated for the years following the completion of implementation of the alternative enhancement scenarios until the target year of 2040.

Based on the above mentioned assumptions, the description of the five scenarios considered in the analysis are as follows:

- **Scenario 0 (2012-2040)**

The reference scenario "do nothing" and its prediction to the target year 2040

- **Scenario 1 (2015-2040)**

Reduce No. of Documents from 8 to 4 as of the year 2015

- **Scenario 2 (2016-2040)**

Scenario 1 plus Reduce Ports &Terminal Handling Time from 3 days for export and 2 days for import to 1 day for each as of the year 2016

- **Scenario 3 (2017-2040)**

Scenario 1&2 plus Reduce International Maritime Transport Times and Costs for Oman by 20% as of the year 2017

- **Scenario 4 (2018-2040)**

Scenario 1&2 plus Reduce International Maritime Transport Times and Costs for Oman by 40% as of year 2018

4. PREDICTED INTERNATIONAL TRADE FLOWS, TIMES AND COSTS: APPLICATION RESULTS AND ANALYSIS

In this section we summarize and analyze the results of the predicted international trade flows, times and costs of imports, exports and re-exports for Oman for all five alternative scenarios (i.e., the reference scenario (scenario 0) and the four alternative enhancement scenarios 1, 2, 3 and 4). The Appendix includes Tables A2-1, A2-2 and A2-3 that show the results of the IFSTEM-Oman Model predictions. The following paragraphs summarize the analysis of these international trade flows, times and costs results for Oman from the base year of 2012 through the target year of 2040.

4.1 The IFSTEM-Oman Model Application

Based on the assumptions invoked in section 3 above, the IFSTEM-Oman Model was first used to replicate the current situation (i.e., the reference scenario (0) for base year 2012). The IFSTEM-Oman Model was applied to the 5 entry/exit points of Oman (i.e., 3 seaports and 2 land border points as indicated in section 3) using the 5 highest volume commodities crossing these points (see Table A1-6 in Appendix 1). The observed international trade flows of imports, exports and re-exports for the selected 5 commodities at these 5 entry/exit points was 811,881 tons.

The Import, Export and Re-Export Data for 2012 obtained from the Omani National Center for Statistics showed that there are 1128 commodities at the five points of entry/exit used in the analysis. The observed flows (volumes) for these 1128 commodities in 2012 were 27,338,746 tons and for all commodities crossing all points of entry or exit in Oman were 37,112,001 tons.

We then expanded the results of the IFSTEM-Oman Model to all exports, imports, and re-exports for Oman by multiplying the model results by the following expansion factor

$$\frac{37,112,001}{811,881} = 45.71113.$$

This simple expansion factor is reasonable and consistent in this particular application of the model since the procedures, times and costs across commodities and entry/exit points in Oman were assumed to be equal. If and when the estimated and collected input data would involve variations among commodities and entry/exit points in Oman, the IFSTEM-Oman Model can then be easily applied to all commodities and all entry/exit points without the need to use an expansion factor.

4.2 Growth Rates of Future International Trade Flows

Based on the assumed average annual growth rate of 4%, the predicted international trade flows for any future year 2012+t up to the target year 2040 are computed as follows:

Predicted International Trade Flows for any future year 2012+t = (Observed or Estimated International Trade Flows for year 2012) x $(1.04)^t$

For IFSTEM-Oman Model application, the annual growth rate for the socio-economic variables E_i and A_{ij} are computed as follows:

E_i For year 2012+t = (E_i for year 2012) x $(1.04)^t$

A_{ij} For year 2012+t = (A_{ij} for year 2012) x $(1.04)^t$

For example, the prediction for 2040 will use

E_i For year 2040= (E_i for year 2012) x $(1.04)^{28}$

A_{ij} For year 2040= (A_{ij} for year 2012) x $(1.04)^{28}$

4.3 Predicted International Trade Flows for Oman (2012-2040)

Table A2-1 in the Appendix 2 shows the results of the predicted international trade flows for all exports, imports, and re-exports for Oman for the reference scenario and the proposed four enhancement scenarios indicated in section 4 above, for all the years of the analysis period from 2012 through 2040. As indicated in Table A2-1 Scenario 1 is assumed to be implemented in 2015, Scenario 2 in 2016, Scenario 3 in 2017, and Scenario 4 in 2018.

Below are Figs. 2, 3 and 4 that show the predicted international trade flow results of Table A2-1 in graphic formats easy to visualize and analyze. The prediction results of the IFSTEM-Oman Model as depicted in Table A2-1 and Figs. 2, 3 and 4 are essentially logical, internally consistent and reasonable. These predictions are satisfactory for the purposes of analysis in this paper, given the limited input data and estimates for this application. As indicated above, if and when more detailed data and estimates become available, the model is flexible, and appropriate to produce more detailed and refined results accordingly.

In all cases, various international researchers and practitioners including the Authors have already established that the IFSTEM simultaneous transportation equilibrium models, such as the model

adopted in this Paper, are able to produce better results than other commonly used models and analysis techniques worldwide such as trend analysis and the sequential traditional transport planning models when applied to similar situation of input data and estimates. This is due to various distinctive features of the simultaneous IFSTEM model mainly its ability to predict increases in total international trade flows within the model, and its internal consistency of predictions of flows and costs, unlike the sequential models. The references cited in the second progress report of the Paper clearly demonstrated these distinctive advantages of IFSTEM.

Fig. 4 shows the predicted high trends and rates of increase of international trade flows during the analysis period for the 4 alternative enhancement scenarios compared to the reference scenario. The graph clearly shows a significant increase of all 4 enhancement scenarios compared to the reference scenario. Comparing among the 4 alternative enhancement scenarios, as expected, scenarios 3 and 4 exhibit relatively the highest increases in absolute value and in terms of the rate of increase of international trade flows compared to scenarios 1 and 2. Comparing between scenarios 1 and 2 we can see that as expected the relative improvement of scenario 2 over scenario 1 is minimal.

Fig. 5 shows the percent increase of international trade flows for the various enhancement scenarios compared with the reference scenario as of 2012 (for example for scenario 1, the percent increase $= \frac{(162,012,098-37,112,001)}{37112001} + 1 = 437\%$) as well as its predictions at the target year of 2040, the percent increase $= \frac{(162,012,098-110,532,300)}{110,532,300} + 1 = 147\%$. Fig. 6 shows the absolute values of international trade flows at 2020, 2030 and 2040 for all 4 enhancement scenarios as well as the reference scenario. These figures show that the expected predictions of international trade for scenario 4 at 2040 would reach around 187 million tons compared with the current volume of around 37 million tons, i.e., scenario 4 would reach around 504% higher compared to the current flows in 2012. The difference would be around 70% higher for scenario 4 compared to the predicted flows by 2040 if we do nothing until that time (i.e., around 110 Million tons).

It is worth noting that scenario 4 implies that international maritime transport times and costs to Omani ports would be 20% less compared to that for Jebel Ali Port. Hence, for this scenario 4 to be realized it would need extensive improvements and enhancements of competitiveness and integration of Omani ports relative to UAE ports. Of course, in reality, UAE as well as world ports are constantly improving and enhancing.

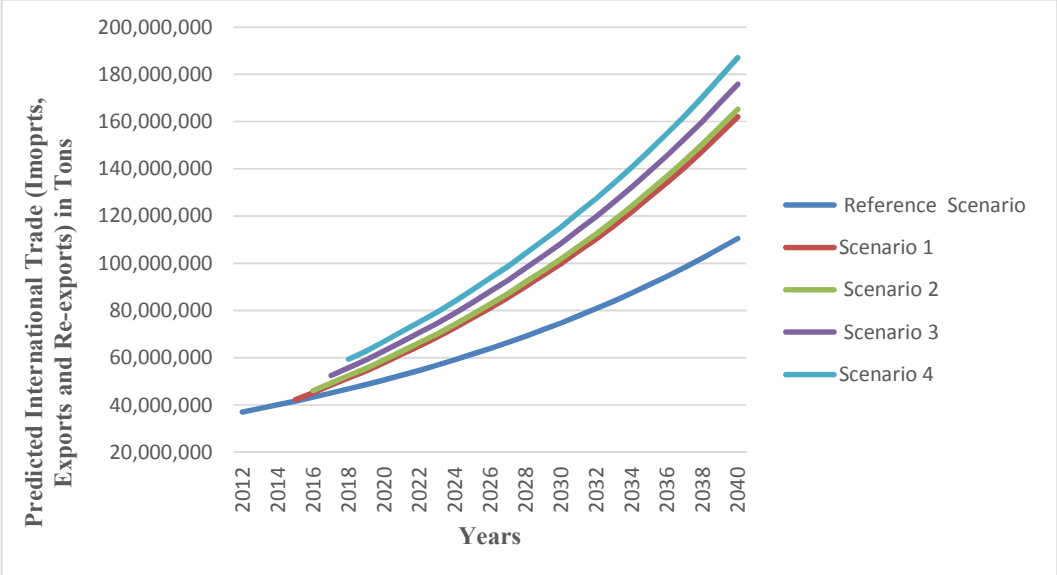


Fig. 4. Predicted international trade (imports, exports and re-exports) in tons for reference scenario and 4 enhancement scenarios for 2012-2040

4.4 Predicted Total Cost per Ton of International Trade Flows

Table A2-2 in the Appendix 2 and Figs. 7 and 8 show the comparison among the reference scenario and the four proposed enhancement scenarios 1, 2, 3 and 4 with respect to the total cost per ton in USD. The figures show that the total cost per ton, decreased from an estimated 254 USD per ton for the reference scenario to around a predicted 202 USD per ton for scenario 4. That is the cost per ton is expected to be decreased by more than 20% for enhancement scenario 4 compared to the reference scenario (0). This should reflect significant savings to the Omani economy.

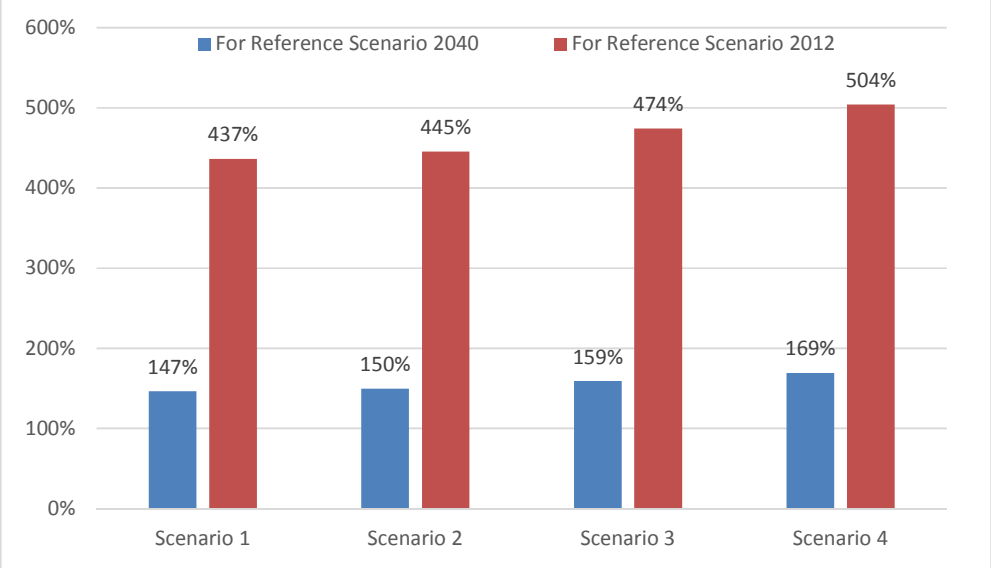


Figure 5. Predicted percent increase of international trade (imports, exports and re-exports) by 2040 for 4 enhancement scenarios compared with the reference scenario for 2012 and 2040

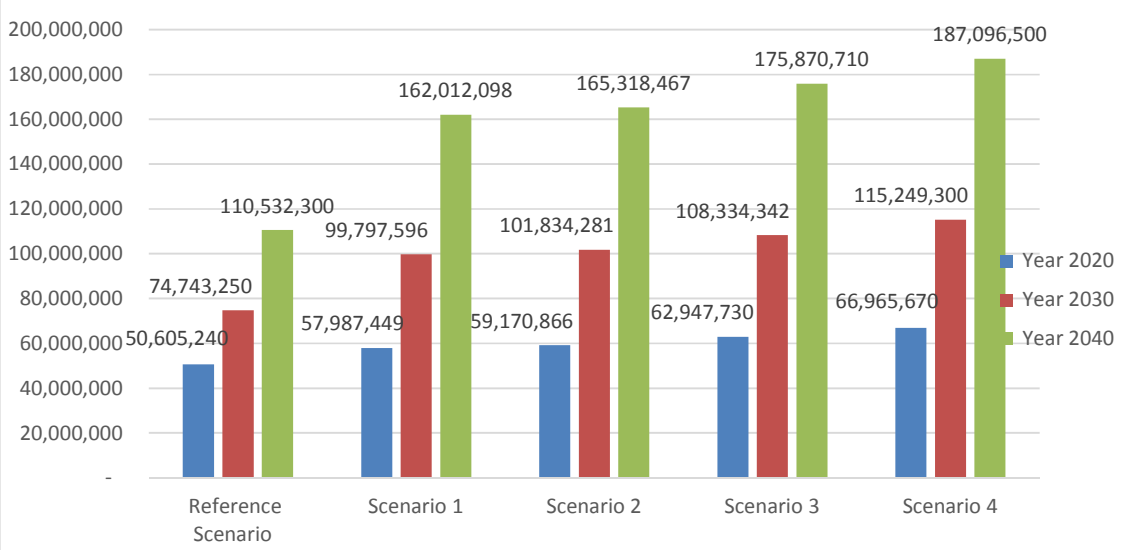


Fig. 6. Comparison of predicted international trade (imports, exports and re-exports) in tons between reference scenario and 4 proposed scenarios for years 2020, 2030, and 2040

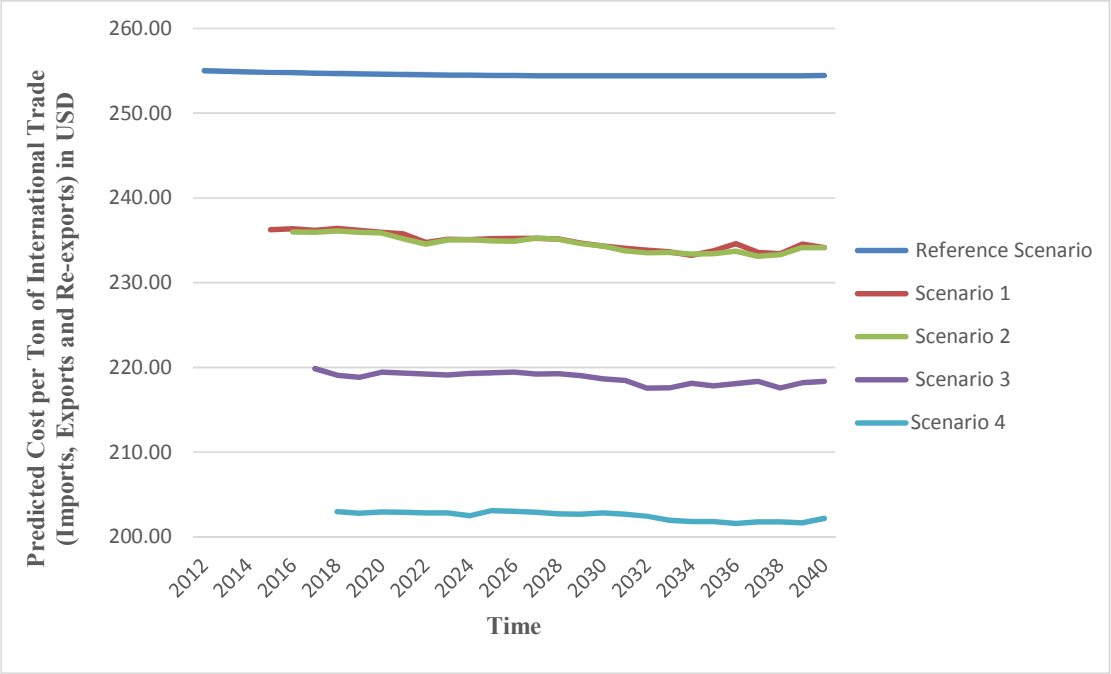


Fig. 7. Predicted total cost per ton of international trade (imports, exports and re-exports) in USD for reference scenario and 4 scenarios for 2012-2040

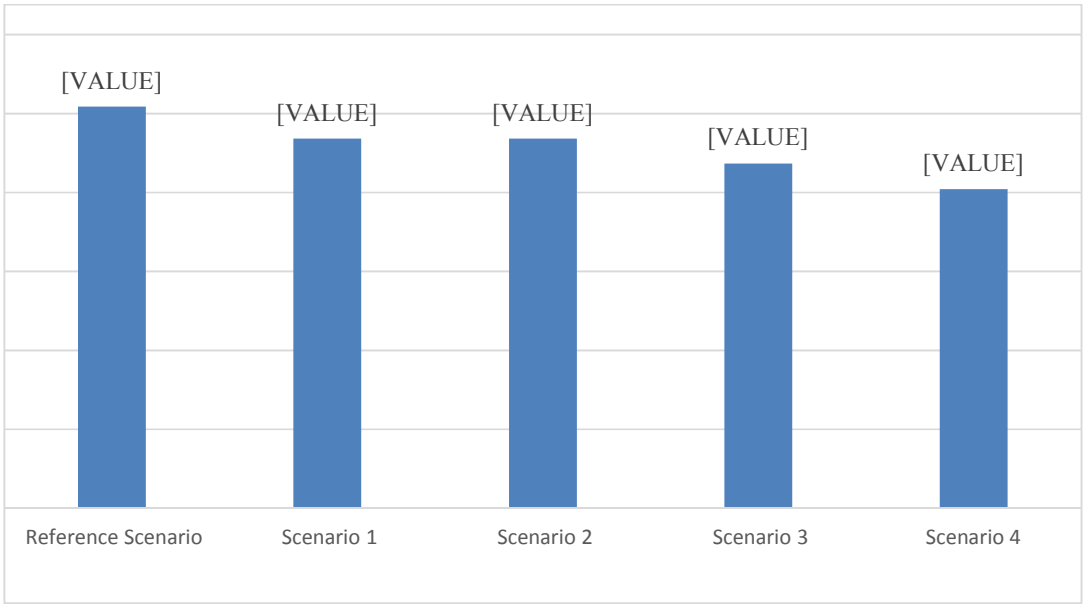


Fig. 8. Comparison of predicted total cost per ton in USD for international trade (imports, exports and re-exports) between the reference scenario and the 4 proposed scenarios for year 2040

4.5 Predicted Average Total Trip Time of International Trade Flows (in Days)

Table A2-3 in the Appendix 2 and Figs. 9 and 10 depicted below show the comparison among the reference scenario and the four proposed enhancement scenarios with respect to the average Total

Trip Time (in days) over the analysis period 2012-2040. The figures clearly indicate a reduction of this average trip time from 42 days for the reference scenario to 32 days for scenario 4. That is around 25% decrease of average total trip time. Again this should result in significant savings in trip time for international trade for Oman and hence significant benefits to the Omani economy.

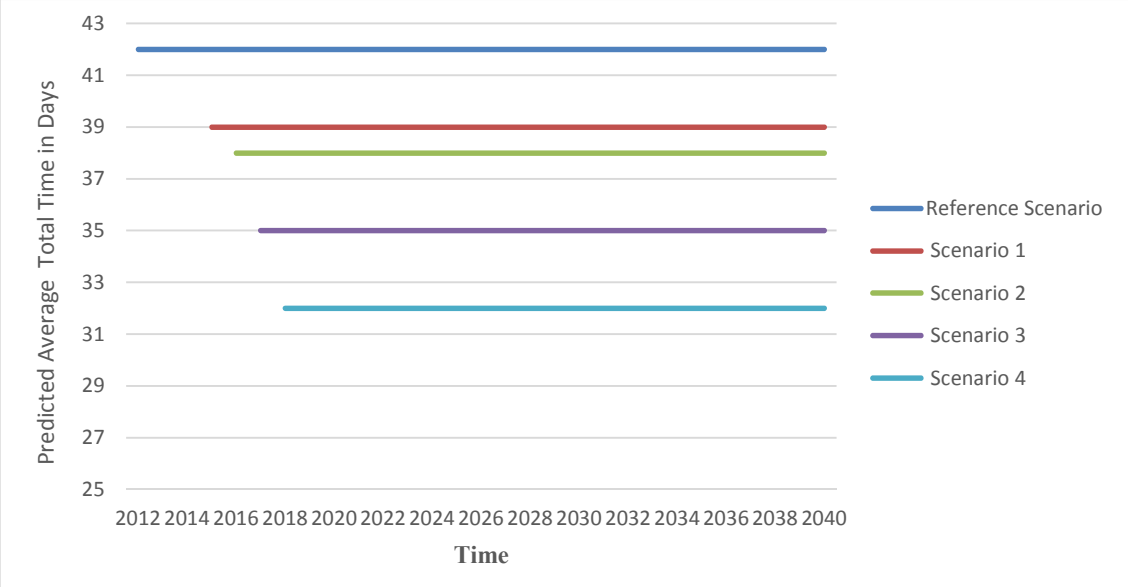


Fig. 9. Predicted average total time in days of international trade (imports, exports and re-exports) for reference scenario and 4 enhancement scenarios for 2012-2040

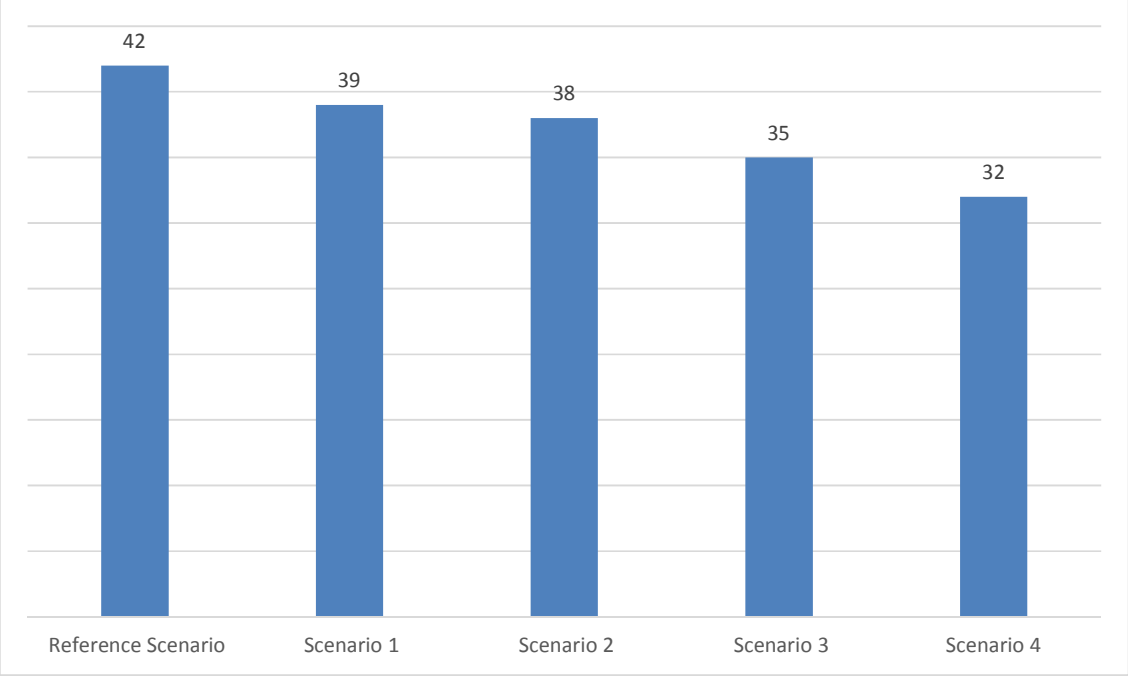


Fig. 10. Comparison of average total time in days for international trade (imports, exports and re-exports) between the reference scenario and the 4 proposed enhancement scenarios for year 2040

5. CONCLUSIONS

- The proposed alternative enhancement scenarios were 4 nested scenarios, i.e., each scenario included the previous one plus an additional enhancement. Scenario 1 involved reducing the number of documents from 8 to 4, and scenario 2 involved scenarios 1 plus reducing the time for port and terminal handling to 1 day (instead of 2 days for imports and 3 days for exports as estimated for 2012 by the World Bank trading across borders report 2013). Scenario 3 involved scenarios 1 and 2 plus reducing the international maritime transport times and costs by 20% (i.e., to become equal to that of the UAE according to the application assumptions), and scenario 4 involved scenarios 1 and 2 plus reducing the international maritime transport times and costs by 40% (i.e., to become 20% less than that of UAE according to the application assumptions). These 4 enhancement scenarios were analysed against and compared with scenario (0), i.e., the reference "Do nothing" scenario.

- The analysis has been achieved in two stages. The first stage involved the prediction of international trade flows (imports, exports and re-exports), times and costs that would result from the application of the 4 alternative enhancement scenarios during the analysis period through the target year of 2040. The second stage involved the assessment of the financial and economic feasibility of the implementation of the 4 alternative enhancement scenarios based on the predictions of stage one and assessment methodology of stage two. The prediction and assessment results were analysed against the reference scenario.

- The predictions were obtained using an advanced International Freight Simultaneous Transport Equilibrium Model adapted for Oman, i.e., IFSTEM-Oman Model. This IFSTEM-Oman Model belongs to the class of the distinguished simultaneous transport planning equilibrium models. The simultaneous planning models were developed over the past 50 years to overcome a few inherent deficiencies of the well-known traditional sequential transport planning models widely used until today by the majority of consultants and authorities worldwide.

- Several recognized international researchers and practitioners over the previous few decades, including the Authors of this Paper, have established that the simultaneous equilibrium models consistently produce better predictions (i.e., internally consistent) compared to the sequential transport planning models. This is of course true when both models are compared under similar situations of input data availability and / or limitations.

- The main advantages of the IFSTEM-Oman Model utilised in this Paper are that it can predict the expected increase in the total international trade flows within the model in a simultaneous manner replicating the decision making process of the exporter and the importer, unlike the sequential modelling process that does not properly replicate the decision making process of the importer and the exporter and cannot predict the total international trade flows internally within the modelling process. Hence the IFSTEM-Oman Model predictions of international trade flows, times and costs are relatively more accurate and are internally consistent, unlike the sequential models.

- The prediction results revealed that the estimated international trade flows (imports, exports and re-exports) for Oman for scenarios 4 would increase by more than 504% by 2040 (i.e., around 187 million tons) compared to the present situation of the base year 2012 (i.e., around 37 million tons). This increase would represent around 70% compared to the "do nothing" reference scenario by the year 2040 (i.e., around 110 million tons) assuming that the average increase of international trade flows in the "do nothing" case would be around 4% annually during the analysis period from 2012 to 2040. The predictions of average total trip time and total cost per ton revealed an estimated decrease for scenario 4 compared to the reference scenario by around 25% and 20% respectively. These results are internally consistent and represented reasonably significant improvements compared to the "Do nothing" reference scenario.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Appendix 1

Input Data for IFSTEM-Oman Model

Table A1-1. Estimates of Documents, Times and Costs of a Typical 20-Ft Container for Exports and Imports, From the World Bank (WB) Report 2013 for Oman

Oman				
Indicator	**Export and Re-Export**	**Import**		
Number of Documents	8	8		
Time (days)	10	9		
Cost (US$ per container 20-foot)	745	680		
	Export and Re-Export		**Import**	
Procedures	**Time (days)**	**Cost (US$)**	**Time (days)**	**Cost (US$)**
Documents preparation	5	285	5	250
Customs clearance and technical control	1	65	1	65
Ports and terminal handling	3	135	2	105
Inland transportation and handling	1	260	1	260
Totals	10	745	9	680

Documents to export	**Documents to import**
Bill of lading	Bill of lading
Certificate of Origin	Cargo release order
Commercial invoice	Certificate of origin
Customs export declaration	Commercial invoice
Packing List	Customs import declaration
Shipping note (pre-advice form)	Packing list
Technical standard certificate	Technical standard certificate
Terminal handling receipts	Terminal handling receipts

Table A1-2. Estimates of Documents, Times and Costs of a Typical 20-Ft Container for Exports and Imports, From the World Bank (WB) Report 2013 for United Arab Emirates

United Arab Emirates				
Indicator	**Export and Re-Export**	**Import**		
Number of Documents	4	5		
Time (days)	7	7		
Cost (US$ per container 20-foot)	630	590		
	Export and Re-Export		**Import**	
Procedures	**Time (days)**	**Cost (US$)**	**Time (days)**	**Cost (US$)**
Documents preparation	4	215	4	175
Customs clearance and technical control	1	30	1	30
Ports and terminal handling	1	180	1	180
Inland transportation and handling	1	205	1	205
Totals	7	630	7	590
Documents to export	Documents to import			
Bill of Lading	Bill of Lading			
Certificate of Origin	Certificate of Origin			
Commercial invoice	Commercial invoice			
Customs export declaration	Customs import declaration			
	Packing list			

Table A1-3. Land Transport and Handling Time (Days) and Cost (US$/TEU) from the Muscat to the 5 Points of Entries/Exits

Oman	Point of Entry	Import		Export		Re-Export	
		Time	Cost	Time	Cost	Time	Cost
	Salalah	2	320	2	320	2	320
	S Qaboos	1	200	1	200	1	200
	Sohar	1	250	1	250	1	250
	wajaja	1	270	1	270	1	270
	Wadi Jizzi	1	270	1	270	1	270

Table A1-4. Land Transport and Handling Time (Days) and Cost (US$/TEU) from wajaja or Wadi Jizzi To Entries/Exits land border to given Arab Countries

	Import		Export		Re-Export	
	Time	Cost	Time	Cost	Time	Cost
UAE	2	235	2	235	2	235
SAU	4	835	4	835	4	835
Qatar	4	835	4	835	4	835
Bahrain	4	835	4	835	4	835
Kuwait	4	835	4	835	4	835
Jordan	5	835	5	835	5	835
Syria	7	1335	7	1335	7	1335
Iraq	5	835	5	835	5	835
Yemen	2	320	320	320	2	320

Table A1-5. A sample of 20 out of 140 Countries for International Maritime Transport Times (in days) and Costs (in USD per 20-ft container) for 2012 for Mina Sultan Qaboos

No.	Country	Import Time	Export Time	Import Cost	Export Cost
1	Afghanistan	12	16	800	1200
2	Albania	32	30	1400	1100
3	Algeria	28	30	1600	1400
4	Angola	30	32	1700	1600
5	Argentina	35	40	2100	1900
6	Australia	40	45	1800	1900
7	Austria	35	40	2000	1800
8	Azerbaijan	28	30	1200	1400
9	Bahamas	24	26	1100	1300
10	Bahrain	14	16	600	800
11	Bangladesh	16	18	800	900
12	Belarus	24	28	900	1100
13	Belgium	26	30	1250	1350
14	Benin	35	40	2000	1800
15	Bosnia Herzegovina	40	45	1800	1900
16	Botswana	30	35	1100	1200
17	Brazil	55	60	2200	2400
18	Bulgaria	50	55	2100	2300
19	Burundi	50	55	2100	2300
20	Cambodia	55	60	2200	2400

Table A1-6. The five highest volume commodities crossing the five entry/exit points

HS_4DG	HS_4DG Description
207	Meat and edible offal, of the poultry of heading 01.05, fresh, chilled or frozen.
1511	Palm oil and its fractions, whether or not refined, but not chemically modified.
7304	Tubes, pipes and hollow profiles, seamless, of iron (other than cast iron) or steel.
7308	Structures (excluding prefabricated buildings of heading 94.06) and parts of structures (for example, bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing frame-works, doors and windows and their frames and thresholds for doors,
8415	Air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity can't be separately regulated.

Appendix 2

Prediction Results for IFSTEM-Oman Model

Table A2-1. Predicted International Trade (Imports, Exports and Re-exports) in Tons for Reference Scenario and 4 Scenarios for 2012-2040

Year	The international Trade in Tons for Reference Scenario	The international Trade in Tons for Scenario 1	The international Trade in Tons for Scenario 2	The international Trade in Tons for Scenario 3	The international Trade in Tons for Scenario 4
2012	37,112,001				
2013	38,573,610				
2014	40,094,540				
2015	41,677,192	42,306,557			
2016	43,324,030	45,204,958	46,127,508		
2017	45,037,530	48,362,077	49,349,058	52,498,998	
2018	46,820,380	51,407,063	52,456,186	55,804,454	59,366,440
2019	48,675,320	54,432,832	55,543,706	59,089,049	62,860,690
2020	**50,605,240**	**57,987,449**	**59,170,866**	**62,947,730**	**66,965,670**
2021	52,613,080	61,440,042	62,693,921	66,695,660	70,952,830
2022	54,701,890	65,041,367	66,368,742	70,605,045	75,111,750
2023	56,874,960	68,689,661	70,091,490	74,565,415	79,324,910
2024	59,135,620	72,661,872	74,144,767	78,877,412	83,912,140
2025	61,487,290	76,789,335	78,356,464	83,357,940	88,678,660
2026	63,933,620	81,089,265	82,744,148	88,025,689	93,644,350
2027	66,478,420	85,480,412	87,224,910	92,792,457	98,715,380
2028	69,125,580	90,144,317	91,983,997	97,855,316	104,101,400
2029	71,879,110	94,911,251	96,848,215	103,030,016	109,606,400
2030	74,743,250	99,797,596	101,834,281	108,334,342	115,249,300
2031	77,722,500	105,069,972	107,214,257	114,057,720	121,338,000
2032	80,821,330	110,254,975	112,505,077	119,686,252	127,325,800
2033	84,044,570	115,941,351	118,307,501	125,859,044	133,892,600
2034	87,397,110	121,806,282	124,292,124	132,225,664	140,665,600
2035	90,884,150	127,908,563	130,518,942	138,849,938	147,712,700
2036	94,511,100	134,114,496	136,851,526	145,586,730	154,879,500
2037	98,283,430	140,691,046	143,562,291	152,725,842	162,474,300
2038	102,207,100	147,425,281	150,433,960	160,036,128	170,251,200
2039	106,287,900	154,697,604	157,854,698	167,930,530	178,649,500
2040	110,532,300	162,012,098	165,318,467	175,870,710	187,096,500

Table A2-2. Predicted cost per ton of international trade (imports, exports and re-exports) in USD for reference scenario and 4 scenarios for 2012-2040

Year	Total Cost per Ton (USD) for Reference Scenario	Total Cost per Ton (USD) for Scenario 1	Total Cost per Ton (USD) for Scenario 2	Total Cost per Ton (USD) for Scenario 3	Total Cost per Ton (USD) for Scenario 4
2012	255.02				
2013	254.95				
2014	254.88				
2015	254.82	236.23			
2016	254.76	236.36	235.987		
2017	254.71	236.17	235.9573	219.859	
2018	254.66	236.39	236.096	219.0882	202.9488
2019	254.62	236.18	235.9646	218.8203	202.7789
2020	254.59	235.98	235.8499	219.4151	202.9237
2021	254.56	235.74	235.1868	219.3325	202.8828
2022	254.53	234.75	234.5462	219.2228	202.8038
2023	254.50	235.10	235.0502	219.1215	202.8226
2024	254.48	235.08	235.0682	219.2917	202.4824
2025	254.47	235.17	234.9347	219.3556	203.1174
2026	254.45	235.23	234.9049	219.4358	202.9796
2027	254.44	235.23	235.2696	219.2267	202.9078
2028	254.43	235.16	235.0936	219.2464	202.6981
2029	254.42	234.68	234.6168	219.034	202.6909
2030	254.42	234.33	234.3177	218.6331	202.8236
2031	254.41	234.08	233.7588	218.4723	202.6829
2032	254.41	233.82	233.5228	217.5586	202.4453
2033	254.41	233.65	233.5644	217.5911	201.9525
2034	254.41	233.22	233.3596	218.1222	201.8384
2035	254.41	233.77	233.4182	217.8148	201.8288
2036	254.42	234.63	233.728	218.0744	201.5846
2037	254.42	233.58	233.114	218.3752	201.7465
2038	254.43	233.42	233.2973	217.5719	201.7378
2039	254.43	234.53	234.1501	218.197	201.6447
2040	254.44	234.17	234.1394	218.3735	202.1851

Table A2-3. Predicted average total time in days of international trade (imports, exports and re-exports) for reference scenario and 4 scenarios for 2012-2040

Year	Average Times in Days for Reference Scenario	Average Times in Days for Scenario 1	Average Times in Days for Scenario 2	Average Times in Days for Scenario 3	Average Times in Days for Scenario 4
2012	42				
2013	42				
2014	42				
2015	42	39			
2016	42	39	38		
2017	42	39	38	35	
2018	42	39	38	35	32
2019	42	39	38	35	32
2020	42	39	38	35	32
2021	42	39	38	35	32
2022	42	39	38	35	32
2023	42	39	38	35	32
2024	42	39	38	35	32
2025	42	39	38	35	32

Year	Average Times in Days for Reference Scenario	Average Times in Days for Scenario 1	Average Times in Days for Scenario 2	Average Times in Days for Scenario 3	Average Times in Days for Scenario 4
2026	42	39	38	35	32
2027	42	39	38	35	32
2028	42	39	38	35	32
2029	42	39	38	35	32
2030	42	39	38	35	32
2031	42	39	38	35	32
2032	42	39	38	35	32
2033	42	39	38	35	32
2034	42	39	38	35	32
2035	42	39	38	35	32
2036	42	39	38	35	32
2037	42	39	38	35	32
2038	42	39	38	35	32
2039	42	39	38	35	32
2040	42	39	38	35	32

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Study on External Reserves Management and Economic Growth in Nigeria (1985-2013)

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ABSTRACT

This study examined the relationship between external reserves management and Nigeria's economic growth over the period 1985 to 2013. The model was specified using external reserves as the dependent variable while gross domestic product, exchange rate, monetary policy rate, foreign direct investment and inflation are the explanatory variables. Secondary data were sourced from Central Bank of Nigeria and estimated using Augmented Dickey-Fuller test, Johansen co-integration test and multiple regression. The study revealed that there is a significant long-run relationship between external reserves and the Nigeria's economy growth. It was further showed that explanatory variables explained and accounted for 90% variations in the dependent variable which is evidence of a good fit of the model. Also, the multiple regression results showed that GDP, MPR and FDI are highly statistically significant while IFR and EXR are statistically insignificant. This implies that FDI, MPR and GDP contributes immensely to the external reserves position in Nigeria and it is statistically significant at 5% level which also implies that a good performance of the economy is a positive signal for the inflow of foreign direct investment which impacts the reserves position of the economy. The study recommended that, good policy that would create a good relationship with foreign investors should be implemented and idle reserves should be invested domestically for production of competitive exportable goods for more foreign currencies earning into the country.

Keywords: External reserves; economic growth; foreign direct investment; exchange rate.

1. INTRODUCTION

No country allows its currency to float in the foreign exchange market without adequate intervention. The concept of exchange market pressure was first proposed by Girton and Roper in 1977 [1]. The monetary authorities attempt to influence the countries' exchange rates by buying and selling currencies to manage the country exchange rate. The reason being that the currency rates impact any given country's economy through the trade balance (capital and current transaction account) and this automatically determined the value and quantity of exchange reserves holdings of a country. From this perspective, almost all currencies are managed since central banks or governments intervene to influence the value of their currencies. According to the [2], 82 countries and regions used a managed float, or 43% of all countries, constituting a plurality amongst exchange rate regime.

In view of the above, management of external reserve stands as one of the integral core functions of Central Bank of any nation including Nigeria. It involves maintaining an adequate volume of the reserve to safeguard the value and exchange rate of the domestic currency. Adequate holdings of external reserves which are mostly denominated in foreign currencies such as Dollar, Pounds, Yen, Euro, Gold, Precious Stones, Foreign Treasury Bills, IMF funds, SDR rights etc are very important to a country. It assists the country to withstand shock that might set in unknowingly or as a cushion effect when an economy is faced with pressing economic problems, intervention when the exchange rate is volatile or to boost country creditworthiness when access to the international market is difficult

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or impossible. Furthermore, it provides a fall back for the rainy day when a nation experience drops in revenue and would need to fall back on their savings as a lifeline and timely meeting of international payment obligations. This is because payment of international trade between countries are done by the use of foreign currencies, therefore, it is mandatory for a country to ensure that adequate foreign reserve is always available [3].

Historically, Nigeria has introduced different exchange reserve management since independence. [4] emphasized that Adhoc administrative measure were applied between 1959 and 1967 when the country exchange rate was maintained in parity with pound sterling until the actualization of sterling by 10% in 1967. Following the change of the Nigeria pounds to Naira in 1973, fixed exchange rates were established for both the Pounds Sterling and the US dollar. To support this, [5] Argued that, world money market forced many countries to change their exchange rate policies in the 1970s due to an unprecedented change that occurred in the international financial system at such time, intransigent high rates of both inflation and unemployment compounded by low productivity and instability. [6]) regard the “move towards greater flexibility of the exchange rates of the main currencies” as an immediate priority and [7] argued that “more market-driven developments could also help to change the incentives for policy-makers” [8].

Also, in 1985, it was agreed that one currency intervention should be adopted where Naira exchange rate was quoted against the US dollar and this made Naira to progressively depreciate from $1 to N1.85 in 1986 when SAP was introduced. To date, Nigeria has adopted the following strategies in managing its exchange reserve which include First Tier Official Exchange Rate (FOER), Second Tier Foreign Exchange Rate (SFEM), Dutch Auction System (DAS), Dual Exchange Rate Policy, Autonomous Exchange Rate Market, Inter-Bank Foreign Exchange Market. However, despite all these, little were achieved by the monetary authority in stabilizing the exchange rate because the structure in place could not support efficient reserves management.

From the nation’s experience, it shows that, the inability of the monetary authorities to proffer a well-structured strategy in managing the country external reserves have posed lots of imbalances on the macroeconomic variables and economic instabilities in the country. Examples of such instabilities include expensive and unstable exchange rates, high rate of inflation, inadequate foreign direct investment, the low growth rate in gross domestic products, low productivity, high rate of unemployment etc.

It can be seen that Nigeria's external reserves have been fluctuating over the years. The stock of external reserves which was US$ 9.91billion in 2000 rose by 5.09% in 2001 and later dropped to US$7.47 billion at the end of December 2003 but increased by 127.00% to US$16.96 billion in 2004. In 2005 the stock of external reserves increased further by 66.80% to US$28.28 billion and in 2006, reserves rose to an all-time high of US$42.20 billion [9,10]. The external reserves continue to move in an upward trend until in 2009 when the economy witnessed another fall in reserves to the tune of 20% to US$ 53.00billion and it continues in that direction till 2013 when the external reserves position was reduced to US$42.8billion.

However, the fluctuation in the external reserves had been attributed to a slowdown in portfolio and foreign direct investment, the inadequacy of foreign exchange receipts, drop in government revenue occasioned by crude oil theft and pipeline vandalism. Other factors include increased government spending from the excess Crude Account, the increase in the amount spent on defending the naira by the Central Bank of Nigeria (CBN), with huge fiscal spending and the consequent pressure on the country’s payments obligations. It must be mentioned that Nigeria is a mono-cultural economy with heavy reliance on crude oil whose price is exogenously determined. Hence, the reserves position of the country at any given point in time is usually a reflection of the circumstances prevailing in the international oil market which invariably affect home currencies and economic stability in the country.

This paper differs from [11,12,4,13], but a continuous work on [9]. The paper focused on the external reserve’s management and its effect on economic growth in Nigeria. Inclusively, the paper examined the effects of foreign direct investment and some macro-economic variables such as exchange rate, inflation, GDP, MPR on external reserve management

1.1 Research Hypotheses

The hypotheses are stated in null form:

Ho_1: There is no significant relationship between external reserves and economic growth in Nigeria.

Ho_2: There is no significant relationship between external reserves and Foreign Direct Investment in Nigeria?

Ho_3: There is no significant relationship between external reserves and stated Macro Economic Variables in Nigeria?

2. LITERATURE REVIEW

External reserves are variously called International Reserves, Foreign Reserve or Foreign Exchange Reserves. It is defined as official public sector foreign assets that are readily available to, and controlled by the monetary authorities for direct financing of payment imbalances, and directly regulating the magnitude of such imbalances, through intervention in the exchange markets to affect the currency exchange rate and/or for other purposes [3]. This definition was also backed up by the International Monetary Fund [14].

According to [15], external reserves are foreign currency deposits of central banks or other monetary authorities. They are assets of central banks held in different reserves currencies such as the Dollar, Pound Sterling, Euro and Yen etc. These reserves currencies are used to back central bank's liabilities, such as the local currency issued, the reserves deposits of various deposit money banks (DMBs), government or other financial institutions. Therefore, foreign exchange holding of individuals, banks, government agencies and corporate bodies do not form parts of the nation's external reserves

In Nigeria, the Central Bank has the sole responsibility of the management of foreign reserves. The components of foreign reserves include monetary gold, reserve position at the International Monetary Fund (IMF), holding of special drawing right (SDRs) and foreign exchange which are convertible currencies of other countries [3]. The purpose of external reserves management varies from country to country depending on the objectives at hand but majorly, country needs to manage her external reserves for the reasons which include ensuring foreign exchange stability.

In most cases reserves are used to intervene in the foreign exchange market to influence the exchange rate, payment for the importation of goods and services, services of the nation's external debt and source of finance for domestic fiscal expenditure, to insure against currency crisis by allowing relevant authorities to support their currency. External reserves also act as a "shock absorber" in terms of fluctuations in international transactions, such as variations in imports resulting from trade shocks, or in the capital account due to financial shocks. It also serves as an immediate purpose of either fighting inflation or deflation, as a precautionary purpose to provide a cushion to absorb unexpected shocks or a sharp deterioration in their terms of trade or to meet unexpected capital outflows, like the negotiated exit payment of the Paris Club Debt by Nigeria. Again, it is also used to manage the exchange rate through intervention in the foreign exchange market and help build international community confidence in the nation's policies and creditworthiness.

From the above, it is crystal clear that each country monetary system must decide the type of exchange rate arrangement to maintain because exchange rate stand as one of the core determinants of the external reserves a country could have at a particular time. This is backed up by [16] which asserts that appreciation of exchange rate results in increased imports and reduced export while depreciation would expand export and discourage import. Also depreciation of the exchange rate tends to cause a shift from foreign goods to domestic goods. Hence it leads to diversion of income from importing countries to countries exporting through a shift in terms of trade, and this tends to have an impact on exporting and importing countries economic growth and besides it will have an impact on the external reserves of a country.

According to [17] reserve management is defined to be a process that ensures that adequate official public sector foreign assets are readily available to and controlled by the authorities for meeting a defined range of objectives for a country or union. In this context, a reserve management entity is normally made responsible for the management of reserves and associated risks.

Sound reserve management practices are important because they can increase a country or regions overall resilience to shocks. Through their interaction with financial markets, reserve managers gain access to valuable information that keeps policymakers informed of market developments and views on potential threats. The importance of sound practices has also been highlighted by experiences were weak or risky reserve management practices have restricted the ability of the authorities to respond effectively to financial crises, which may have accentuated the severity of these crises. Moreover, weak or risky reserve management practices can also have significant financial and reputational costs. Several countries, for example, have incurred large losses that have had direct, or indirect, fiscal consequences. Accordingly, appropriate portfolio management policies concerning the currency composition, choice of investment instruments, and acceptable duration of the reserves portfolio which reflects a country's specific policy settings and circumstances, serve to ensure that assets are safeguarded, readily available and support market confidence.

Sound reserve management policies and practices can support, but not substitute for, sound macroeconomic management. Moreover, inappropriate economic policies (fiscal, monetary and exchange rate) can pose serious risks to the ability to manage reserves. Therefore, reserve management should seek to ensure that adequate foreign exchange reserves are available for meeting a defined range of objectives. Examples are, liquidity, market, and credit risks are controlled prudently; and subject to liquidity and other risk constraints, reasonable earnings are generated over the medium to long term on the funds invested.

Reserve management forms a part of official economic policies, and specific circumstances will impact on choices concerning both reserve adequacy and reserve management objectives. To ensure the availability of reserves, and as part of setting appropriate investment priorities, the reserve manager needs to have an assessment of what constitutes an adequate level of reserves. Such an assessment may be made by the reserve management entity, or it may involve consultation between the reserve management entity and other agencies.

There are no universally applicable measures for assessing the adequacy of reserves and the determination of reserve adequacy. Relevant factors have traditionally included a country's monetary and exchange rate arrangements, and the size, nature, and variability of its balance of payments and external position. More recently, financial risks associated with a country's external debt position and the volatility of its capital flows has received particular attention, especially for economies with significant but not fully certain access to international markets. In the process, ensuring the availability of reserves will be influenced by the exchange rate system practiced by the country and the particular objectives for which they are held.

To ensure that reserves are available at the times when they are needed most, liquidity-which is the ability to convert quickly reserve assets into foreign exchange, usually receives the highest priority, albeit with a cost that usually involves accepting lower-yielding investment instruments. Closely following is the need for the management and control of risks to ensure that asset values are protected. Market and credit risks, for instance, can lead to sudden losses and impair liquidity.

Finally, earnings are an important outcome of the management of reserve assets. For some countries, they play a role in offsetting the costs associated with other central bank policies and domestic monetary operations, which among other things fund the acquisition of reserves. In other cases, such as where reserves are borrowed in foreign markets, earnings play an important role in minimizing the carrying costs of reserve assets. Accordingly, achieving an acceptable level of earnings should be a priority within clearly defined liquidity and risk constraints.

In sum, the reserve management entity should seek to maximize the value of reserves, within the prudent risk limits that form the framework for reserve management, so that reserves are always

available when they are needed. As a consequence, reserve asset portfolios tend to be highly risk-averse, with a consequent priority for liquidity and security before profit, or carrying cost considerations. This necessarily involves making a trade-off between risk and return in the context of setting reserve management priorities.

[18] Identified other uses of foreign reserves that necessitate its accumulation and management by the central banks as payment for the importation of goods and services, serving the nation's external debt and finance domestic fiscal expenditure

Prior to the inception of the Central Bank of Nigeria in 1959, Nigeria formed part of the defunct West African Currency Board (WACB). The board which was established in 1912 by the British colonial government was intended to serve as the central bank for the Anglophone West Africa countries. In that period, management of external reserves posed little or no problems to the country because of how the Board operated prevented such problems from arising. Optimal deployment of reserves was not an issue since Nigeria's non-sterling earnings were deposited in London in exchange for credit entries in the sterling accounts maintained there [19]). Subsequently, the 1959 Act which established the Central Bank of Nigeria (CBN) required the Bank to hold external reserves solely in Gold and Sterling. With the amendment in 1962, the Bank acquired the mandate to maintain the country's foreign exchange reserves not only in sterling balance but also in non-sterling assets such as gold coin or bullion, bank balances, bills of exchange, government and government-guaranteed securities of countries other than Britain and Treasury Bills in other countries. The monetary options available to the country widened upon joining the International Monetary Fund (IMF) in 1961 to include many more assets [20].

The problems of reserve management began during the periods of the First National Development Plan from 1962 to 1966 and the Nigerian Civil War of 1967 to 1970. In these periods, financing the plan and the war consumed a large portion of the country's reserves. Also, the tempo in the foreign trade sector dropped, following the disruption of economic activities in the country. The problems became compounded immediately after the war in the wake of the Federal Government's efforts to reconstruct and reactivate the war-ravaged economy which continued to demand immense foreign exchange reserves. Because of the exigencies of this period, the CBN became committed to maintaining an 'adequate' level of external reserves [21,9].

[22] Noted that in addition to the problem of depleting reserves, Nigeria faced a new scenario with reserve management following the admission into the Organization of Petroleum Exporting Countries (OPEC) in 1973 and the oil boom era. The problem of reserve management switched from that of 'inadequate' to that of 'excess reserves'. This remained so until 1981 when the country was hit by the global economic recession that led to a consistent decline in her external reserves. In the light of this development, economic stabilization measures revolving stringent exchange control, which ran from April 1982 to June 1986 (when growth process to external reserves was low), were introduced. By the end of 1985, it was evident that the use of stringent economic control was ineffective in restraining external reserves depletion. To this end, exchange and trade controls were discontinued in 1986, following the adoption of market-based policy measures, the Structural Adjustment Programme (SAP) in July 1986.

However, after more than seven years of liberation, the government felt that the overall performance of the economy was unsatisfactory. Hence, in January 1994, some measures of control were re-introduced which saw the CBN as the sole custodian of foreign exchange and together with its designated agents. Again, the trade and exchange policies in 1994 failed to substantially achieve the desired objectives. The guided deregulation introduced in 1995, among other things, abolished the 1962 Exchange Control Act, in a bid to enhance the flow of capital and the reserves position of the country. Other measures aimed at boosting external reserves include the introduction of an Autonomous Foreign Exchange Market (AFEM) for trading in foreign currencies at market-determined rates and further liberation of the foreign exchange system in 1997 and the trade and exchange regime in 1998.

2.1 Exchange Rate Practiced in Nigeria since the Introduction of Structural Adjustment Programme (SAP) in Nigeria

Since the introduction of SAP in 1986, the central bank has implemented different techniques in the management of the exchange rate. Under SAP the exchange rate strategy was to float the naira and establish an institutional framework for its trading in a market determined environment [4]. Below listed are the techniques since 1986.

Table 1. Exchange rate techniques practiced in Nigeria

S/n	Year	Event	Remark
1	1959 – 1967	Fixed Parity Solely with the British Pound Sterling	Suspended in 1972
2	1968 – 1972	Included the US dollar in the parity exchange	Aftermath of the 1967 devaluation of the pound and the emergence of a strong dollar.
3	1973	Revert to fixed parity with the British Pounds	Devaluation of the US dollar
4	1974	Parity to both pounds and dollars	To minimize the effect of devaluation of the individual currency
5	1978	Trade (import) – Weighted basket of currency approach.	Tied to seven currencies; British Pounds, US Dollars, German Mark, French Franc, Japanese Yen, Dutch Guilder, Swiss Franc.
6	1985	Reference on the dollar	To prevent arbitrage prevalent in the basket of currencies
7	1986	Adoption of the second tier foreign exchange market	Deregulation of the economy
8	1987	Merger of the first and second tier markets	Merger of rates
9	1988	Introduction of the interbank foreign exchange market	Merger between the autonomous and the FEM rates
10	1994	Fixed Exchange rate	Regulate the economy
11	1995	Introduction of the Autonomous Foreign Exchange Market (AFEM)	Guided Deregulation.
12	1999	Re-introduction of the inter-bank foreign exchange market (IFEM).	Merger of dual exchange rate, following the abolition of the official exchange rate from January 1st.
13	2002	Re-introduction of the Dutch Auction System (DAS).	Retail DAS was implemented at first instance with CBN selling to end-users through the authorized users (banks)
14	2006 - 2010	Introduction of Wholesale DAS	Further liberalized the market

Source: Central Bank of Nigeria Bullion (2006)

2.2 Empirical Review

[23] investigated the impact of change in external reserves position of Nigeria on domestic investment, inflation and exchange rate between 1986 and 2006. He used a combination of ordinary least square and vector error correction models. The results show that changes in reserves influence only foreign direct investment and inflation rates.

[24] examined the management of external reserves and economic development in Nigeria between 1980 and 2008. The study employed Ordinary Least Square (OLS) estimation technique. The empirical result of the data analysis revealed that there is statistically significant relationship in the management of Nigerian external reserves.

[9] examined analysis of effect of external reserves management on macroeconomic stability of Nigeria from 1981-2010. Secondary data were sourced and analyzed using multiple regressions, granger casualty test, VAR model and unit test. The study revealed a direct relationship between external reserves and explanatory variables and external reserves were observed to be inversely related to macroeconomic instability.

[4] examined foreign exchange management and the Nigeria's economic between 1960 and 2012. Gross domestic product was the proxy for dependent variable while exchange rate, volume of export, inflation, volume of import and foreign direct investment were proxies for independent variable. Secondary data were sourced from CBN Statistical Bulletin and estimated using johansen co-integration and error correction model (ECM). The study found that there is a unique long run relationship among Y, EXCR, EXPT, IMP, INF and FDI. The result further showed that the explanatory variables explained and account for about 99% of variation in economy growth. In addition, it was found that the explanatory variables are jointly significant in explaining economic growth.

[13] studied the relationship between foreign exchange reserves accumulation and macroeconomic stability in Nigeria spanning 1986 to 2011. Foreign exchange reserves were the dependent variable while exchange rate and inflation were proxies for independent variable. Secondary data were sourced from CBN Statistical Bulletin and estimated using regression technique. The study revealed that exchange rate has positive and significant relationship with foreign external reserves accumulation while inflation has negative and insignificant relationship with foreign external reserves in Nigeria.

[10] assessed the impact of Nigeria foreign reserves on domestic economy within the temporal scope 1970 to 2011. Gross domestic product was the proxy for dependent variable while private consumption, domestic investment, reserves, net international trade and government expenditure were the independent variable. Secondary data were sourced from CBN Statistical Bulletin and estimated using Greenspan-Guidotti method and multiple regressions. The study showed that external reserves negatively influence the level of domestic economic productivity and investment.

3. METHODOLOGY

The relevant data for this study were extracted from secondary sources such as CBN statistical bulletin. Data collected were presented and analyzed with the use of E-views statistical package and as well subjected to Augmented Dickey Fuller, Johansen co-integration, and multiple regression from 1985-2013.

3.1 Model Specification

The study adopted the econometric model used by [9] in evaluating the management of external reserves in the Nigeria economy. The econometric model used was to determine the relationship between external reserves and selected macroeconomic variables (exchange rate, inflation, monetary policy rate and foreign direct investment) for the period of 1985 and 2013 towards adopting a policy

option. In the modification, foreign direct investment and monetary policy rate were introduced to show the effects of direct investment inflows on the external reserves and monetary policy was also introduced because it is a rate that affect all other banking rates in the economy which automatically transmit to retail market rate, lending rate and deposit rate. Based on this specification, a functional model was specified as follows:

$$EXTR = f(EXR, MPR, INFLR, GDP, FDI) \quad (1)$$

The explicit form of equation 1 is represented as follows;

$$EXTR = \beta o + \beta_1 EXR + \beta_2 MPR + \beta_3 IFLR + \beta_4 FDI + \beta_5 GDP + \varepsilon 1 \quad (2)$$

Where, EXTR = External Reserves, EXR= Exchange rate, MPR = Monetary Policy Rate, INFR = Inflation rate, GDP = Gross Domestic Product, FDI = Foreign Direct Investment.

3.2 Estimation Technique

The following were the estimation technique adopted. Augmented Dickey fuller test were used to test the stationarity of the variables, Johansen co-integration test was used to test for long run relationship between external reserves and the other explanatory variables while multiple regression was used mainly as the estimation technique to ascertain the extent of the variation in dependent variable as accounted by explanatory variables as well as the significant of each variable,

4. ANALYSIS AND INTERPRETATION

4.1 Descriptive Statistics of the Variables of the Model

From Table 2, the mean and standard deviation of the variables respectively are: ETR (16370.64, 17394.13), EXR (74.11, 61.76), MPR (17.24, 6.38), IFR (19.50, 18.25), GDP (477892.00, 201165.20), FDI (702656.10, 1224059.00). The mean values of the variables reveal that they all have positive averages over the study period, and the standard deviation shows volatile external reserves, gross domestic product and foreign direct investment. On the average, the FDI of 702656.1 is high with deviation of 1224059. The variables are positively skewed based on the descriptive analysis. Jarque-Bera test reject the normality of MPR, IFR AND FDI at 5% level since their values (22.33, 14.59 & 16.16) being higher than the X^2 value of 12.59 at 5% level. EXR (5.42), EXR (3.87) and GDP (4.21) suggest normality. The results are as depicted by skewness and kurtosis of the data.

Table 2. Result of descriptive statistics of the variables

	ETR	EXR	MPR	IFR	GDP	FDI
Mean	16370.64	74.11055	17.24138	19.50000	477892.0	702656.1
Median	7641.810	92.69340	16.60000	11.80000	393107.2	111290.9
Maximum	58472.88	157.4994	38.00000	72.80000	950100.0	3924100.
Minimum	981.8100	0.893800	8.600000	5.400000	253013.3	434.1000
Std. Dev.	17394.13	61.75586	6.378228	18.24745	201165.2	1224059.
Skewness	1.034096	0.051812	1.563094	1.598133	0.922594	1.706818
Kurtosis	2.547298	1.211601	5.951005	4.363169	2.725603	4.313236
Jarque-Bera	5.416184	3.877672	22.33179	14.58983	4.205017	16.16448
Probability	0.066664	0.143871	0.000014	0.000679	0.122150	0.000309
Sum	474748.6	2149.206	500.0000	565.5000	13858868	20377027
Sum Sq. Dev.	8.47E+09	106786.0	1139.090	9323.140	1.13E+12	4.20E+13
Observations	29	29	29	29	29	29

Source: E-view Result

Table 3, presented the Augmented Dickey-Fuller unit root test for the variables so as to verify if the variables are stationary or not. The findings of the results revealed that ETR, EXR, MPR, IFR, and FDI are stationary and does not have a unit root problem at 5%, first differencing and at lag 1 within the period considered except for GDP which does not have a unit root problem at lag 2.

Table 3. Augmented Dickey-Fuller unit root test for the variables

Variables	ADF	5%	Integration	LAGS
ETR	3.4102	0.0195	1	1
EXR	5.0090	0.0004	1	1
MPR	4.9011	0.0005	1	1
IFR	4.6526	0.0010	1	1
GDP	8.4217	0.0000	1	2
FDI	7.0496	0.0000	1	1

Source: Author computation from Eviews 7

The Table 4 shows the Johansen's Multivariate Co-integration test of the variables used in this research study. Based on the hypothesized number of co-integrated equation(s), it is revealed that both the Trace and Max-Eigen statistic test has five co-integrating equation because their p-value is lesser than the test of significance at 5%; we therefore reject the null hypothesis and conclude that there is five co-integrating equation between the variables.

Table 4. Johansen's Multivariate Co-integration test

Hypothesized No. of CE(s)	Eigen-value	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.9908	264.2338	95.7537	0.0000	121.8723	40.0776	0.0000
At Most 1*	0.8520	142.3616	69.8189	0.0000	49.6707	33.8769	0.0003
At Most 2*	0.7957	92.6909	47.8561	0.0000	41.2866	27.5843	0.0005
At Most 3*	0.6769	51.4042	29.7971	0.0001	29.3783	21.1316	0.0028
At Most 4*	0.5594	22.0260	15.4947	0.0045	21.3079	14.2646	0.0033
At Most 5	0.0272	0.7181	3.8415	0.3968	0.7181	3.8415	0.3968

Source: Author computation from E-views 7

5. PRESENTATION OF REGRESSION RESULTS

The regression result on the relationship between external reserves management and economic growth in Nigeria is presented below:

Table 5. Regression analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR	-66.60809	49.90870	-1.334599	0.1951
MPR	1326.869	249.3541	5.321223	0.0000
IFR	-18.48518	69.92657	-0.264351	0.7939
GDP	0.058693	0.026695	2.198644	0.0382
FDI	0.001801	0.002783	0.647103	0.5240
C	-30523.94	7413.866	-4.117142	0.0004
R-squared	0.902276	Mean dependent var		16370.64
Adjusted R-squared	0.881031	S.D. dependent var		17394.13
S.E. of regression	5999.551	Akaike info criterion		20.41875
Sum squared resid	8.28E+08	Schwarz criterion		20.70164
Log likelihood	-290.0719	Hannan-Quinn criter.		20.50735
F-statistic	42.47126	Durbin-Watson stat		0.977644
Prob(F-statistic)	0.000000			

Source: E-views Result output

Table 5 presents the regression result of the research study. The findings revealed that the result is spurious due to a high value of Durbin-Watson statistic when compared to the coefficient of determination (R^2) that is having a significantly higher value as well. However, the significant high value of R^2 which is approximately 90.23% explains the true behaviour of the independent variables (EXR, MPR, IFR, GDP & FDI) while 9.77% explains the disturbance error term in the model. The adjusted R^2 of approximately 88.10% explains the true behaviour of the R^2. Hence, the model shows a good fit.

Based on the t-statistic test, it is revealed that only the calculated value of MPR and GDP (5.32 & 2.20) as variable against it p-value (0.00 & 0.04) is lesser than the test of significance at 5%. This revealed the significant relationship between external reserves management and economic growth of Nigeria due to the overriding effect of monetary policy rate as it is been influenced by the gross domestic product within the period considered.

The overall test of statistic, the F-statistic, revealed that the p-value (0.00) of the calculated F-statistic (42.47) is lesser than the test of significance at 5%; we, therefore, reject the null hypothesis and conclude that there is a significant relationship between external reserves management and the economic growth of Nigeria within the period considered.

5.1 The Dynamic Analysis of Result

The findings revealed that the variables used in the research study are spurious. The Augmented Dickey-Fuller unit root test was employed to correct the degree of spurious of the variables. At first and second differences and lag 1, it is revealed that the variables are stationary and does not have a unit root problem except for gross domestic product which does not have a unit root problem at lag 2. The co-integration test revealed five co-integrating equations among the variables. The dynamic effect of this is that the variables have a long and short-run relationship.

5.2 Policy Implication of Results

The coefficient of the variables, which is the exchange rate and inflation rate, is negatively signed except for monetary policy rate, gross domestic product and a foreign direct investment that is positively signed. Only monetary policy rate and the gross domestic product has a significant effect on the research study in a positive direction. This implies that as gross domestic product increases, it in turn, increases the monetary policy rate which harms the exchange rate and an inflation rate of the economy thereby causing a shock on the external reserves in terms of proper management within the period considered. This is supported in the work of [9,4,13].

6. SUMMARY AND CONCLUSION

The study examined external reserves management and its effects on Nigeria economic growth. It reveals that external reserves are essential to the economy of Nigeria and must be kept at a desirable level so to achieve its purpose. Therefore, the study concluded that foreign direct investment, monetary policy rate and gross domestic product have a relationship with external reserves management but was negatively affected by inflation and exchange rate. This conclusion supported and confirmed the results of others who have researched this area of study.

7. RECOMMENDATIONS

The study recommends as follows:

i. Since foreign direct investment enhance and increase the level of external reserves position of a country, the government is therefore encouraged to implement good policies which will increase the relationship of the country with foreign investors so as to encourage them to invest more in the Nigeria economy.

ii. Idle cash/ reserves will not generate interest and may be affected by the movement or fluctuation in exchange rate. Government is therefore encouraged to invest more domestically especially in the infant industries, SME'S, an agricultural sector to boost the level of domestic outputs for exportation which will equally generate more income to the country.
iii. Monetary policy rates also influence and enhances increase in external reserves; therefore, monetary authorities are endeavors to keep the rate at a competitive level which will stimulate economic growth through the activities of the local investors

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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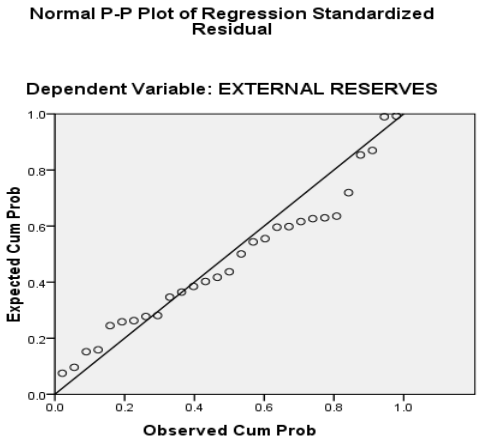
APPENDIX

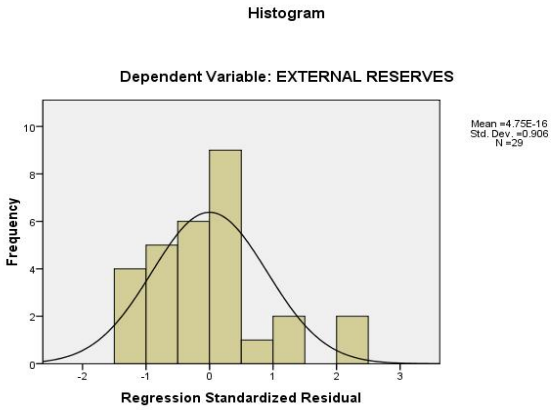
Data Presentation from 1985 to 2013

Years	ETR (USD in billion)	EXR(USD)	MPR	IFR	GDP (Naira in billion)	FDI (USD in billion)
1985	1657.9	0.8938	16.6	5.5	253013.3	434.1
1986	2836.6	2.0206	17.7	5.4	257784.5	735.8
1987	7504.6	4.0179	14.3	10.2	255997	2452.8
1988	5229.1	4.5367	14.6	38.3	275409.6	1718.2
1989	3047.6	7.3916	12	40.9	295090.8	13877.4
1990	4541.4	8.0378	11.2	7.5	328606.1	4686
1991	4149.3	9.9095	13.8	13	328644.5	6916.1
1992	1554.6	17.2984	12.7	44.5	337288.6	14463.1
1993	1429.6	22.0511	15.2	57.2	342540.5	29660.3
1994	9009.1	21.8861	16.5	57	345228.5	22,229.20
1995	1611.1	21.8861	9.9	72.8	352646.2	75940.6
1996	3403.9	21.8861	8.6	29.3	376218.1	111.290.90
1997	7222.2	21.8861	9.9	8.5	377830.8	110.452.70
1998	7107.5	21.8861	12.2	10	388468.1	80.749.00
1999	5424.6	92.6934	13.4	6.6	393107.2	92792.5
2000	9386.1	102.1052	13.1	6.9	412332	115,952.20
2001	10267.1	111.9433	18.4	18.9	431783.2	132,433.70
2002	7681.1	120.9702	19.3	12.9	451785.7	225224.8
2003	7467.8	129.3565	19.7	14	495007.2	258.388.60
2004	16955	133.5004	18.7	10.1	527576	248224.6
2005	28279.1	132.1470	18.1	11.5	561931.4	341,717.25
2006	42298.1	128.6516	20.5	8.6	595821.6	740,208.19
2007	51333.2	125.8331	24.8	6.6	634251.1	1,640,136.13
2008	53000.4	118.5669	33	15.1	672202.6	2,006,498.17
2009	42382.5	148.8802	38	12.1	718977.3	224,046.56
2010	32339.3	150.2980	20.2	11.8	776332.2	2,978,258.30
2011	32639.8	153.8616	19.3	10.3	834000.8	3,506,908.71
2012	43830	157.4994	19.4	12	888893	3,466,351.10
2013	42847.3	157.3112	18.9	8	950100	3,924,100.00

Sources: CBN Statistical Bulletin: Annual Bureau of Statistics of different Editions

Validating the assumptions underlying the use of regression





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He obtained his Bachelor degree -B. Sc (Hon) Finance (Banking) from the University of Lagos, Akoka-Lagos, Nigeria in June 1980. He had his postgraduate study at the Nigerian Premier University, University of Ibadan, Ibadan and graduated with an M. Sc (Banking & Finance) in May 1991. He worked in the Treasury Department of both Commercial and Merchant Banks and rose to become the Treasurer of Industrial Bank Ltd (Merchant Bankers) in December 1991. He proceeded to the United Kingdom to study for his Doctorate degree in Finance, with specialisation in Real Estate Finance at the University of Wolverhampton, Wolverhampton – West-Midland, United Kingdom. During his PhD study, he gained exposure to the dynamics of mortgage finance in precarious economies and became interested in housing finance in emerging and developed economies, specifically the far reaching implications of subprime mortgage lending on securitisation as a mortgage tool. He successfully defended his PhD Thesis titled: An investigation into factors affecting housing finance in emerging economies: A case study of Nigeria in August 2009. He joined as a faculty member (Senior Lecturer – Banking & Finance), Achievers University, Owo – Ondo State, Nigeria in October 2014. He's being the Ag Head of Department (Banking & Finance), Ag Dean, College of Social and Management Sciences (COSMAS) and presently, Director of Academic Planning Unit of the University. He is having over twenty-five (25) publications in both national and international journals amongst which are Journal of Real Estate Literature (Publication of American Real Estate Society), International Journal of Business and Finance Management Research, Asian Business Research, Journal of Social Science and Humanities Research and European Journal of Accounting, Auditing and Finance Research.

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DISCLAIMER
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