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# Measuring Co-Movement in International Portfolio Diversification

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**Abstract.** This study aims at measuring co-movement in international portfolio diversification from 1981-2016. The study adopted the survey research design and time series data was sourced from World Bank. Various stock indexes were modeled to see the correlation among these indexes; and these foreign indexes were stress-tested against the all share price index of banks in Nigeria. The study employed the techniques of correlation, Cholesky Monte Carlo simulation, ARCH, ordinary least squares, unit root test and granger causality test. An examination of the OLS regression estimate shows that Dow Jones industrial Average, JSE index, Nikkei, Sao Paulo index, Shang and Tokyo price Index(Topix) have positive and significances relationship with All Share Index of banks in Nigeria, But Johannesburg Index, Standard and Poor index and Dax index have insignificant relationship with All Share Price of Banks. The results of the Johansen co-integration test shows that there are nine linear combination of the variables that are stationary in the long run and also confirms the existence of positive long run dynamics relationship with the dependent variable. The positive long run effects confirm to the expectation of this study and the contagiousness and spillover of stock market worldwide. It can be seen that the Cholesky innovation standard deviation emanating from these exogenous shock simulated into the share indices of the Nigerian banking sector affected the sectorial share index. Thus, the study concludes that there is high level of contagiousness and spiral effects between the various stock markets globally. This work recommends that, all investors should carefully appraise the stocks and markets they wish to invest in or ensure that the portfolio combinations are uncorrelated; this they could do by employing the services of a reputable investment consultants.

**Keywords:** Portfolio, International Portfolio, Diversification, International Portfolio Diversification

## 1. Introduction

The foundation for Modern Portfolio Theory ("MPT") was established in 1952 by Harry Markowitz with the writing of his doctoral dissertation in statistics. The most important aspect of Markowitz's model was his description of the impact on portfolio diversification, which implies holding uncorrelated securities as portfolio, (Megginson, 1996). His dissertation findings were first published in The Journal of Finance with the title The Journal of Finance. These findings were significantly expanded with the publication of his book, Portfolio Selection: Efficient Diversification (1959). This set the pace for other researchers to further advance the theory of portfolio diversification in the different economies of the world.

In 1958, economist James Tobin in his essay, Liquidity Preference as Behavior Toward Risk,

derived the 'Efficient Frontier' and 'Capital Market Line' concepts based on Markowitz' works. Tobin's model suggested that market investors, no matter their levels of risk tolerance, will maintain stock portfolios in the same proportions as long as they "maintain identical expectations regarding the future" (Megginson, 1996, citing Tobin, 1958). Consequently, their investment portfolios will differ only in their relative proportions of stocks and bonds. Again, Capital Asset Pricing Model (CAPM), evolved from the works of Markowitz's and Tobin's. It independently developed by William Sharpe, John Lintner, and Jan Mossin, (Megginson, 1996). It provided an important evolutionary step in the theory of capital markets equilibrium, better enabling investors to value securities as a function of systematic risk. Sharpe (1964) significantly advanced the Efficient Frontier and Capital Market Line concepts in his derivation of the CAPM. Sharpe would later win a Nobel Prize in Economics for his seminal contributions. A year later, Lintner (1965) derived the CAPM from the perspective of a corporation issuing shares of stock.

Reducing risk effectively and earning maximum return comparably from domestic investment is through international portfolio (Black F, 2004). It is paramount because stocks of foreign market with their domestic counterpart have lower correlations. Unique specific shock affects different markets and countries in various ways, to hedge against shock, international diversification is considered (Sorenson 2007). Idiosyncratic shocks may be diversified away. Thus investors who pursue cross-country diversification strategies may eliminate country-specific risks but remain vulnerable to common shocks. One of the ways investors can potentially increase return, dampen volatility and lower risk is diversifying across regions or asset classes.

## 2. Literature review

### 2.1 Portfolio and International Diversification

The roots of diversification trace back thousands of years. "…divide your investments amongst many places, for you do not know what risks might lie ahead." (Ecclesiastes 11:2). To reduce potential risk, we hold pool of assets and securities in order to minimize exposure in a portfolio (Kacperezk, 2004).

A portfolio is grouping of financial assets such as stocks, bonds and cash equivalents, as well as their funds counterparts, including mutual, exchange-traded and closed funds. Portfolios are held directly by investors and/or managed by financial professionals. Prudence suggests that investors should construct an investment portfolio in accordance with risk tolerance and investing objectives (Investopedia). An investment portfolio can be thought of as a pie that is divided into pieces of varying sizes, representing a variety of asset classes and/or types of investments to accomplish an appropriate risk-return portfolio allocation. Many different types of securities can be used to build a diversified portfolio, but stocks, bonds and cash are generally considered a portfolio's core building blocks. Other potential asset classes include, but aren't limited to, real estate, gold and currency.

An international portfolio is designed to give the investor exposure to growth in emerging and international markets and provide diversification. International portfolios allow investors to further diversify their assets by moving away from a domestic-only portfolio. Due to the integration of global financial markets, many companies already have operations in more than one country (Khoury, 1980). During the last decade, there has been a relaxation of international capital controls, a dramatic expansion in the volume of trading in international financial markets, and, more generally, an increase in international financial integration (Rezayat, 2006). International portfolio diversification is an investment risk reduction strategies and vehicle by which a rational investors, hold various classes of assets which include both domestic and foreign assets which is geared towards risk reduction objectives.

### 2.2 Economic Significance of Portfolio Diversification

What drive investors into diversifying beyond the geographical confines of his residence and

holding assets is to minimize the entire risk inherent in his or her portfolio (Rezayat, 2006). The underlying significance of portfolio diversifications are: risk reduction and hedging, maximization of return, risk spreading, and breaking new market grounds to benefit from unique investment policies and incentives and taking calculated risk to enhance maximum portfolio performances in the face of domestic systematic risk which seems undiversifiable (Grauer, 1976).Diversification:

### 2.3 Determinants of Financial Market Spillovers

In a broader sense, spillovers refer to the impact of shocks or policy changes in one country on another because of the large volume of trade or financial linkages. Spillovers can take various forms; for example, shocks in country X can adversely affect country Y's economic growth if these two countries have stronger economic or financial ties. Spillovers can take place in financial markets, observed by financial market indicators' co-movement worldwide. Bilateral financial market spillovers are defined as the co-movement of equity return or bond yields between two countries. As pointed out in Forbes and Rigobon (2002), the onset of the 2008 global financial crisis, economic and financial shocks have been greatly transmitted throughout the world. Financial markets are highly interconnected worldwide and, consequently, negative shocks in one country have spilled over into other countries. Financial market spillovers can be thought of as the correlation between two countries' financial market returns, for example, on equity or debt markets.

### 2.4 Stress Testing the Risks to ensure Diversification

One significant challenge of crafting a well-diversified multi-asset-class portfolio is that not all risks impact all asset classes in the same way – in fact, arguably the reality that certain investments may respond differently to a similar risky event is what defines them as different asset classes, Lessard (2013). For instance, consider the case of inflation. Both stocks and commodities react well to modest inflation, but significant inflation may be especially good for commodities while turning bad for stocks (in part because the more-expensive commodities cause higher input costs that drive down the price of stocks!). Similarly, modest inflation may allow government bonds to perform well, but significant inflation forces interest rate increases that adversely affect interest-rate sensitive bonds. On the other hand, corporate bonds may perform especially well in a rising inflationary environment, as companies eventually pass through price increases that lift their nominal earnings and make their debt easier to service (even if real earnings are not rising).different asset class dynamics can also apply to deflation (and may vary depending on the cause of deflation), growth vs. recession environments, rising vs. falling interest rates, or even times of peace vs. environments with geopolitical unrest. The added complexity to investing in this manner, as noted earlier, is that not only do different asset classes react differently to external events, but their reactions are not always symmetrical. Deflation is more severely bad for commodities than inflation is good. Modest inflation is good for stocks, but severe inflation can be bad (and deflation is bad, too). Government bonds underperform corporate bonds in growth environments, but outperform them in the recessions when they're needed most for diversification.

These dynamics mean that in practice, it's not enough to simply look at basic portfolio statistics such as long-term average correlations. Instead, portfolios must be evaluated for their exposure to specific risks, with recognition of how the portfolio might respond to those particular risks – and ensuring that there is a healthy level of diversification to a wide range of possible outcomes. Fortunately, a growing number of tools are becoming available to advisors specifically to analyze and "stress test" such scenarios. Companies like Hidden Levers, RiXtrema, and Macro Risk Analytics all provide solutions for advisors to input portfolio allocations, and evaluate how the portfolio might respond to scenarios from an inflation shock to a further oil crash, from inflation picking up or rolling over into a deflationary direction. The purpose of all these tools: to identify scenarios

where a portfolio is "too aligned" towards a single outcome, and thus over-exposed to the potential of being wrong (or outright unprepared for a risk to occur). Portfolio stress testing allows you to truly test how diversified you really are. As with all of these uncertainties, there is still some "base case" scenario that is most likely to play out – inflation is more likely than deflation (at least in the modern era), peace is more likely than an actual geopolitical war, and even though recessions may be "inevitable" growth is still more likely to occur from year to year (all else being equal).

## 2.5 Theories of Portfolio Diversification

### 2.5.1 Modern Portfolio Theory

Technically speaking Modem Portfolio Theory (MPT) is comprised of Markowitz Portfolio Selection theory, first introduced in 1952, and William Sharpe's contributions to the theory of financial asset price formation which was introduced in 1964, which came be known as the Capital Asset Pricing Model (CAPM) (Solnik, 2004). The modern portfolio theory emphasis holding maximum number of assets in other to enhance return and reducing risk if only the assets combinations are uncorrelated (Markowitz, 2002). Diversification implies "never put all eyes in one basket".

The framework for international portfolio theory (IPT) includes numerous assumptions about markets and investors. Some of these assumptions are explicit, while others are implicit. Markowitz built his portfolio selection contributions to MPT on the following key assumptions (Markowitz & Bofah, Wecker 1952): (i) Investors are rational (they seek to maximize returns while minimizing risk), (ii) Investors are only willing to accept higher amounts of risk if they are compensated by higher expected returns, (iii) Investors timely receive all pertinent information related to their investment decision, (iv) Investors can borrow or lend an unlimited amount of capital at a risk free rate of interest, (v) Markets are perfectly efficient, (vi) Markets do not include transaction costs or taxes, (vii) It is possible to select securities whose individual performance is independent of other portfolio investments. These foundational assumptions of international portfolio theory have been widely challenged.

### 2.5.2 Post-Modern Portfolio Theory

Critics from the Markowitz portfolio model brought about the post-modern portfolio. Internal rate of return is used as a yard stick for including securities in a portfolio, the higher the internal rate of return on assets possess the preferences for such assets. This theory prefer downside to total risk, which uses the internal rate of return as a benchmark or hurdle rate for portfolio combination and asset selections decisions, the uses calculus as a mathematical model to achieve this objective.

### 2.5.3 Risk Parity and Maximum Diversification Theories

This theory rank risk of assets and apportion preferences to assets (Yavas, 2012). Firstly, all assets risks are measured, thereafter, a comparism is done, and those assets with minimum risk are added to the portfolio given the investors risk profile. Maximum diversification theory also uses volatility to measure risk. Each asset volatility is measure and an average is taken, each weight is multiply by the number of the assets in the portfolio. The ratio of diversification should be exceed one, if it is more than one, it means that the total portfolio risk has provide a margin of safety comparably to the individual assets risks, (Stulz, 1980). It is good to understand each theory and apply it when the need arises; the bottom line is diversification is a good tool for hedging against risk.

## 2.6 Empirical literature

The empirical literature regarding benefits of international diversification is available since 1960s. Grubel's (1968) risk –return strategy was used in a bit to reduce country systematic risk through international diversification. This risk-adjusted diversification was studied by many researchers (Wilcox1992; Bekaert & Harvey 1995; Divecha et al. 1992; Speidell & Sappenfield 1992; Harvey 1995, Gilmore et al.

2005; Naranjo and Porter 2007; Olgun & Ozdemir 2008; Ozdemir 2009; Ozdemir & Cakan 2007; Ozdemir et al. 2009). Various methodologies were used by the researchers for the determination of co-movement among the stock indices. Ripley (1973) in his study finds out by using variance methodology that US have low degree of variability, whereas Japan and South Africa were demonstrated the high degree of association.

Hui & Kwan (1994) used data from Asia-Pacific and US equity prices to examine covariation among the stock prices by employing factor analysis. Results revealed that Japan, Taiwan, Hong Kong, and U.S markets were categorized into different factors which showed that these countries are suitable for diversification. Naughton (1996) in his study using factor analysis as an analysis tool and observed that correlation exist between developed and Asian markets. Meric & Meric (1997) focused the period of pre-crisis and post-crisis of 1987 to verify the co-integration of European stock indices. Using factor analysis technique, they reported that three factors were found statistically significant before crash but after crash, only two factors were shown in the analysis. Tuluca & Zwick (2001) used Factor analysis technique was applied and analysed, and it was reported that all markets other than Asian markets were into one factor, whereas Asian equity markets were divided into two groups. Therefore, the study suggested that potential diversification was reduced as the case long-run diversification.

In international Portfolio Theory (IPT), the key determinant of optimal portfolio is that the correlation between the securities must be negative or their relationship should be weak. There exist different motives for investment in the various stock markets of the world of which the most prominent among all is to earn a reasonable return on investment. However, selecting investments on the basis of returns alone is not sufficient (Brodie, Daubechies & Loris, 2009). The fact that most investors invest their funds in more than one security suggests that there are other factors, besides return, and they must be considered, investors not only like return but on the other hand avoid or dislike risk and this makes the financial market, despite the benefits and rewards as a complexly volatile industry that requires critical analysis to adequately evaluate risks relative to returns to assist investors in decisions as regards participation in the industry (Sabbadini, 2010). For instance, Forbes and Rigobon (2002) showed that when markets experience increased volatility, and then the correlation measure is biased upwards, it may lead to an incorrect conclusion of financial market contagion.

To examine the determinants of stock market vulnerability defined by local markets' co-movement with the United States (US), Didier et al. (2010) analyzed the co-movement between monthly stock returns of the US and those of each country in the sample. They argued that each market's correlation vis-à-vis the US market is interacted with country-level characteristics that affect co-movement such as real and financial linkages between it and each country.

Using stock and flow data, Forbes (2012) empirically investigated financial market spillovers through trade, bank exposure, portfolio investment exposure, and portfolio inflows. This paper features the analyses of how financial market spillovers are explained by the size of bilateral asset holding. With respect to the second point, the contribution of this paper is that it explains bilateral financial spillovers by country-level geographical portfolio preferences. It should be noted that because of the lack of relevant data, country-level geographical preference in connection with financial market spillovers has been less exploited. Sorenson et al.(2007) calculated country-level home bias using commercial data distributed by Standard & Poor's and found that home bias is associated with international risk sharing defined by equalization of consumption growth. IMF (2011) provides a comprehensive discussion on spillovers. Standard correlation coefficients as proxies for spillovers may raise the problem of heteroskedasticity and are potentially biased. Therefore, they propose an "adjusted correlation coefficient", which accounts for this bias by assuming that only one country causes shocks to

be transmitted to the other country and that there are no exogenous global shocks. In this context, this paper calculates the adjusted correlation coefficients as well as standard correlation coefficients.

## 3. Research Methodology

We use the survey research design and we will adopt the methodology of Gravelle et al (2006) .To the best of our knowledge, no other study has employed this innovative technique to study the transmission of stock market shocks. Hence we can focus on the G-7 countries and detect changes in the transmission of shocks that may have originated elsewhere. This is going to be particularly beneficial in the latter part of our sample when the Asian and Russian crisis occurred. Studies that focus on market contagion tend to concentrate on smaller markets that are geographically close to the source of the shock but we believe that a portfolio manager will be more concerned with the co-movements of the larger countries that typically get included in asset allocation strategies due to their size and diversity. Different stock market index will be sourced; these data will be source from World Bank data base.

Based on the objectives of the study, the functional model is specified as follows:

$ASP_B$ =F( SP,SHANG,DAX,JSE,DON,SAO,FTSE)- …. (1)

Rewritten equation one in econometric form:

$\ln ASP_B = \beta_0+\beta_1 \ln SP+\beta_2 \ln SHANG+\beta_3 \ln DAX+\beta_4 \ln JSE+\beta_5 \ln DOW+ \beta_6 \ln SAO+\beta_7 \ln FTSE+ \beta_8 \ln NIK +\mu$ … (2)

Introducing the stress testing scenario

$ASP_B = f (\delta_1 \delta_2 \delta_3 \delta_4 \delta_5 \delta_6 \delta_7)$ … (3)

The existence of contemporaneous correlation between the stressed test scenario $\Omega_{1 \text{ to }} \Omega_4$ suggests that common structural shocks are driving both returns. Then the forecast errors and exogenous shocks simulation are written as:

$ASP_B = ASP_B\delta_1 + ASP_B\delta_2 + ASP_B\delta_3\ ASP_B\delta_4+\mu$ …. 4)

We allow both the common and the idiosyncratic shocks to switch between two states: high and low volatility. In other words, the observed increase in the variance and correlation of returns during turbulent periods is due to increased assumption of regime switching in the common shocks is necessary for the identification of the system.

### 3.1 Estimation Techniques

First is Autoregressive Conditional Heteroskedasticity (Arch), second is correlation coefficient Cov ($R_x$, $R_Y$) = $\sigma_\chi \sigma_\gamma \rho\chi\gamma$, and third is Cholesky test (Monte Carlos): This test is a stimulus-responses test using standard deviation as shocks, it shows the level of volatility of one variable as its respond to another variables. It is a causal relationship involving Monte Carlo simulation. Other tests include stationarity tests, co-Integration test (Johansen' test), and Granger causality test, and our a priori expectation is stated thus: we expect $\beta_1$ to $\beta_7$ to be positive. i.e. $\beta_1>0$…… $\beta_6>0$; $\delta_{1 \text{ to }} \delta_7$ to be positive since we expect contagiousness.

## 4. Results and Discussion

The estimates and results of the models and techniques as formulated in chapter three of this work are presented in this chapter. The short run regression results of the various indexes, the unit roots test, the test of co-integration and normalized co-integration were present. The granger causality test was used to examine the causal relationship running from the independent variable to dependent variable and from dependent to independent variables. Cholesky standard deviation innovations were used to stress test the All Share Index of Nigeria banks against foreign index. The Ordinary Least Square (OLS) estimates for the models and the discussion of hypotheses and findings were also presented.

**Table 1: Correlation matrix**

| | ASPB | SP | DOW | DAX | SAO | SHANG | FTSE | JSE | TOPIX |
|---|---|---|---|---|---|---|---|---|---|
| ASPB | 1.000000 | -0.693402 | -0.628525 | -0.573939 | -0.553271 | -0.149687 | -0.201150 | -0.147776 | -0.007460 |
| SP | -0.693402 | 1.000000 | 0.980947 | 0.683755 | 0.835116 | 0.643867 | 0.062292 | 0.291577 | 0.054826 |
| DOW | -0.628525 | 0.980947 | 1.000000 | 0.666052 | 0.804208 | 0.672391 | 0.086830 | 0.295941 | 0.066663 |
| DAX | -0.573939 | 0.683755 | 0.666052 | 1.000000 | 0.783973 | 0.514593 | 0.294964 | -0.056819 | 0.242256 |
| SAO | -0.553271 | 0.835116 | 0.804208 | 0.783973 | 1.000000 | 0.741406 | -0.019578 | -0.059303 | 0.124521 |
| SHANG | -0.149687 | 0.643867 | 0.672391 | 0.514593 | 0.741406 | 1.000000 | -0.094004 | -0.028058 | 0.119239 |
| FTSE | -0.201150 | 0.062292 | 0.086830 | 0.294964 | -0.019578 | -0.094004 | 1.000000 | 0.136134 | 0.160926 |
| JSE | -0.147776 | 0.291577 | 0.295941 | -0.056819 | -0.059303 | -0.028058 | 0.136134 | 1.000000 | 0.060725 |
| TOPIX | -0.007460 | 0.054826 | 0.066663 | 0.242256 | 0.124521 | 0.119239 | 0.160926 | 0.060725 | 1.000000 |

Source: E-view output

The correlation matrix shows that the banking sector index as represented by ASPB has negative correlations in relation to other indexes as SP, DOW, DAX, SAO, SHANG, TOPIX, FTSE, and JSE. This shows that, there is no level of contagiousness or that the stock return of Nigeria index does not correlate with those indexes with negative coefficient. Hence portfolio managers can diversify internationally by holding those stocks in his or her portfolio with negative correlation. The correlation matrix is carried out on the time series to see if any of the independent variable correlates with each other so as to avoid multicollinearity while the chow break point test is conduct to show the effect of structural break on return on asset over the period of the study.

## 5. Discussion of findings

Based on our results, a U.S. investor having holding foreign assets like that of Nigeria securities will not benefit in risk reduction, but invariably by investing in German stocks, SHANG, and Nikkei which has positive coefficient. On the other hand, the same Nigeria investor will have better diversification benefit by investing in the Japanese market cum for German investor. This is so because a Germany-Japan combination will yield better diversification than with a Germany-U.S. combination. Similarly, investors in Japan can achieve equally desirable portfolio diversification benefits when they invest in Germany or the U.S. Solnik (2004) and Karolyi & Stulz are examples of two of the studies that find that the correlations between the major stock markets increase after global shocks. To see if data used in this study could provide support for the above hypothesis, we studied the recent financial crisis from 2007 till date. The findings reported in Table above shows that during the Chinese Stock Bubble Of 2007, only NIKKEI have positive coefficient, which mean, Nigerian portfolio cannot be diversify with NIKKEI stock in the portfolio, while the rest indexes have negative covariance. Also during the 2015–16 Chinese Stock Market Crash there was not international investment opportunities presented, because all market shows gross positive co-movement.

## 6. Conclusion

Given the relative size of markets and the observed home bias in asset holdings (French and Poterba, 1991), diversification benefits were large in the aftermath of the 1987 crash when the Nigerian investor most needed protection. Therefore, we conclude that the benefits of hedging idiosyncratic risks outweigh the burden of bearing common shocks. Idiosyncratic shocks are found to be more frequent, more persistent and larger in magnitude than the common shock. Both our statistical and economic results reinforce the belief that international portfolio diversification strategies are worthwhile and provide the investor with insurance against domestic risk. Even if everybody loses in an absolute sense, diversification benefits remain sufficiently large to compensate the investor who has spread her risk internationally. Methodologies that require the market from which the shock emanated to be included, often force studies to concentrate on relatively small or regional markets. In discussing the implications for portfolio selection, we should focus on the larger markets of the world and by

choosing the G-7 countries; we cover about 80% of world market capitalization. Obviously, these markets will be the major recipient of capital inflows and hence vehicles for international portfolio diversification.

## 7. Recommendations

Our results show that the Nigerian investor should allocate funds to international assets and the fear of increased co-movement during periods of global market turbulence should not prevent such diversification. We must look at the pros and cons of international portfolio diversification. Investors must employ strategic investment techniques to ensure that they minimize risks and maximize returns. Particular caution should be given to the choice of country; choice of market; the correlation between the securities and markets chosen; optimal portfolio weights; and portfolio balance to obtain maximum diversification benefits.

It is crucial to ensure that portfolios are mean-variance efficient, as the portfolio components derived from this method are relatively stable. It might be most sensible for the private investor to consider investing in international mutual funds, preferably those that are linked to a world capital market index (suitable indices).

Finally, this paper recommends that, all types of investors should carefully research the stocks and markets that they wish to invest in or ensure that they employ the services of a reputable investment management company.

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