Safe Haven or Hedge: Diversification Abilities of Asset Classes in Pakistan

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Abstract: This study compares the safe haven properties of asset classes of real estate (house, plot and residential), gold, dollar, and oil against equity returns in Pakistan for the period January 2011-December 2020. We employ the wavelet coherence to encapsulate the overall dependence and correlation of asset classes. Our results show the dependence is weaker (stronger) in short (long) term investment horizon. We also study the potential of diversification at the tail of returns distribution by applying wavelet value-at-risk (VaR) framework that reveals the degree of co-movement between gold and equity returns greatly affects the portfolio risk followed by residential property and oil. Our findings are beneficial for the individual investor, fund managers and financial advisors looking for the optimal portfolio combination that hedge the excessive negative movements in equity returns subject to the heterogeneity in the investment horizon.

Keywords: Equity; Real Estate; Oil; Gold, US Dollar; Diversification; Pakistan**.**

JEL **Classification:** G11, G15, F21, Q02.

1. Introduction

The institutional investors as well as the individual market participants manage their investments to ascertain the higher rate of returns through the diversified portfolios. The wise folk of "not putting all of your eggs in one basket" remains a dominant phenomenon in the theory of portfolio. The seminal work of Markowitz (1952) followed by Tobin (1958) and Samuelson (1967) determine the analytic tools to quantify the benefits obtained through the increased risk diversification. The invention of tools to measure the diversification effect, signifies the importance of studying the co-movement among different asset classes, at national and international level, to minimize the variance. However, recent studies brought our attention to the rapid increase of integration among economies and within the sectors in the economy, possibly strengthening a positive co-movement, has lowered the benefits of diversification across countries over the time (Bouri, Shahzad, Roubaud, Kristoufek and Lucey, 2020; Rua and Nunes, 2009; Brooks and Del Negro, 2005,2006; Forbes and Rigobon 2002). The integration among domestic sectors eradicates the diversification opportunities in Pakistan as highlighted by Yousaf and Ali (2020) that despite having a different degree of liquidity, the stock market and real estate in Pakistan behave dependently and diversified portfolio does not reduce the variance.

It is also observed in practice the co-movement of stock returns is evaluated through the correlation coefficient, whereas, either rolling window correlation coefficients or non-overlapping sample periods are utilized to investigate the evolving properties. Nevertheless, the diversification analysis should inculcate the difference among stock returns' co-movement for the investor in short and long term (Candelon et al. 2008). From the portfolio perspective, short term investors are more concerned about the co-movement of returns at high frequencies spectrum (short term variations), whereas long term investors consider co-movement magnitude at low frequencies, i.e., long term variations. Hence, it is important to carry out the analysis that focuses on returns co-movement among asset classes in time and frequency domain to discover the co-movement at different frequency levels (Bouri et al. 2020; Pakko 2004; A'Hearn and woitek 2001). Despite the recognition of distinction in co-movement of returns in short and long term, less consideration has been drawn in financial literature for time-frequency localization for stock returns movement with other assets classes and vice versa in Pakistan.

Historically, Pakistan has been experiencing a rapid growth in investment in stocks as well as in other asset classes such as gold, real estate, and dollar from 1999 to 2020. The return on stocks, gold and real estate remains well above the rate of inflation, respectively, and particularly in real estate the price appreciation, with and without comprising the rental yield, are approximately 11.3% and 14.3% since 1999[1]. The investment in real estate is considered one of the safest investments in Pakistan due to the rapid price appreciation and rental yield. Moreover, in the last decade, an unusual increase in the gold prices, Rs. 116,590/troy ounce in 2011 to Rs 296,588/troy ounce in 2020 yielded 154.4% returns for investors that are higher than the returns over alternative

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[1] A study carried out by author who is the founder of a fintech start-up that provide investment advisory services to individuals in Pakistan. The study is available on the following link. Why (and how much) Pakistanis overinvest in real estate - Profit by Pakistan Today

investments[2] (Qureshi at el., 2016; Aazim, 2011). The hike in gold prices led to a higher trade of gold futures in Pakistan Mercantile Exchange (PMEX) in local market (Shahbaz et al, 2014; Qureshi et al, 2018). Despite of economic downturn, Pakistan has increased its holding for gold for future stability and security (Qureshi et at, 2018).

Thus, the role of gold in Pakistan economy cannot be set aside. Keeping the significance in mind several studies have analyzed the co-movement of gold prices and exchange rate through various econometric estimation models (Capie et al, 2005; Sjaastad 2008; Sari et al, 2010; Joy; 2011; Pukthuanthong and Roll, 2011; Reboredo, 2012; Reboredo, 2013; Reboredo and Rivera-Castro, 2014; Apergis, 2014; Beckmann et al, 2015; Zhang et al. 2016; Jain and Biswal, 2016; Zhang et al, 2016; Wang and Lee, 2016; Pershin, Molero, & de Gracia, 2016). Generally, the previous literature concludes that the negative interplay between gold and exchange rate is because of gold acts as a hedging factor for the currency devaluation and prices of gold indicated in a currency can be linked with fragility in that currency. On the other hand, declining value of currency against dollar, Rs. 85.70/$1 in 2011 to Rs. 159.9/$1 in 2020 yield 86.2%, for the investments in dollar, have attracted the attention of practitioners and researchers to further investigate the co-movement of between gold prices and exchange rate. Furthermore, gold is also considered as a safe haven to hedge the stock movement especially during financial crisis (Baur and Lucey 2010). However, recently the concern has been raised over the ability of gold to compensate the negative stock movement in post global financial era, (Baur and Glover 2012; Bekiros et al, 2017; Klein 2017), when central banks introduced an ultra-loose monetary policy and financialization of commodity markets for investments (Bouri et al, 2020).

This study aims to explore the diversification opportunities among stock, real estate, exchange rate, gold, oil and US dollar returns for short and long-term investors in Pakistan. The contribution of our study is threefold. *First*, we imply the number asset classes to explore the co-movement among returns to identify the best risk minimizing combination. The co-movement of returns is a key for risk management for the diversified portfolios in short and long-term. On one side, varying co-movement for different level of frequencies the associated risk is also changing for each type of investor. On the other hand, one should be able to capture the time varying feature that implies a dynamic risk exposure. This study facilitates short and long-term investors as both have distinct preferences in term of returns fluctuations over time. There are less studies find in the literature that have shown the round trip of co-movement among larger set of asset classes but none in case of Pakistan. Moreover, we have introduced real estate sectors which is considered one of the most return promising sectors in Pakistan and most of the saving are channelized in this sector. Second, we applied wavelet coherence approach to uncover the degree of co-movement among asset classes. The save haven assets may be dependent upon the frequency which may vary across investment horizons of various market participants. The wavelet coherence approach is advantageous over the standard methods that only capture the time domain perspective of dependence whereas wavelet encapsulates sluggish but persistent co-movement that allows nuanced comprehension of the asset's interdependence. Third, we quantify the diversification

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[2] Such as bank deposits, mutual funds, national saving schemes, Pakistan investment bond or corporate bond. See Qureshi at el., (2016).

power of each asset class via value-at-risk (VaR) using the approach wavelet VaR model highlighted by Rua and Nunes, (2009); Bouri (2020). The current study is beneficial for the portfolio managers, financial advisors and individual investors who are searching for the best asset combination among stock, real estate, exchange rate, gold, oil and US dollar to manage their portfolio risk while accounting for the heterogeneity in investment horizon of investor in Pakistan.

The rest of the study is organized as section-2 discusses the background of current study. Section-3 describes the data collection, variables and methodology explanation, section-4 shows the empirical results and discussion. Section-5 concludes the empirical findings and provides recommendations.

2. Review of Literature

This section reviews the literature on different asset classes that possessing a diversification ability to manage the risk of portfolio. In the universe of asset classes that carry distinct features especially in terms of their liquidity, prices appreciation and rental yield, investors are keen to construct an optimal portfolio to maximize their returns while keeping the variance (risk) of the portfolio minimum. Selecting a combination of an appropriate asset classes for risk reduction is often involve a complex decision making especially if one has limited knowledge of investment process. Such type of investors usually relies upon markets trends to invest in available options that bring them substantial returns with reasonable risk. For instance, since 2000s', specifically in last decades, an abundant amount is invested in real estate in Pakistan to gain price appreciation, which subsequently give enormous hike in real estate prices. Many investors have ascertained an abnormal profit in real estate sector.

2.1.Portfolio Diversification and Traditional Models

Many studies have focused on the short-run association between real estate and stock market returns in developed and developing countries. Gyourko and Keim (1992) analyze US markets from 1978 to 1990 by applying a simple regression model and find a short-run relationship exists between real estate and stock market. By studying Australian market through co-integration technique, Wilson et al., (1996) find a short-term association between real estate and stock returns from 1984 to 1996. However, Quan and Titman (1999)'s simple regression analysis support the absence of real estate-stock market short-run association in US, except UK, Japan, and other small countries, from 1984 1996. Kopyl et al., (2016) investigated 32 global asset classes (hedge as well as safe haven assets)[3] as bond, currencies, commodities and alternative assets to their possible linkages with S&P 500, US stock market index. The real estate data from 1987 to 2014 indicates an overall negative relationship with S&P 500. However, when sample size is split as pre financial crises and post financial crises, the real estate is insignificant (significant) with S&P 500 in pre financial crises (post financial crises).

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[3] Hedge assets are classified as negatively related to the other assets in portfolio on *average* and used for diversification in the long run, whereas safe haven assets are characterised as negatively related to other assets in the portfolio during *market crises* and used for diversification in the short run (see Kopyl et al., 2016).

On the other hand, there are some recent studies that have investigated the existence of cointegration between the real estate and stock markets in the perspective of diversification i.e., the higher the assets are integrated lower the diversification benefits are. The cointegration technique highlights that the real estate and stock markets of US and UK are not cointegrated, however, the cointegration exists in Australian markets from 1971 to 1973 (Wilson and Okunev 1999). On the contrary, Apergis and Lambrinidis (2011) show the real estate and stock markets are cointegrated in US and UK 1985 to 2006. Similarly, McMillan (2012) also support the existence of cointegration between real estate and stock markets in US and UK from 1974 to 2009. Out of US and UK markets, real estate and stock markets are also integrated in Singapore, from 1985 to 2002, and Greece from 1997 to 2015 (Liow 2006; Gounopoulos et al. 2019), however, Wang et al. (2017) do not support the integration of real estate with stock markets in Taiwan. The portfolio of comprising real estate and stocks can diversify the overall portfolio risk in Taiwan.

There are few studies found on diversification ability and integration of real estate with other asset classes pertaining to Pakistan. For instance, Umar et al. (2019) who investigate the impact of monitory policy on real estate housing market in Pakistan. Their finding suggest that the tight monitory policy have an adverse effect on housing prices in Pakistan. More recently, Yousaf and Ali (2020) find that real estate sector and stock market in Pakistan are cointegrated – long run causality between housing and stock market whereas short run causality between plot and stock markets. These finding suggest that the real estate and stock market in Pakistan are substitute and do not possess diversification ability.

Another asset class, gold, have broader implication in the perspective of risk reduction. Several studies on developed and developing countries have highlighted the importance of diversification ability of gold against political uncertainty, inflation, currency risk, economic growth, oil prices and other financial and macroeconomic variables (also see Qureshi et al., 2020; Shahbaz et al., 2014; Reboredo, 2013; Joy, 2011; Lucey and Tully, 2006a; Capie et al., 2005). More recently, Ji, Zhang and Zhao, (2020) investigate whether the diversification ability of gold and exchange rate with equity returns is still valid at the time of COVID-19 pandemic when investors are facing unprecedent risk in the financial markets and encountered with increasing need to safe haven assets to diversify their portfolio risk. They study the highly infected regions, China, Europe and United States from August-December 2019 as a training period and from 1st December 2019 to 30th March 2020 as a testing period. The sequential monitoring procedure is employed to captures the changes in the left quantile of assets returns. This procedure help assess whether the inclusion of safe haven assets in the portfolio can offset the tail changes in stock returns. The overall finding suggests that during COVID-19, the role of safe haven, exchange rate, has deteriorated whereas gold remains as robust safe haven asset with time varying property.

Pertaining to Pakistan, Raza et al., (2016) estimate the nonlinear relationship between gold, oil prices, and their volatilities with stock prices. The nonlinearity exists across short and long run. Further results indicate that gold prices affect stock prices positively whereas gold volatility influences stock price negatively in emerging markets, including Pakistan. Similarly, the crude oil price exhibits positive impact on BRICS stock markets, however, crude oil volatility, with different magnitude of coefficients, negatively affect the stock market of India, Brazil and Thailand in the short run. Almost the similar relationship is also highlighted for the long run as well. These findings suggests that the construction of portfolio comprising gold, oil and stock market can well

diversify the overall risk of portfolio. In the context of Pakistan, such findings are also supported by Bilal et al., (2013) suggesting no cointegration between gold prices and stock prices in Pakistan and India.

Likewise, Aftab et al., (2019) estimate the relationship between gold prices, exchange rate and equity prices in 12 countries covering East Asia, South Asia, and Southeast Asia equity markets from 1993 to 2013. Overall, dynamic conditional correlation-multivariate generalized autoregressive conditional heteroscedasticity (DCC-MGARCH) estimation suggests gold acts as a safe haven rather as hedge against Asian currencies[4]. The adverse impact of gold is more pronounced in Singapore, Korea and Thailand, however, such an association with stocks even gets more negative during Asian financial crisis (1997 to 1998) and subprime crisis (2007 to 2009).

2.2.Portfolio Diversification and Wavelet Analysis

The previous section highlights the studies that employed traditional model to estimate the relationship, short and long term, among asset class as being hedge or safe haven. This section focuses the studies that have utilized wavelet approach to study the relationship among asset classes in time and frequency domain.

Rau and Nunes (2009) study the co-movement of stock returns across Germany, Japan, UK and United States on aggregated as well as sectoral levels. The diversification ability of the stocks from different countries is measured through a statistical tool, value at risk (VaR). The wavelet coherency overall suggests the strength of the co-movement of international stock returns is frequency driven where the two stock markets share stronger co-movement at lower frequency (in the long term). Thus, these finding establish that the reap of diversification is less in long term than in short-term. These finding are very important for the investor whose investment horizon is short. Moreover, wavelet coherency also confirms that the strength of co-movement in time and frequency space differs across countries as well as across sectors. The study produces interesting finding as, for instance, even though Japanese stock market exhibits weak correlation with other stock markets in developed counties (Berben and Jansen 2005); but still some sectors, such as technology and consumer goods, show strong co-movement at specific time and frequency span. The degree of co-movement among assets across countries has changed over time, however, these changes are confined to specific frequency ranges.

Furthermore, these changes also differ in term of their persistence in time. For instance, the co-movement of US and UK stock markets with German stock markets are characterized as gradual but steady increase at lower frequencies but afterwards it suddenly increases for other frequencies. On the contrary, the stronger co-movement between US and UK can be observed at higher frequencies around 1987 crash and around burst of technological bubble. The co-movement between US and UK stock markets with German stock markets is a phenomenon that may be because of increases integration among financial markets, whereas the stronger co-movement between US and UK stock markets is many be due to contagion. This detailed insight into the co-movement among international stock markets become possible by applying time and frequency varying properties of stock returns.

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[4] Please refer to note 3 for the definition of safe haven and hedge asset classes

More recently, Bredin, Conlon and Poti (2015) study the role of gold with traditional investment assets, equity and bond, in US, UK and Germany from 1980 to 2013. Purposely, they investigate the property of gold as being hedge or safe haven with traditional investment assets, simultaneously in calendar year and investment horizon. The wavelet coherency demonstrates the lower codependence, on average, between gold, bond and equities for UK, US and German markets. These findings support the status of gold as being hedge for traditional assets for the horizon of one year investment. However, during market turmoil, Black Monday crash in 1987, gold act as a safe-haven, negative codependence, for equities for up to one year of investment horizon. These findings are important for the short-term investors. In contrast, gold is not found to be as safe haven for US based equities, rather exhibiting positive association, during economic downturn in 1980s. These findings are further supported by Bouri et al., (2020) as low codependence of gold with equities in developed, developing, US and Chinese markets is also observed.

There are three problems emerged after considering above studies. First, there is a lack of studies that have thoroughly investigated the maximum number of asset classes in Pakistani market and identify their status as being hedge or safe-haven assets. Second, we are unaware of a comprehensive study that have explored the co-movement of real estate with other available investment classes in Pakistan collectively. This missing link is very important to analyze as due to uncertain economic and political circumstance in Pakistan, investors are highly inclined towards safe investment in real estate to ascertain price appreciation and rental yield. Third, existing studies could not establish the nature of co-movement among asset class in Pakistan i.e., whether co-movement is stronger (weaker) at different level of frequencies (short and long term) and does the nature of co-movement changes over time and how these asset classes respond to market crashes or economic down turns?

3. Data Collection, Variables Description and Methodology Explanation

3.1. Data and Variables

The objective of the study is to identify the save haven properties of asset classes in Pakistan over the monthly period from January 2011 to December 2020. For this purpose, we have taken five asset classes for save haven investments such as equity, real estate, oil, US Dollar and gold. The KSE-100 index as an indicator of the stock market equity of Pakistan. In depth analysis, we, further, disaggregated real estate sector into three dimensions such as house, plot/land, and residential property. For real estate sector, data is taken from the well-known website for real estate in Pakistan (Zameen.com). The reason for choosing the portal zameen.com is of its well-known reputation among domestic and international real estate customers. This company claims that it is the fifth largest portal for property dealings all over the world, adding to this over five million users and 350,000 monthly listings Umar et al. (2019); Yousaf and Ali (2020). The data of these three real estate dimensions is taken at the country level (Pakistan). The data series of Equity, House, Plot, Resident, Oil, Gold and US dollar is converted into Pakistan Rupees. Then we have calculated their returns to evaluate the save haven investment portfolio. Table-1 describes the name of variables, their definition, and data source.

Table-1: Data Description and Source

Variable Name	Definition	Source
Equity	KSE-100 Index	Yahoo Finance
House	House PKR Price/ Sq. Ft.	Zameen.com. Umar et al. (2019); Yousaf and Ali (2020)
Plot/Land	Plot PKR Price/ Sq. Ft.	Zameen.com. Umar et al. (2019); Yousaf and Ali (2020)
Resident	Residential Property PKR Price/Sq. Ft.	Zameen.com Umar et al. (2019); Yousaf and Ali (2020)
Oil	Oil Prices (PKR/bbl)	World Bank Commodity Price Data
Gold	Gold Prices (PKR/troy oz)	World Bank Commodity Price Data
US Dollar	Nominal Exchange Rate	State Bank of Pakistan

3.2. Wavelet Analysis

The wavelet coherence, average cross wavelet power and (Grinsted et al, 2004) and wavelet VaR (Rua and Nunes, 2009) is applied to ascertain the diversification ability across seven asset classes (stock, real estate house, real estate plot, real estate residential, exchange rate, gold, and oil). The wavelet coherence reveals the co-movement among safe haven assets at time-frequency domain. The nature of seven asset classes, in terms of investment horizon and liquidity, is distinct, hence, attract number of market participants such as investors and speculators. For instance, investment horizon is long, several months to several years, for institutional investors and portfolio managers whereas, in contrast, speculators, chartists, event-driven or day traders, have investment horizon from several minutes to several days (Bouri 2020). The wavelet coherence and cross average wavelet power provide answers to each type of market participants. Notably, wavelet analysis identifies the bast combination of asset classes to hedge portfolio risk and also shows the causal relationship over the range of difference time-frequencies domain.

The current study estimates the diversification ability of all assets classes in time-frequency domain to provide the portfolio implication by employing value-at-risk (VaR), wavelet VaR, introduced by Rua and Nunes (2009). Finally, the wavelet VaR approach identifies risk reduction portfolio due to either weak or no co-movement between underlying assets.

3.2.1. Wavelet Coherence

The wavelet function is comprised of small wave which can be squeezed or stretched over time to obtain the frequency factor from a dense signal. The wavelet function decomposes the time series into time and scale components and further highlights the structure and variability of stochastic process on a scale.

The mother wavelet, that produces smaller waves, is a function expressed in time *(t)* and scale *(s)*. The mother wavelet is as:

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}} \psi\left(\frac{t-\tau}{s}\right)$$

(1)

In equation (1), τ represents the translation parameter (time position), s denotes dilation parameter related to frequency (scale) and $\frac{1}{\sqrt{s}}$ is a normalization factor that makes sure the comparability of wavelet transformation persists across time and scale[5].

Depending upon the research objective, the current literature encapsulates the various types of wavelet approaches to decompose the time series data. To identify the safe haven and best combination among asset classes in Pakistan, we apply Morlet wavelet approach. One of the benefits of Morlet wavelet is to provide the finest balance between time and frequency localization (Addison 2002; Rau and Nunes 2009; Bouri et al, 2020). Morlet wavelet is the most commonly used approach in mother wavelet (Rau and Nunes 2009) which is defined as:

$$\psi^M(t) = \frac{1}{\pi^{1/4}} e^{i\omega_o t} e^{-t^2/2}$$

(2)

In equation (2) we use $\omega_0 = 6$ as a central frequency which provides appropriate localization between time and frequency[6] (Torrence & Compo 1998; Grinsted et al., 2004; Aguiar-Conraria et al, 2008).

The wavelet analysis can either be performed through continuous wavelet transform (CWT) or the discrete wavelet transform (DWT). The CWT is advantageous over the DWT in terms of the freedom it provides to select wavelet as per the length of time series. Moreover, CWT discovers the patterns and make them easier to interpret (Aguiar-Conraria and Soares 2011). The CWT of W_x, discrete time series data $\left(x(t), t = 1, \ldots N\right)$, with respect to the ψ_t is represented through the following convolution.

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t)\psi_{\tau,s}^*(t)dt = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t)\psi^*\left(\frac{t-\tau}{s}\right)dt$$

(3)

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[5] To decompose the time series, mother wave $\psi(t)$ must meet certain properties that it should have zero mean, $\int_{-\infty}^{\infty} \psi(t)dt = 0$, and it has square integrated to unity, $\int_{-\infty}^{\infty} \psi(t)dt = 1$. This is that $\psi(t)$ is confined to interval of time. Furthermore, the condition of admissibility should also be satisfied as $0 < C_\psi = \int_{-\infty}^{+\infty} \frac{|\psi(\omega)|^2}{\omega} d\omega < +\infty$, where $\psi(\omega)$ is a Fourier transform is represented of $\psi(t)$, that is $\psi(\omega) = \int_{-\infty}^{+\infty} \psi(t)e^{-i\omega\tau}dt$.

[6] $\omega_0 = 6$ is commonly used in analysis in economics. (Also see Shahzad et al., 2017)

The * in equation (3) represents the complex conjugate. Conspicuously, wavelet transform store the energy of time series data that can further be analysis by the power spectrum. Similarly, the variance of the time series is given by the following formula.

$$\left\| x \right\|^2 = \frac{1}{C_\psi} \int_{-\infty}^{+\infty} \left[\int_{-\infty}^{+\infty} \left| W_x(\tau,s) \right|^2 dt \right] \frac{ds}{s^2}$$

(4)

The cross-wavelet power $\left| W_{xy}(\tau,s) \right|$ of two time series $x(t)$ and $y(t)$ with the continues transforms $W_x(\tau,s)$ and $W_y(\tau,s)$.

$$W_{xy}(\tau,s) = W_x(\tau,s).W_y(\tau,s)$$

(5)

The cross-wavelet power determines the high common power shared by the two time series in time and frequency domain. According to Torrence and Compo (1998) wavelet coherence is the squared absolute value of the smoothed cross wavelet spectra that is normalized by the product of the smoothed individual wavelet power spectra. The squared wavelet coherence is presented as following convolution.

$$R^2(\tau,s) = \frac{\left| S\left(s^{-1} W_{xy}(\tau,s) \right) \right|^2}{S\left(s^{-1} \left| W_x(\tau,s) \right|^2 \right).S\left(s^{-1} \left| W_y(\tau,s) \right|^2 \right)}$$

(6)

In equation (6), the wavelet coherency and smoothing factors are stated by R^2 and $S(.)$, respectively. The intuition behind the wavelet coherency is analogous to squared coherency in Fourier analysis. The wavelet coherency, as can be seen in equation (8), is simply a ratio of squared cross wavelet spectrum to the product of two wavelet spectra. In simple words, squared wavelet coherency acts as a correlation coefficient around every moment in time as well as in frequency. Thus, the wavelet coherency can be estimated to measure the extent to which two series comove in different time over different frequencies. The value of $R^2(\tau,s)$ is between 0 and 1, which shows high (low) values, indicating a strong (weak) movement between two time series. Therefore, the wavelet coherency graph helps detect the areas of frequency space where two time series move together, moreover, it captures both time and frequency varying attributes. Hence, this provides greater picture on co-movement among asset classes.

Additionally, wavelet coherency analysis shows us the lead-lag association between time series data, however, it avoids the issue of squared coherency that is not being able to distinguish between the positive and negative relationship between time series.

$$\phi_{x,y} = \tan^{-1} \frac{\xi\{W_{xy}(\tau,s)\}}{\Re\{W_{xy}(\tau,s)\}}, \qquad \phi_{x,y} \in [-\pi, \pi] \tag{7}$$

Equation (7) identifies the phase difference where ξ and $\Re$ provide the imaginary and real portions of smooth power spectrum. The directional arrows represent the standard phase difference on time-scale wavelet coherence chart. The arrows pointing to the right (left) support positive (negative) correlation between the series and, moreover, arrows pointing upwards means first series leads the other by $\pi/2$, whereas vice versa if arrows pointing downwards.

The wavelet coherency produces results on a standard chart with time on x-axes and scales (also called frequencies) on y-axes. The coherence between two time series is depicted by the color scheme where hotter (cold) color means higher (lower or no) coherency. Monte Carlo simulations provide the statistical significance, marked by tick black curves, and assume a red noise (AR (1) process). The validity of wavelet results suffers because wavelets are more stretched at higher frequencies. In order to deal with this issue, wavelet chart presents cone of influence to distinguish between the reliable and less reliable regions of time and frequency space.

From the perspective of diversification ability of six asset classes as being safe haven for equity, if the combination of two assets shares low or no relationship i.e., lower co-movement. The low or no co-movement is highlight by blue color whereas higher co-movement is represented by red hotter color. The former is a sign of assets being save haven and latter reject the combination of two assets as being save haven.

3.2.2. Wavelet VaR

To measure the diversification ability all asset classes for risk management, we carry out the VaR analysis of portfolio of each combination consisting two assets. The VaR quantifies the likelihood of loss of a portfolio over a specific timeframe. VaR also identifies the reduction in risk due to weak or no co-movement between assets classes. For the portfolio of N assets, the VaR is defined as:

$$VaR(\alpha) = V_0 \Phi^{-1}(1-\alpha)\sigma_p$$

(8)

In equation (8), α confidence level, V_0 is an initial investment, $\Phi(.)$ is a cumulative distribution function of the normal distribution whereas σ_p is square root of portfolio variance. The variance of the portfolio is estimated through the following formula.

$$\sigma_p^2 = \sum_{i=1}^{N} \omega_i^2 \sigma_i^2 + \sum_{i}^{N} \sum_{i \neq j}^{N} \omega_i \omega_j COV(r_i r_j) \tag{9}$$

Equation (9) estimate the variance of the portfolio where ω_i, σ_i^2, and r_i represent the weight, variance and returns of asset *i* in the portfolio, respectively. The variance of portfolio, in right side of the equation (9), is comprised of two components. First, component reflects the return variance of each stock in the portfolio whereas, second, component reflects the degree of co-movement[7] . Based on the methodology of Rua and Nunes (2009), we calculate the VaR of portfolio assuming that there is no co-movement between the two stocks, which is the first part of left-hand side of the equation (9). Then we compute another VaR of same portfolio assuming the co-movement between the two assets (complete equation (9)). For a greater insight and comparison purposes, we compute the VaR ratio between two VaR measures – called ratio of portfolio VaR. The ratio of portfolio VaR identifies the increase/decrease in the risk of the portfolio due the co-movement. If the ratio is equal to one that means co-movement does not affect the risk of the portfolio, however, if the ratio if greater (less) than one, it means co-movement increase (decreases) the over risk of the portfolio. Thus, the ratio less than one indicates that the two assets can be considered as safe haven and carrying a diversification ability whereas ratio more than one suggests that the assets cannot be regarded as safe haven. We apply wavelet analysis on our VaR variant; thus, its findings are parallel the results of wavelet coherency.

4. Empirical Findings

This section provides the empirical finding of wavelet coherence and wavelet VaR framework. Before the estimation, Table-2 provides the summary statistics for the data. KSE100 index has the highest mean returns followed by plot, residential, gold house, oil, and US dollar. Surprisingly, oil has a lowest mean returns but highest standard deviation which represents the higher volatility in oil due to recent hike in the prices. On the other hand, KSE-100 index and plot are negatively skewed where left hand tail is longer than right hand tail and house, residential, dollar, gold, and oil negatively skewed where right hand tail is longer than the left-hand tail. Furthermore, plot, dollar, and oil have a heaver tail (carrying more date on tail) than the normal distribution, whereas KSE100 index, house, residential and gold characterized with light tail (carrying less data on tail) than the normal distribution. This suggests a greater degree of losses if the time series has heavier tail.

Table-2: Descriptive Statistics

Asset Classes	Mean	Median	Standard Deviation	Skewness	Kurtosis
KSE 100 Index	0.012	0.018	0.059	-0.359	1.727
House	0.008	0.006	0.010	0.473	0.496
Plot	0.009	0.004	0.017	-0.206	4.028
Residential	0.009	0.006	0.011	0.248	2.733
Dollar Exchange Rate	0.005	0.0007	0.020	1.579	6.433

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[7] Following the similar approach of Rua and Nunes (2009), we use the counterparts of the variance and covariance to apply wavelet VaR approach.

| Gold | 0.009 | 0.009 | 0.039 | 0.676 | 1.570 |
| Oil | 0.005 | 0.016 | 0.104 | 0.052 | 4.613 |

Figure-1 shows wavelet coherency graphs that captures the co-movement between equity and other six asset classes and identify safe-haven assets in time and frequency space. The wavelet coherency contour plot presents time domain on horizontal axis and frequency domain on vertical axis. The frequency domain is shown, which is also called scale, in number of months where higher number indicates longer investment horizon. The colour patterns in graphs represents the strength of relationship between asset classes i.e., the hotter the colour the higher the association between two assets. Moreover, the lead-lag relationship and sign of dependence is indicated by the direction of arrows. For instance, the arrows pointing to the East (West) signifies the positive (negative) association between two assets. On the other hand, arrows pointing North shows first asset leads to the second asset, whereas arrows to South indicate second asset leads to first asset. All the graphs, from A to G in figure 1, carry equity (KSE100 index) as first assert or representative assert whereas the second assert is a potential safe haven.

In Figure-1A, the association between equity and house is mostly dominated by the blue colour in lower frequency (short term) pace throughout the sample period. Mostly the correlation coefficient remains below 0.3 which indicates lower co-movement where portfolio risk can be diversified in the short-term investment horizon. However, recently, in 2020, correlation increases around 0.5 significantly and reduces the role of house as safe haven asset. Moreover, south-west arrows in the significant area indicates negative relationship where KSE100 leads housing prices for the investment less than a month horizon in 2020. These findings are evident that house acts as safe haven in the short-term investment horizon. On the other hand, diversification ability of house deteriorate as the investment horizon increases from 2 to 8 months as indicated by green colour dominance, a sign of modest coherency. The wavelet coherency increases above 0.9 for investment horizon of 4 months throughout the sample period as shown by the red colour. The investment greater than 8 months almost complete eradicates the risk reduction ability of house because of dominance of red colour indicates higher coherency. Overall, Figure-1A suggests house acts as a safe haven but in short term investment horizon.

In case of plot, Figure-1B presents a coherency between equity and plot prices. Analogous to housing prices, plot also possesses hedging properties up to one month investment horizon, as shown by the blue colour throughout the sample period from 2011 to 2020 with few exceptions in 2017 and 2020. At a medium investment horizon from 1 to 4 months, the evidence is mixed which suggest a sustained period of modest coherency, on average the green colour is prominent. Thus, reducing the diversification ability of plot. However, the coherency again decreases for 2 months investment horizon throughout the sample period. The direction of arrows in significant patches shows the relationship changes in the short- and medium-term investments horizon. For instance, west (east) facing arrows indicate negative (positive) relationship between equity and plot. Moreover, in 2017 plot prices lead equity and vice versa for 2018 as indicated by west-north and west-south facing arrows, respectively. The changing direction of arrows further imply that plot acts at a safe haven. Although long term investment horizon mostly eliminates the diversification

ability of plot as shown by red colour in moth 7 to 8, at lower frequency, but blue colour line in month 5 to 6 still suggests hedging properties of plot for equity.

The residential property in Figure-1C carries higher degree of safe-haven properties for equity as indicated by the dominance of blue colour in the short as well as up to medium term investment horizon. Investment in residential property diversify the portfolio risk from 2017 to 2019 up to 2 months investment horizon however, safe-haven properties decrease low frequency phase (4 to 8 months). The real estate variables show almost similar patterns of colour from short to long term investments. One plausible reason is the higher degree of investment in all three areas of real estate (house, plot and residential) in Pakistan. The rapid appreciation of plot prices and rental yield for plot and house is the safest investment in Pakistan. The overall impact of diversification between stocks and different dimensions of real estate affects almost in similar manner.

The association between US dollar and equity in Figure-1D also varies across time and frequncy. From 2016 to 2020 correlation coefficeint remains below 0.3 in short to medium term investment horizon. In this phase exchange rate acts like a save-hevan. However, the diversification ability of exchange rate decreases in the long term invesment horizon and correlation coefficent reaches above 0.8. The arrows facing west, in the significant regions, indicate a negative relationship between exchange rate and KSE100. Moreover, north-west left upward facing arrows indicates exchange rate leads KSE100 index. Overall figure D shows that the exchange rate does not diversify the portfolio risk in long term investment horizon, from 2 to 8 months.

Figure E details the wavelet coherency between equity and gold. On aggregate level, Figure-1E suggests higher diversification abilities, lower codependency, in the short term investment horizion up to 2 months which is dominated by the blue colour where correlation coefficient is below 0.3 almost throughout the sample period. However, there is a little band of higher coherency, green colour, characterized by upward north-west facing arrows. This suggests that gold prices causes the equity prices in the short term investment horizon. These finding also suggests that glold act as a hedge for equities in the short term. Moving towards the long term investment horizon, figure E shows existence of higher coherency, signified by the breif bands of green and red colouring. The mediam and long term investment horizon also welcome the negative coherency between gold and equity indicated by the doward arrows. The south-west facing arrows also indicate that equity prices causes gold prices from 2016 to 2018 for 2 month investment horizon, however, these findings are opposite the finding in the short term investment horizion. The upward north-west facing arrows indicate gold causes equity prices from 2015 to 2018. Overall our results suggest that relationship between gold and equity changes from short to long term investment horizon as shown by the direction of arrows in the significant bands.

Figure-1: wavelet coherence between KSE-100 and other six asset classes such as house, plot, residential, dollar exchange rate, gold, and oil from figure A to F, respectively.
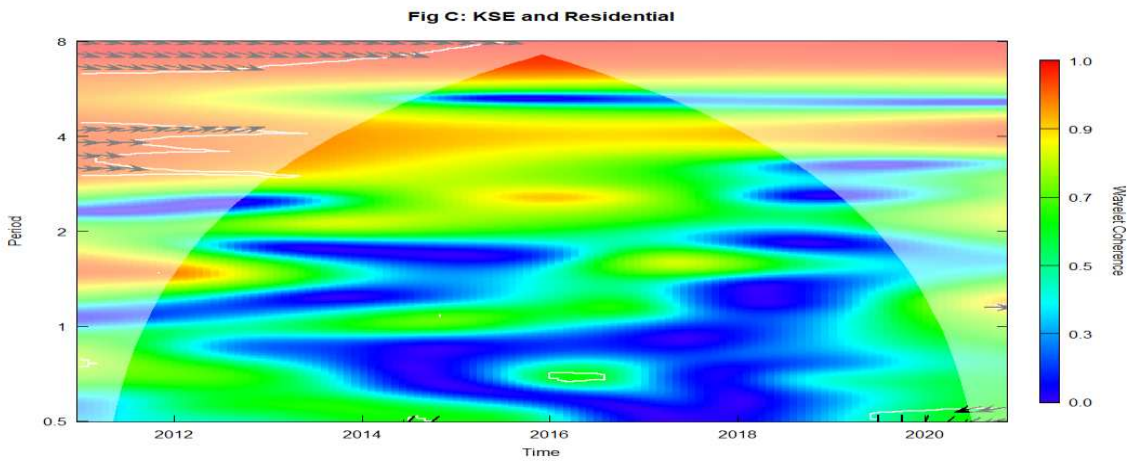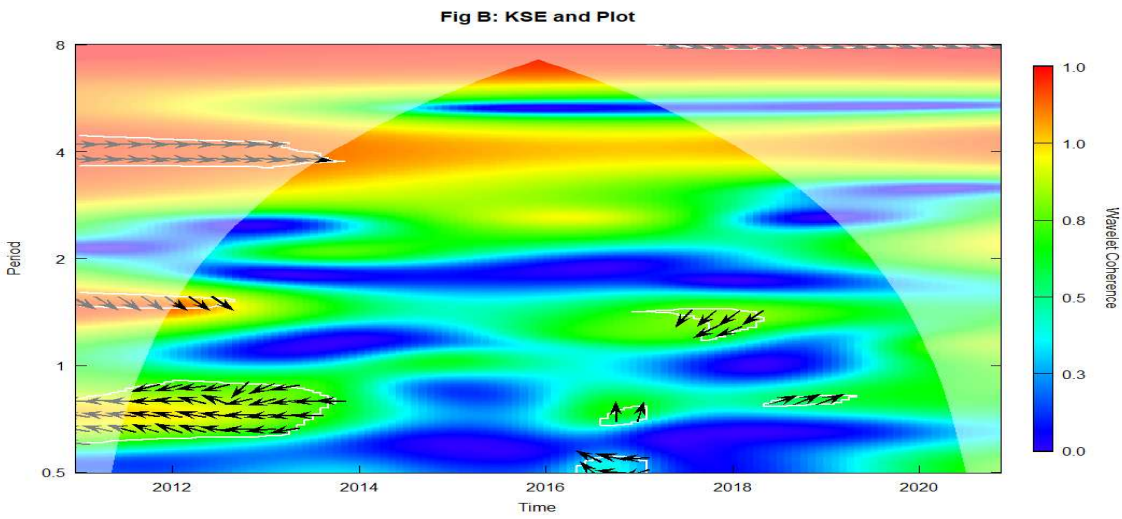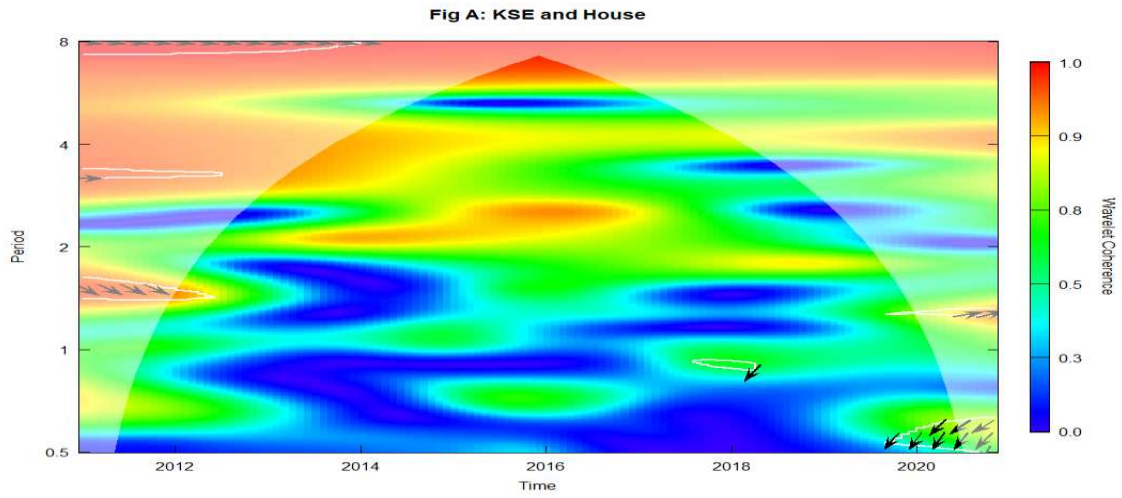

Fig A: KSE and House

Fig B: KSE and Plot

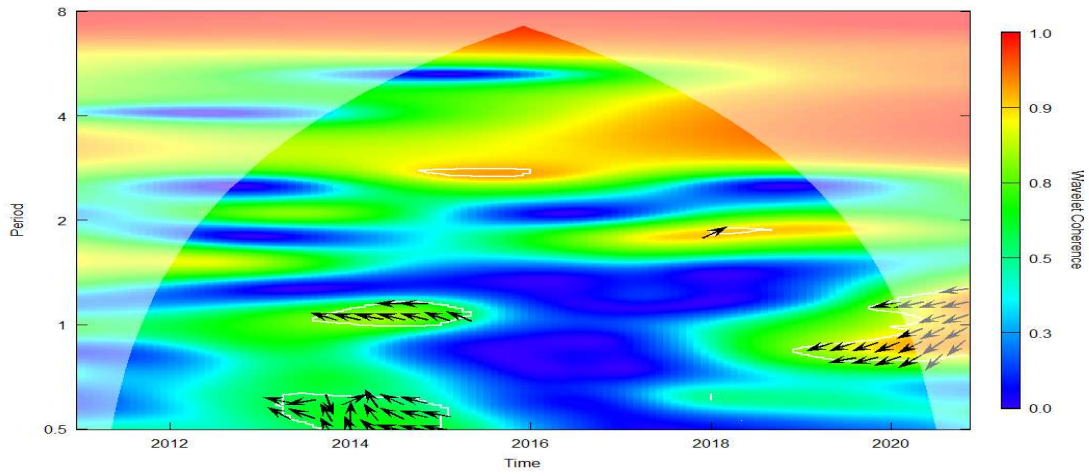Fig C: KSE and Residential
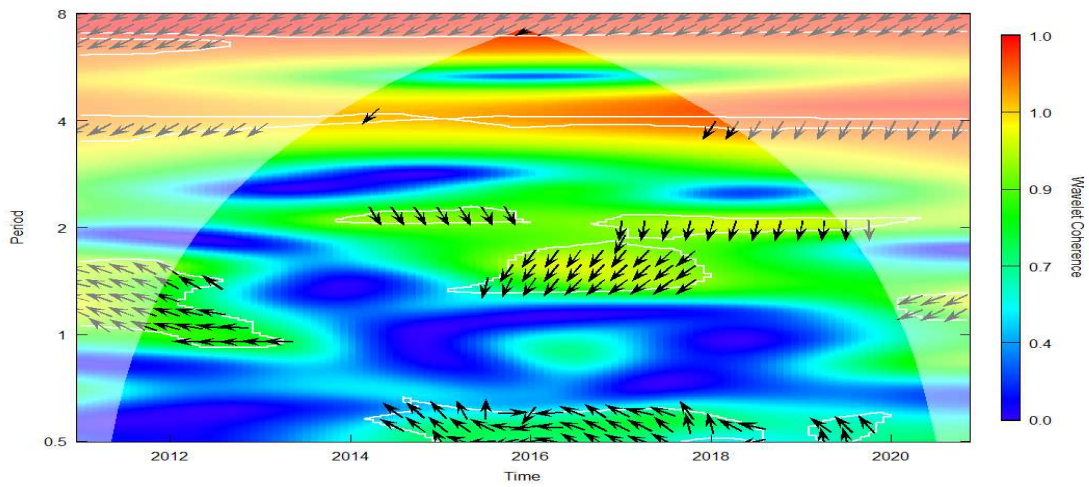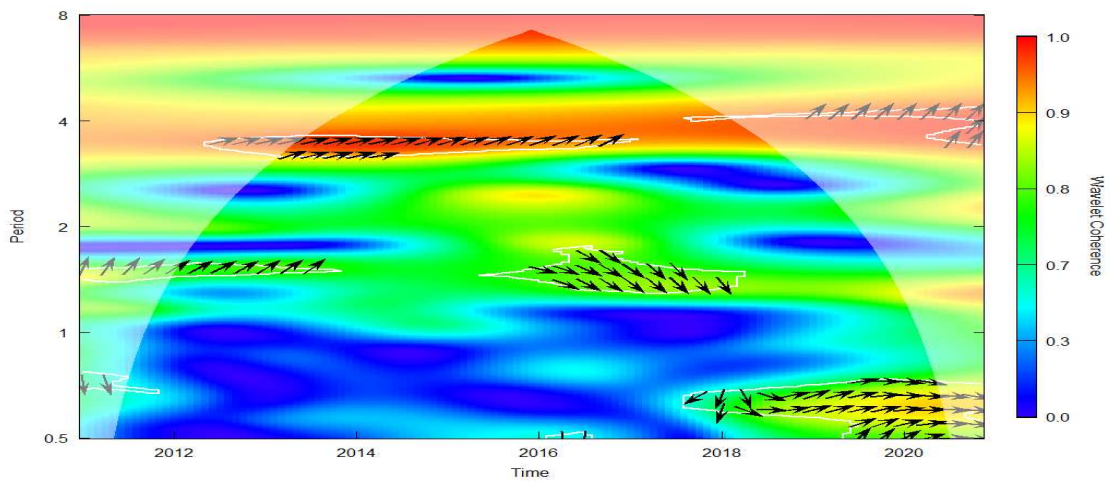
Fig D: KSE and Exchange Rate

Fig E: KSE and Gold

Fig F: KSE and Oil

In case of oil, in figure-1F, diversification is more pervasive in the short term investment horizon from 2011 to 2018. However, 2018 onward coherency increases to 0.8 and 0.9 as indicated by green and yellow colours, respectively. The arrows facing towards east in the significant band shows a positive relationship between oild prices and equity prices in the short term investment. Moreover, the downwards left arrows in the short term investment band indicate oil pirce causes the equity prices. The asset class oil act as a hedge in the short term investment horizon. The diversification ability of oil subsententially decreases when investment horizon is greater than 1.5 months. In the mediam term investment the correlation remain between 0.7 to 0.8. In the early phase of sample period, 2011 to 2014, stock prices causes the oil prices in the mediam term investment, however, such causation reverses as stock prices causes the oil prices from 2016 to 2018. Oil does not reduces the portfolio risk in the long term investment specaially in 4 months investment horizon and above 6 months.

We extend our analysis of wavelet coherence to offer more insight into the safe haven role of six asset classes through their respective association with equity prices using wavelet VaR framework. The estimation of portfolio risk through VaR is essencial for investor and portfolio managers. The results of wavelet coherence are deep-rooted but, through a direct connectivity with safe haven properties, VaR provide them more solid ground. The graphs of wavelet VaR are in pairs of each six asset classes with equity in figure-2. The interpretation of these graphs is parallel to wavelet coherence graphs. For instance, the hotter colours (red and yellow) indicates higher VaR whereas cooler colours (blue and green) represents lower VaR. The former suggests that the asset class under study lacks the safe haven properties whereas the latter suggests otherwise.

Figure-2A for real estate variable, house, we observe that the green colour mostly dominates along with few exception in 2015 to 2016 and 2019 to 2020 where red colour represents significant losses in mediam and short term investment horizon. These finding suggests that the risk of portfolio increases at early phase of investment for 2016 and 2020, however, decreases when investment horizon increases. Contrary to house, investment in plot, to diversify the portfolio risk, figure-2B shows the dominance of red and yellow colours. These finding suggests that investment in plot and equity is more prone to losses. These losses are significant from 2013 to 2020 and spread almost across short to long term investment horizon. The risk contribution from plot is much higher than the house where the VaR ratio remains above one. This concludes, comparatively, that plot is not a good diversifer. The results for thrid real estate variable residential, figure-2C, provides much more informative insight than those solely based on wavelet coherence. We can see the risk is dominant only for 2014 to 2015 for short and mediam term investment horizon. For the remaining sample period wavelet VaR ratio remains below one. These finding suggests that residential property is the best diversifable asset class as compared to house an plot. However, overall, the all three dimensions of real estate are subject to some losses during the investment horizon. Beside residential property, losses in house and plot are more confined to latter phase of the sample period. One possible reason could be because of government imposing a restriction on selling real estate property within the 3 years of the purchase to control the rapid increase in the real estate prices which disrupted property prices in real estate market. Our findings are in line with Yousaf and Ali (2020).

For the US Dollar, figure-2D, the losses are concentrated in later part of sample period for short and long term investment horizon. One of the reasons for these losses could be higher degree of volatility in US dollar exchange rate to Pakistan ruppees in recent era. A free flight of dollar and government's effort to control the rapid increase of dollar against Pakistan ruppees lead to higher volatility in exchange rate againt dollar. A greater uncertaintiy in US dollar value runs into losses. However, investment in dollar overall decreases the portfolio risk. Gold possesses more loss diversifying properties as compared to US. dollar as shown in figure-2E. The wavelet VaR ratio is higher for early phase of the sample period, however, significantly decreases for the remaining sample period. One of the reasons for higher diversifiying ability of Gold is rapid increase in Gold prices in recent era that has invited short term invesment from investors in Pakistan. The dominance of green and blue colour suggests gold is a good diversifier for short as well as for long term investment horizon. These finding are also supported by Chang, et al., (2020). Figure-2F shows the risk diversifying ablity of oil. The wavelet VaR ratio remains above one from 2013 to 2015, however, spreads when move from short to mediam term investment horizon. In recent years from 2016 to 2020 VaR ratio remains below one. Based on the finding specailly for the later part of the sample period, we can conclude the oil is a good risk diversifier. One of the reasons of risk diversifiability is the constantly rising oil prices in Pakistan which attact investors and portfolio managrs. However, oil is not as good risk diversifier as gold. Similara finding are also supported by Raza et al. (2016) who defined oil as risk diversifying asset class in emerging markets.

Figure-2: Wavelet VaR between KSE-100 and other six asset classes such as house, plot, residential, dollar exchange rate, gold, and oil from figure A to F, respectively.
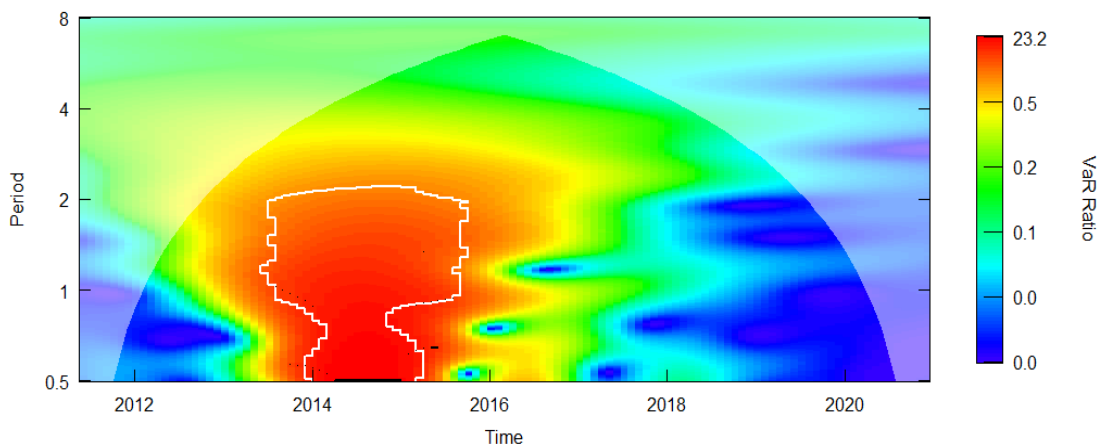

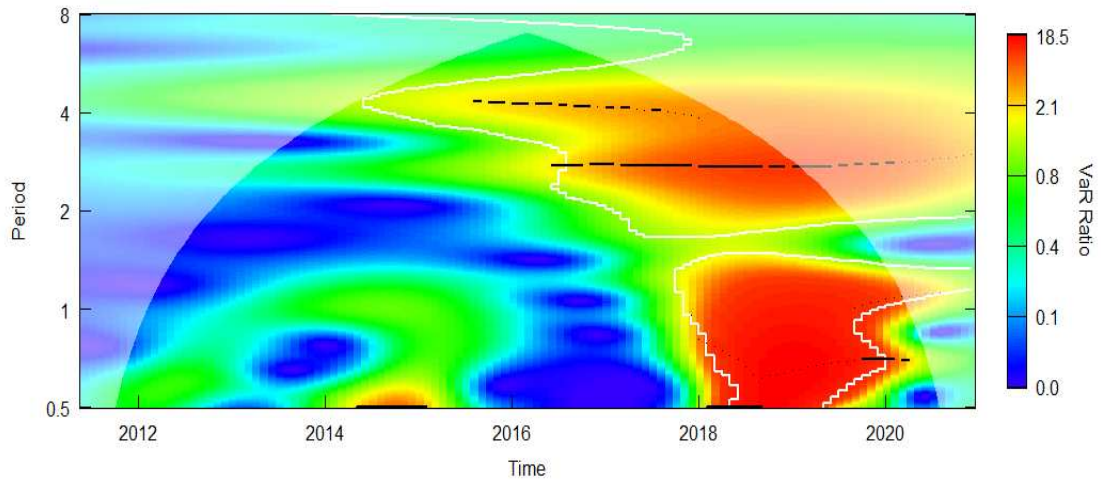Fig A: Wavelet VaR for KSE and House with and without comovement
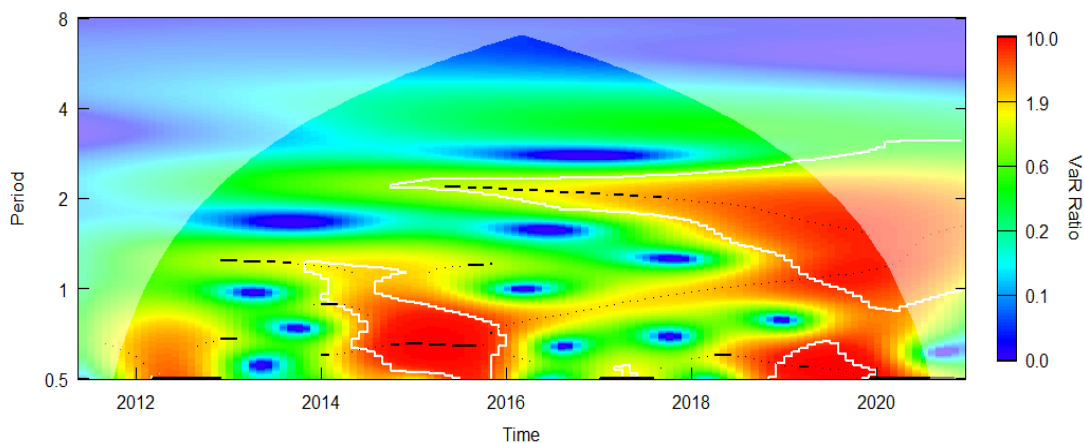
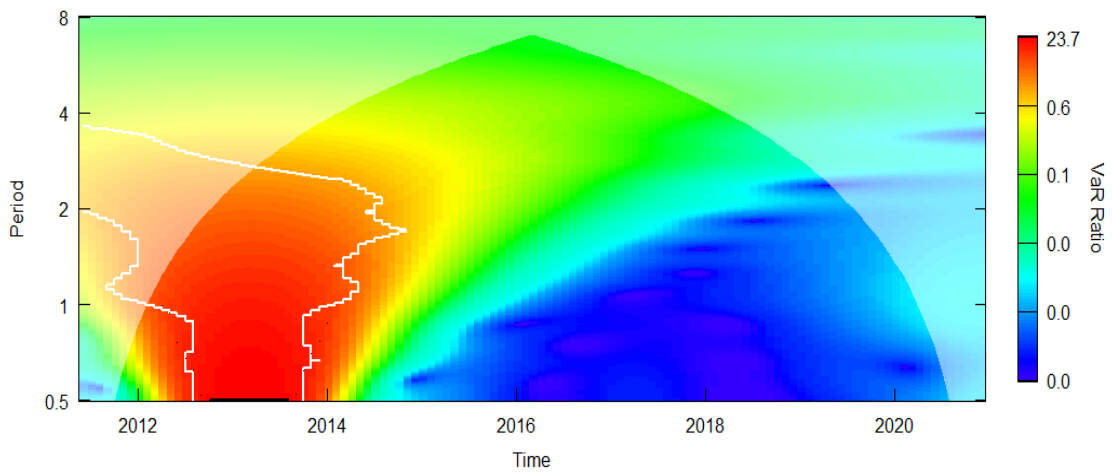Fig B: Wavelet VaR for KSE and Plot with and without comovement
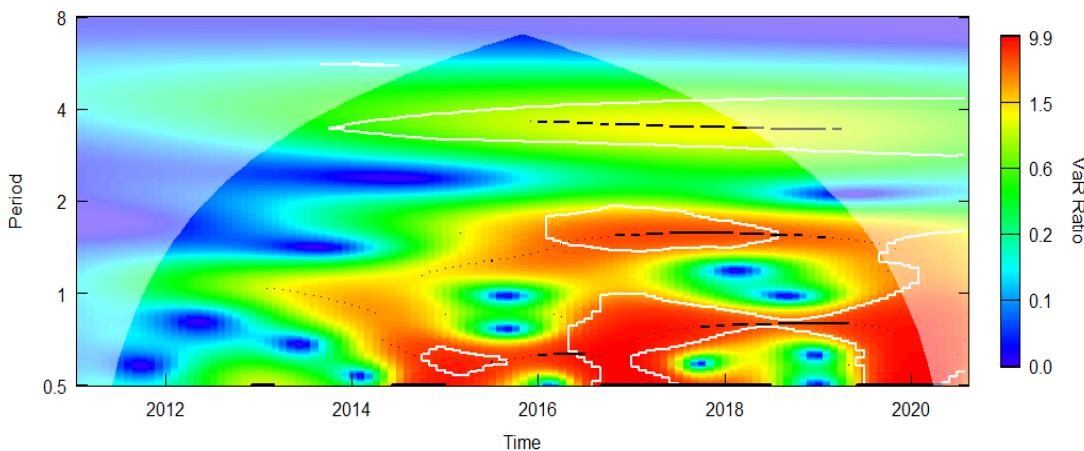
Fig C: Wavelet VaR for KSE100 and Residential with and without comovement
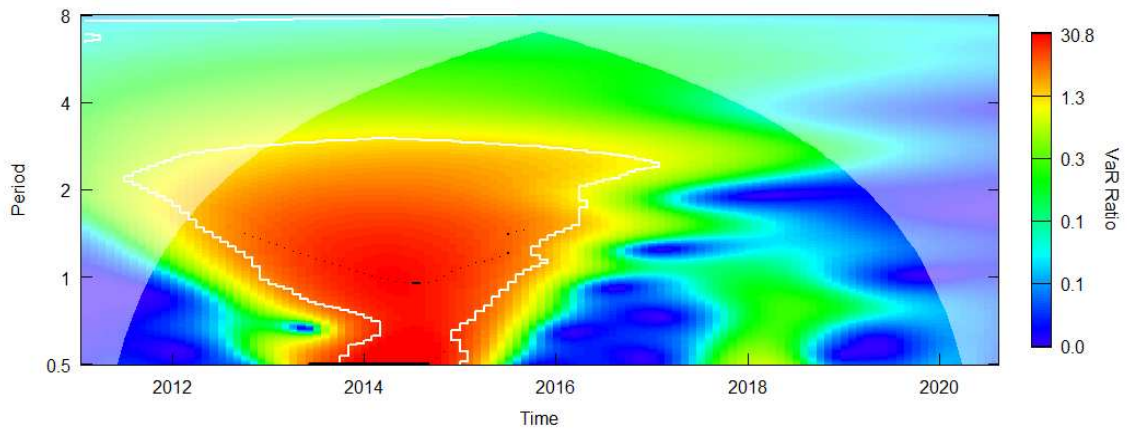
Fig D: Wavelet VaR for KSE100 and Exchange with and without comovement

Fig E: Wavelet VaR KSE100 and Gold with and without comovement

Fig F: Wavelet VaR for KSE100 and Oil with and without comovement

5. Conclusion and Recomendations

In this study, we compare the safe-haven role of six assets classes (house, plot, residential, exchange, gold, and oil) against equity (KSE100 index) in Pakistan. We utlize the approach that encompasses heterogeneity across time and sclae evolution. We also employ wavelet value-at-risk that encapsulates risk across time-frequency space for the portfolio comprised of equity and one possible safe-haven asset. Our findings are important for the financial investors and business developers, with short and long term investments, who pursue the assets with higher risk diversifying ability to minimize the likehoold of extream portfolio losses.

We summuarize our main findings as follows, Firtly, the wavelet coherence analysis is evident that among the real estate variables hosue and residential properties are more independent than the plot property, whereas, plot property exhibits greater phases of negative dependence. Wavelet VaR estimation, focusing on tail dependecne, shows that residential property possesses a supperior degree of risk diversification followed by house and plot, respectively. Secondly, The wavelet coherence is also evident that the gold shares higher degree of negative relationship with equity followed by oil, and exchange, respectively. These findings are also supported by wavelet VaR analysis that encapsulates gold with a greater degree of portfolio risk diversifier followed by oil, and exchange, respectively. Third, we also abserve that the wavelet coherence produces some how simlar results for each asset class against equity. For instance, subsentential amount of benefits of diversification is visible in the short term investment horizon, however, such benefits decrease as investment span increase. These trends are analogious across all asset classes in Pakistan. Moreover, these trends exhibits that all the assets classes cointegrate with stock market, particularly in the long run. Furthermore, The wavelet VaR apparently shows the presence of losses associated to each asset class in time and frequency dimensions. Thus, based on these findings, we conclude that the magnitude of diversification varies in the short term investment horizon across asset classes, however, tend to deminishes (correlation increases) for mediam to long term investments.

Based on our findings, this study suggests few safe haven assert classes for investment that eventually reduce the portfolio risk. It makes easier for an individual investor and portfolio mangers to comprehand such co-movements through diagrams. Local and international investors can allocate their investments in the equity along with residential property or gold and avail the diversification benefits in the short term, maximum up to 4 months investment horizon. Therefore, the nature of the investor, in terms of short or long-term profile, should be taken into account when addressing the portfolio diversification problem at national level. We As an optimal combination, investor should first condiser the gold as a risk diversifier agaist equity over the shrot term investment horizon in case of Pakistan. Moving forward, real estate, especially residential property, is found to be second save haven investment along with equity. Furthermore, as a thired best safe haven investment combination is oil and equity that reduces the portfolio risk. Finally, investors can attain the benifites of diverstificaiton normally in the short to median term investment horizon. However, based on our finding and economic situation in Pakistan, we do not suggest investment for long horizon as market of each asset class correlates with other assets class. One possible explannation could be the developing nature of Pakistan's econmany where the market of each asset class does not move independently, whereas, their comovements are possitively correlated.

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