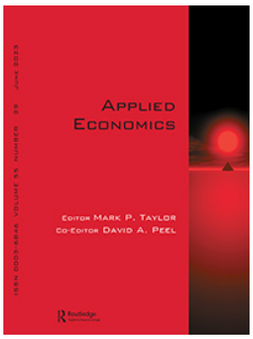

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# The influence of economic policy uncertainty shocks on art market

Emmanuel Joel Aikins Abakah[a], Aviral Kumar Tiwari[b,c], Emmanuel Kwesi Arthur[d] and Luis Alberiko Gil-Alana[e,f]

[a]University of Ghana Business School, Accra, Ghana; [b]Indian Institute of Management Bodh Gaya (IIM Bodh Gaya), Bodh Gaya – 824234, India; [c]Rajagiri Business School, Kochi, India; [d]Kenyatta University, Nairobi, Kenya; [e]University of Navarra, Pamplona, Spain; [f]University Francisco de Victoria, Madrid, Spain

**ABSTRACT**
We contribute to the literature by studying the impact of economic policy uncertainty shocks on returns in the global art market, the global paintings market and the U.S.A art market from 1998:Q1 to 2018:Q3. Based on the frequency domain Granger causality test and continuous wavelets analysis, the results show that an increase in policy uncertainty shocks significantly reduces returns on art and paintings and that the effect is stronger during extreme volatility periods. Policy implications are derived at the end of the article.

**KEYWORDS**
Global and USA art markets; policy uncertainty; global wavelet analysis; painting market returns

**JEL CLASSIFICATION**
C22; Z11

## I. Introduction

Scholars in recent years have given considerable attention in the market of real alternative investments and collectables since the 1990s (Le Fur 2021a, 2021b). In particular, these assets weights in portfolios of specific investment funds and high-income households are expanding (Satchell 2009). Arts, fine wines, coins, classic cars, rare whiskies, and stamps have emerged as the main components of collectable assets among market participants (Le Fur 2018, 2020). Among the collectables, arts are valued as they are a popular investment asset class and it is now very common for investors to include art in their portfolio as diversification assets (Le Fur 2020). Li, Ma, and Renneboog (2022) posit that the surge in art markets is influenced by increasing art prices and demand. The underpinning determinants of demand for art are economic growth, wealth accumulation and concentration, income inequality and the development of new art-buying audiences such as the financial elite of emerging economics such as Russia, China and India. It is worth mentioning that the modern day art market is growing rapidly. Over the past half-century, the art market which up to the 1950s was dominated by European auction houses is now a global market with more than 30,000 auction houses globally that have auctioned artworks produced by over 150,000 artists. The growth in studies on art as an alternative asset class over the past 30 years provides evidence of increasing interest in the financial effects of art market to investors. According to Deloitte and ArTactic (Deloitte & ArtTactic 2019), high-net-worth individuals approximately hold about USD 1.74 trillion worth of art collectables. Sales in art market globally grew from USD 40 billion in 2009 to USD 67 billion in 2018 but declined in 2019 to levels of USD 64 billion. In 2020, the outbreak of COVID-19 pandemic led to a decrease in value of global art auction to USD 50 billion.

A strand of academic research focuses on the macroeconomic determinants of real alternative investments and collectables such as art, fine wine, etc. For example, Cardebat and Figuet (2019) document a strong relationship between real exchange rates and fine wine. In the case of art market, some studies have focused on the performance of art market (Korteweg, Kraussl, and Verwijmeren 2016; Lovo and Spaenjers 2018); its financial and macro-economic market drivers, such as equity market evolution and income inequality (Goetzmann, Renneboog, and Spaenjers 2011); sentiment and hype (Pénasse, Renneboog, and Spaenjers 2014); gender bias (Cameron, Goetzmann, and Nozari 2019; Adams

**CONTACT** Luis Alberiko Gil-Alana alana@unav.es Department of Economics, University of Navarra, Pamplona E-31009, Spain

et al. 2021; Bocart, Gertsberg, and Pownall 2021); the impact of colour (Ma, Noussair, and Renneboog 2021); behavioural anomalies, such as anchoring (Beggs and Graddy 2009; Graddy et al. 2015); art market bubbles (Pénasse and Renneboog 2021) and artists' death as a supply shock (Pénasse, Renneboog, and Scheinkman 2021). Another set of studies explores how different kinds of uncertainty impact the pricing of real alternative investments and collectables with most studies focusing on how weather and market uncertainties impact prices of fine wine (Noparumpa, Kazaz, and Webster 2015; Hekimoğlu, Kazaz, and Webster 2017). However, to date, the existing literature has largely overlooked whether economic uncertainty could potentially impact the art market returns. In this study, we fill this gap by providing empirical evidence on how changes in economic policy uncertainty (EPU) levels affect art market returns. Findings from this study may provide significant timely implications for the global art markets industry since prior studies have ignored the effects uncertainty shocks could have on the art markets. For example, Srivastava and Babu (2016) provide an analysis on financial rates of return from art markets and compare them with other types of assets. Other studies on the efficiency of the art market and other stylized facts are also discussed in the economic literature (David, Oosterlinck, and Szafarz 2013; Botha, Snowball, and Scott 2016). Globalization of the art market (Afonso 2012; Munteanu and Pece 2015; Schultheis et al. 2015) and dependence dynamics across art markets (Hodgson and Seckin 2012). From the above, it is evident that studies on the development of art prices have not considered EPU impacts returns in the industry.

We focus on economic policy uncertainty for several reasons. In recent years, several studies examining the role played by economic policy uncertainty (EPU thereafter) in driving macroeconomic fluctuations and financial asset returns have been discussed extensively among academics, policymakers, and practitioners. These studies document that economic activity and the behaviour of economic agents at the household, firm level and broader economy are greatly influenced by economic policy uncertainty (Bernanke 1983; McDonald and Siegel 1986; Dixit 1989; Dixit, Dixit, and Pindyck 1994; Carroll 1997; Bansal and Yaron 2004). As mentioned earlier on, previous studies have ignored the effects uncertainty shocks have on the art markets. Uncertainty however creates instability, which in turn affects asset prices. Thus, this paper hypothesizes that economic policy uncertainty (EPU) shocks influence returns in the global art market. The very essence of investigating this hypothesis stems from the key role played by policy uncertainty in the broader economy and how it affects asset prices.

A significant issue that requires explaining is the argument regarding the impacts of economic policy uncertainties on the arts markets and the linkage between policy uncertainty and arts markets. Economic policy uncertainty (EPU) is defined as the agents' inability to predict future economic policies as well as the consequences of policies that have already been adopted by the government. Agents often face uncertainty about the timing, content and potential effect of policy decisions. Quantifying policy uncertainty is very difficult because of its unobservable nature. Baker, Bloom, and Davis (2016) constructed an index for EPU based on newspaper coverage frequency, the underlying idea being that a higher number of news articles about EPU reflects a higher level of uncertainty faced by agents. Subsequent papers have followed a similar approach for developing EPU indices for other countries (Bhagat, Ghosh, and Rangan 2013; Kroese, Kok, and Parlevliet 2015; Cerda, Silva, and Valente 2016; Hlatshwayo and Saxegaard 2016; Arbatli et al. 2017; Zalla 2017; etc.). The effect of EPU on asset prices can run along numerous channels. EPU can increase risk in financial markets, interest rates, inflation and expected risk premium (Pastor and Veronesi 2012, 2013). In addition, EPU may increase financing and production costs by affecting supply and demand channels. Thus, an increase in uncertainty changes can impact several asset markets including the art and paintings markets. This is because the economic value of the arts and paintings market is mainly determined by its artistic value, which is constructed within the art world, rather than buying expensive materials for its production. Today's art world is valued based on qualities that are not a function of technical skill, production costs or external criteria. Indeed, the artistic status of an art work or painting evolves from an inter-subjective

process of experts, institutions, and media in the art field assessing work and conferring reputation. As a results, buyers and sellers of arts and paintings are faced with fundamental uncertainty since most art and painting works are pieces whose quality is mainly influenced by aesthetic judgements, and whose performance as financial assets can hardly be estimated until sold.

Economic and political events have heightened interest in the economic impact of policy uncertainty (Bloom 2009; Sharif, Aloui, and Yarovaya 2020). Existing studies also show that economic policies underpin the rules of the game under which economic agents such as firms and investors make investment decisions and high levels of uncertainty can delay decision making and affect economic output adversely (Lam, Zhang, and Zhang 2017; Brogaard and Detzel 2015). On the other hand, Pastor and Veronesi (2012) note that changes in government policies that have an impact on the economic environment affects price reactions in financial markets. In recent times, several empirical studies have examined the effect of policy shocks on a large set of economic and financial variables: inflation and employment (Fernández-Villaverde, Guerrón-Quintana, and Rubio-Ramírez 2014), stock markets (Kang and Ratti 2015; Arouri et al. 2016); financial stability (Phan et al. 2020); investment cost of capital (Drobetz et al. 2018), foreign direct investment (Choi, Furceri, and Yoon 2020). However, relatively little attention has been paid to the links between economic policy uncertainty shocks on global art and paintings markets. The recent Brexit, with London being an epicentre of the art market and the various trade wars and tariffs, throws a considerable amount of concern on the need to investigate the impact policy uncertainties have on the arts and paintings market. Our paper contributes to this emerging strand of the literature which examines the effects of uncertainty in the economy by providing the first historical investigation of the impact of policy uncertainty on global art and paintings markets as well as the US art market for the period from 1998 to 2018.

To the best of our knowledge, this is one of the foremost studies to examine the impact of economic policy uncertainty on art market. Our contribution to the literature is threefold. First, it presents the foremost empirical evidence of the impact of an important macroeconomic variable that has recently garnered a significant amount of attention from academics, policymakers and practitioners, namely, EPU on art and painting markets. The second contribution of the paper consists in the use of the index of global EPU in the PPP prices as well as global EPU current prices to further shed light on the impact of EPU on art market returns during normal, high and extreme volatility periods. Third, we employ the continuous wavelets (i.e. time-frequency) approach. This approach is adopted as it has the capacity to reveal underlying processes with changing trends, lead-lag interactions and non-stationarity that characterize the behaviour of data considered. The application of the wavelet method permits us to discover the relations between the incidence of policy uncertainty and art markets. In contrast to other traditional econometric models that estimate the parameters in only one or at most two time scales. The wavelet approach permits the study of time-series in both the time and frequency domain. The wavelet framework, by these reasons, has superior advantages over the traditional frequency methods when the time-series under study are non-stationary. We document several interesting findings. Based on the frequency domain Granger causality test and continuous wavelets analysis, the results show that an increase in policy uncertainty shocks significantly reduces returns on art and paintings and that the effect is stronger during extreme volatility periods

The remaining part of the paper proceeds as follows. Section II is devoted to the literature review. Section III tackles methodology while section IV reports and discusses our data and empirical findings. Section 5 concludes the paper and provides some policy implications.

## II. Brief literature review

Policy uncertainty about the state of the economy can affect arts and paint market. Due to the increased availability of data, efforts have been put to construct indices to examine the policy uncertainty shocks on returns in the global arts and paintings markets. The art markets have their specifications in terms of market segmentation, asymmetry, abnormalities,

monopolistic price setting, and the existence of some psychic returns. These in return bring to bear idiosyncratic factors which makes investing in the art markets an attractive portfolio diversification tool. A higher degree of economic policy uncertainty pushes up financing cost (Fernandez-Villaverde et al., 2012) leading to lower investment and economic slowdown in the arts and paintings market.

Literature on the linkages between economic policy uncertainty and the arts market is hard to come by though traces can be found. A strand of literature tests for the existence of bubbles in the art markets. Assaf (2018) finds the existence of two regimes and bubble documented in some specific art segments before the financial crisis of 2008. After 2008, it was observed that these markets are going through an adjustment process and tend to behave like financial markets. Similarly, Bernales, Reus, and Valdenegro (2020) show that there are speculative bubbles in artworks that tend to increase with art supply constraints, heterogeneous beliefs, and emotional value. Erdos and Ormos (Erdös and Ormos 2010) applied the variance test ratios based on non-parametric methods to determine the size of the random walk in the US art market. They found that the random walk hypothesis does not hold over the whole sample period, thus from 1875 to 2008. However, they detected several structural breaks after 1935, hence the random walk hypothesis and the weak-form efficiency was not rejected from the period, 1935 to 2008. In the area of paintings, Taylor and Coleman (2011) constructed the art price index for 4000 paintings by Australian Aboriginal artists. The authors found the art price index to be stationary signifying that art prices may mean revert. If this holds, then it makes the art prices predictable. However, they found little evidence of this market inefficiency. Le Fur (2020) investigates the short and long-run linkages between art market indexes between 1998 and 2016. The Granger non-causality test showed that there exists causal links among some of the 15 art's market index. This implies a violation of weak form efficiency as past prices of one market index can be used to predict another index.

To the best of our knowledge, there are no known studies in the current literature examining the time frequency and causality effect of economic policy uncertainty on the arts and paintings market returns, as a result, this study seeks to contribute to the further understanding of the impact policy uncertainties play on global arts and paintings market by using a newly constructed Arts and EPU indexes.

## III. Empirical methodology

### *Time frequency wavelets based approach*

We assume the time-series $\{X_n\}$, where n = 0 ... *N*-1, with $\delta t$ time spacing, and a Morlet wavelet function $\psi_0(\eta)$, depending by the non-dimensional 'time' parameter η.The simplified version of Morlet function is as follows:

$$\psi_0(\psi_0) = \pi^{-\frac{1}{4}} e^{i\omega_0\eta_0 - \frac{1}{2}\eta^2}, \tag{1}$$

where $\omega_0$denotes the non-dimensional frequency (6 in our case), in order to satisfy the admissibility condition (Farge 1992); i is $\sqrt{-1}$. Following Aguiar-Conraria and Soares (2011) we obtained all CWT-based results with the choice ω0 = 6. For this parametrization of the Morlet wavelet, it provides good balance between frequency and scale in such a way that there exists an inverse relation between wavelet scales (*s*) and frequencies (*f*), $f \approx 1/s$, which helps in make simpler the explanation of the empirical results and thus one can use scale and frequency terms interchangeably.

The CWT of a discrete time series $\{X_n\}$ of N observations, with $\{X_n,\ n = 0, \ldots, N\text{-}1\}$, scale s and time step $\delta t$ is written as follows:

$$w_n^x = \frac{\delta_t}{\sqrt{s}} \sum_{n=0}^{N-A} x_{n^1} \Psi^* \left( (n' - m) \frac{\delta_t}{s} \right) \tag{2}$$

with m = 0, 1, . . ., *N*-1

### *Wavelet power spectrum*

$\left|W_n^x\right|^2$ is the wavelet power spectrum, revealing the local variance. A cone of influence is considered to illustrate the edge effects of the observations. Herein, the observations are influenced by the edge effects below cone. The statistical significance of wavelet power is tested by null hypothesis, which claims that the data generating process is the result of a stationary process with a certain background power spec-trum $P_f$. White and red noise wavelet power spectra are presented by Torrence and Compo (1998).

The distribution for the local wavelet power spectrum, under the null hypothesis, is as follows:

$$\mathrm{D}\left(\left(\frac{\left|W_n^x(s)\right|2}{\sigma_x^2} < p\right)\right) = \frac{1}{2} P_f \chi_v^2, \tag{3}$$

Where, $P_f$denotes the mean spectrum at the Fourier frequency $f$ for the wavelet scale s (i.e. s $\approx {}^1/_{\mathrm{f}}$. $\sigma$is the variance and $\chi^2$shows the product of two distributions. The probability attached to a process $P_f$ is greater than p, when v takes value 1 for real wavelet and 2 for complex one. The general processes have as ground the Monte-Carlo simulations.

### Cross-wavelet power

The cross-wavelet power (×WT) is the seminal work of Hudgins, Friehe, and Mayer (1993) and connects two time series,$\mathcal{X} = \{\mathrm{X_n}\}$ and $\mathrm{y} = \{\mathrm{y_n}\}$.

$$W_n^{xy} = W_n^x W_n^{y*}, \tag{4}$$

where, $W_n^x$and $W_n^{y*}$are the wavelet transforms of $\mathcal{X}$ and y, respectively, whereas $\left|W_n^{xy}\right|$is the cross-wavelet power. Relied on the Fourier power spectra $P_f^x$and $P_f^y$, the WXT illustrates the confined covariance between of two series, for each scale.

According to Torrence and Compo (1998), the theoretical distribution is:

$$\mathrm{D}\left(\left(\frac{\left|W_n^x W_n^y\right|}{\sigma_x \sigma_y} < p\right)\right) = \frac{Z_v(P)}{V}\sqrt{P_f^x P_f^y}, \tag{5}$$

where, $Z_v(p)$is the confidence level of the probability $p$ for a *pdf* re-presenting the square root of the product of two $\chi^2$ distributions.

### Wavelet coherency

The wavelet coherency (WTC) is 'the ration of the cross-spectrum to the product of the spectrum of each series, and can be thought of as the local correlation, both in time and frequency, between two time series' as Aguiar-Conraria et al. (2008) note.

WTC is as follows:

$$R_n(S) = \frac{\left|S\left(s^{-1}W_n^{xy}(s)\right)\right|}{S\left(s^{-1}\left|W_n^x\right|\right)^{\frac{1}{2}} S\left(s^{-1}\left|W_n^y\right|\right)^{\frac{1}{2}}}, \tag{6}$$

where, S illustrates the smoothing operator in both time and scale.

### Phase difference

The phase $\phi_x$ time series $\chi = \{\chi_n\}$ denotes the position in the pseudo-cycle of the series, based on Aguiar-Conraria et al. (2008). By extending this status over $\chi = \{\chi_n\}$ and $y = \{y_n\}$ series, the phase difference $\phi_{x,y}$ is given by the mean and confidence interval of phase difference, with this form:

$$\phi_{x,y} = tan^{-1}\left(\frac{\Im\{W_n^{xy}\}}{\Re\{W_n^{xy}\}}\right) \text{and } \phi_{x,y} \in [-\pi, \pi], \tag{7}$$

where $\Re$ and $\Im$ represent the real and imaginary part of a complex number, respectively. When the phase difference is zero, the time series move together at the specified frequency. We say the series are in phase and $\chi$ leads $y$ when $\phi_{x,y} \in \left[0, \frac{\pi}{2}\right]$, and $y$ leads $\chi$ for $\phi_{x,y} \in \left[-\frac{\pi}{2}, 0\right]$, respectively. By contrast, when the phase difference is $\pi$ or $-\pi$, the series are in anti-phase. Therefore, $\chi$ leads $y$ for $\phi_{x,y} \in \left[-\pi, -\frac{\pi}{2}\right]$, and $y$ leads $\chi$ when $\phi_{x,y} \in \left[\frac{\pi}{2}, \pi\right]$ respectively.

### Wavelet cohesion

Wavelet cohesion (WC) is proposed by Rua (2011), having as starting point the work of Croux et al. (2001). When the WTC is based on very nosy time series, it cannot be able to offer relevant information about the phase of the two time series. On this ground, Rua (2011) constructs a co-movement measure $\rho_{\chi_n y_n}$, as real number on $[-1, 1]$. Relied on WTC, the nominator uses only the real part of wavelet cross-spectra. As novelty, the WC captures also the negative correlations and has this form:

$$\rho_{\chi_n y_n} = \frac{\Re\left(W_n^x W_n^y\right)}{\sqrt{\left|W_n^x\right|^2 \left|W_n^y\right|^2}}, \tag{8}$$

where, $\Re$ denotes the real part of the cross-wavelet spectrum of $\chi = \{\chi_n\}$ and $y = \{y_n\}$ series, being calculated as the squared root of two power spectra for the given time series in denominator.

## IV. Data and empirical findings

### Data

The study uses quarterly data on art series from 1998:Q1 to 2018:Q3. The data is obtained from Artprice, available for download from: http://www.artprice.com. For our paper, we use global art, global paintings, and the US art price indices. The Artprice database is commonly used in the literature (Aye et al. 2017; Demir, Gozgor, and Sari 2018; Assaf et al. 2021). The Artprice has been in operation since 1987 and covers a wide range of art auctions and artists. The Artprice also publishes annual reports and articles concerning the art market developments through their annual summary Trends. Detailed information on art market price indices can be obtained from the website of Artprice™, a company specializing in art market information and data services (: http://www.artprice.com). The data for the Global EPU index constructed by Baker, Bloom, and Davis (2016) have been downloaded from the website http://www.artprice.com. We use global EPU in current prices and for robustness, we use the index of global EPU in the PPP prices instead of current prices.

### Empirical analysis

For the purpose of this study, we first transform all series into their natural logarithm and report the descriptive statistics of the log-returns in Table 1. We find that the daily mean returns of Global Art (−0.083) and Global Paintings (−0.311) are negative while the returns of the U.S.A Art price series are positive (0.002). On skewness, results indicate negative skewness for Global Paintings and U.S.A Art price series. Negative (positive) skewness connotes the tendency of higher negative (positive) returns without matching the tendency of positive (negative) returns. With regard to kurtosis, all series recorded kurtosis, with less than the threshold of 3, which indicated that the returns series for the period do not have flatter tails. From the standard deviation, Global Art (10.460) is the most volatile, followed by U.S.A Art (0.3913). The results show a considerable size of volatility in the Global Paintings and U.S.A Art price, predicting possible financial uncertainty in these markets. This shows that uncertainties in the arts and paintings market influence its returns. Table 2 reports the pairwise correlation between art markets and policy uncertainty. We find a positive correlation between global art and global paintings markets and a negative correlation between policy uncertainty measures and global paintings and U.S.A art markets.

Figure 1 displays the time series plots of all the series in the natural logarithm form and log-returns. From the plots, we observe that there are stretches of time where volatility is relatively high

**Table 1.** Descriptive statistics.

| | Global art | Global Painting | USA art | GEPU current | GEPU_PPP |
|---|---|---|---|---|---|
| Mean | −0.083 | −0.311 | 0.002 | 0.926 | 1.111 |
| Standard Error | 1.148 | 0.379 | 0.430 | 2.293 | 2.361 |
| Median | 0.339 | −0.150 | −0.013 | −0.515 | 0.000 |
| Standard Dev. | 10.460 | 3.451 | 3.913 | 20.891 | 21.511 |
| Kurtosis | 0.821 | 1.397 | 1.111 | −0.083 | 0.008 |
| Skewness | 0.485 | −0.350 | −0.320 | 0.279 | 0.434 |
| Count | 83 | 83 | 83 | 83 | 83 |

**Table 2.** Linear correlation.

| | Global art | Global Painting | USA art | GEPU current | GEPU_PPP |
|---|---|---|---|---|---|
| Global art | 1 | | | | |
| Global Painting | 0.41974 | 1 | | | |
| USA art | 0.246978 | 0. 633071 | 1 | | |
| GEPU current | 0.064433 | −0.13641 | −0.00657 | 1 | |
| GEPU_PPP | 0.099418 | −0.13044 | −0.04511 | 0.987216 | 1 |

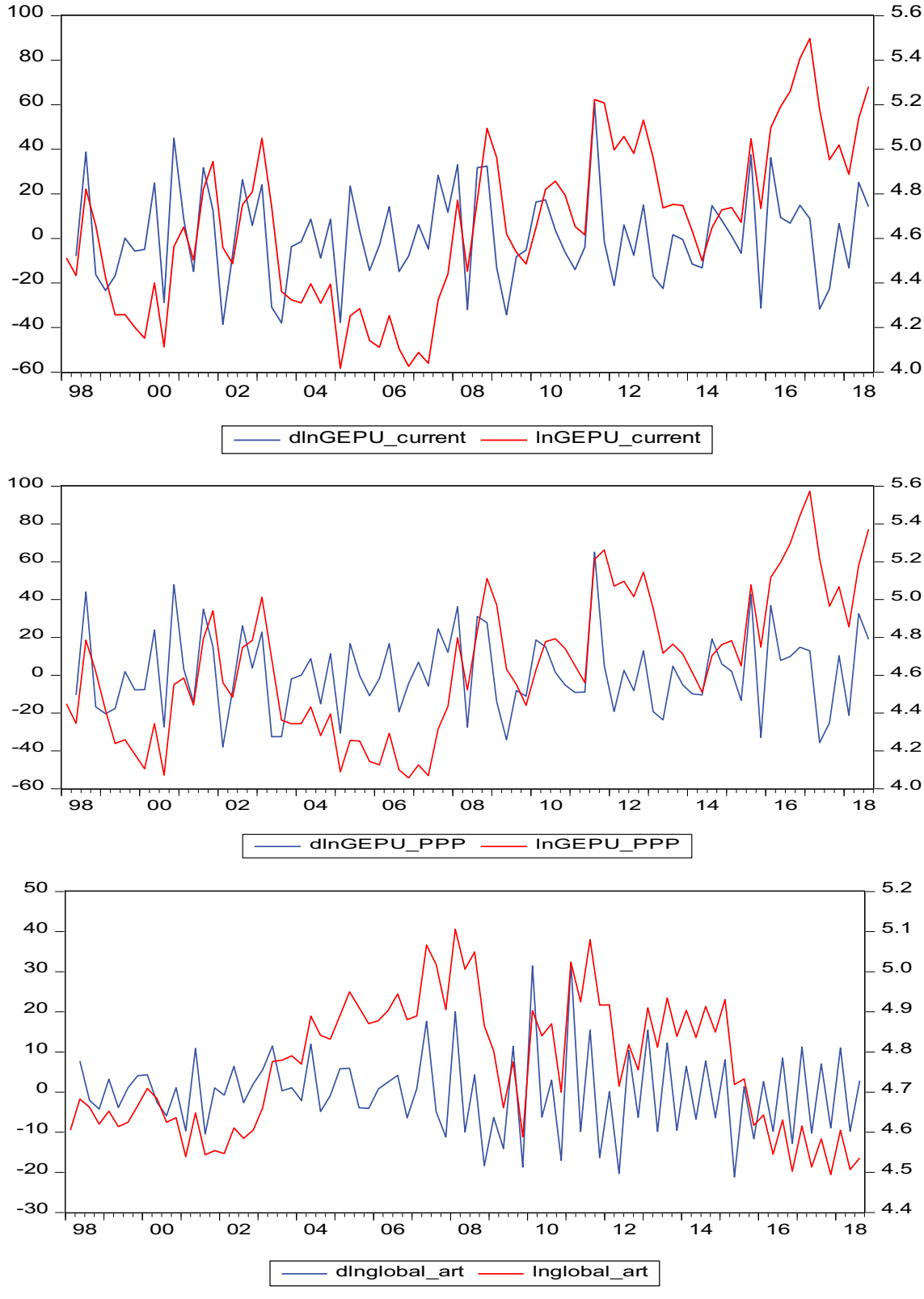


**Figure 1.** Time series plots of art market returns and policy uncertainty.

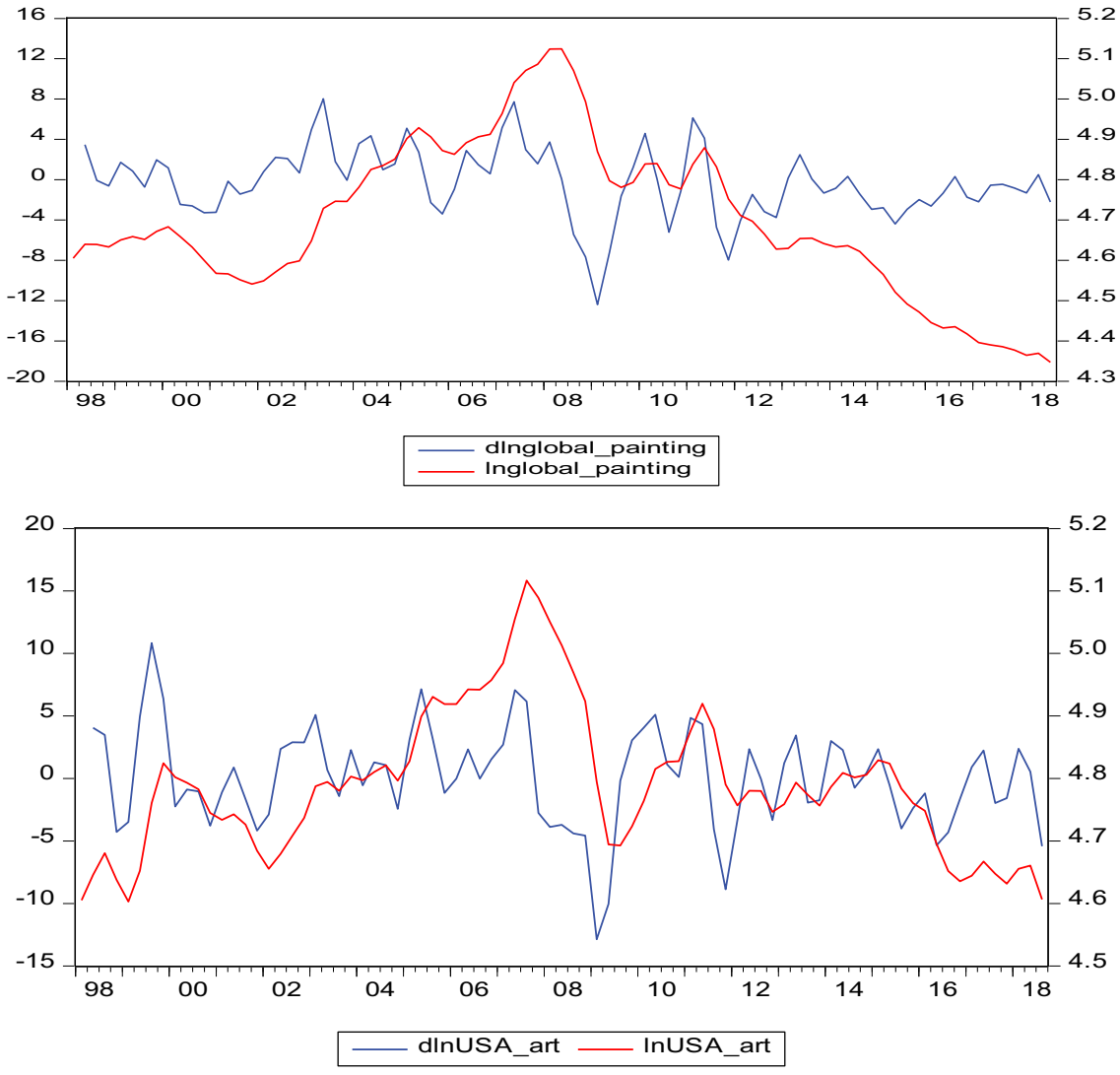


**Figure 1.** (Continued).

and certain stretches of time where volatility is relatively low, which suggests an apparent volatility clustering in some periods. This further suggests that connectedness may be prevalent between the series. We observe intense nose-diving across all return's series throughout the period for all series around the same time.

### *Frequency domain Granger causality results*

Figure 2 describes frequency domain Granger causality test between art markets, paintings markets and global EPU in current prices. The results give a broader view of the direction and strength of causality in different frequencies, which one cannot find using other methods. The frequencies (Omega) are placed on the x-axis, whereas the y-axis shows the F-statistics testing the null hypothesis of no Granger-causality. For the causality running from Global Art returns to global EPU in current prices, results show that at the 5% level of significance, the Global Art market Granger-causes global EPU (GEPU) in the short run, while for the case of causality running from GEPU in current prices to global art markets, we find significance at the levels of frequencies reflecting medium-run and long-run cycles. These results are in congruence with a strand of the art economics literature that examines the existence of bubbles in the art markets.

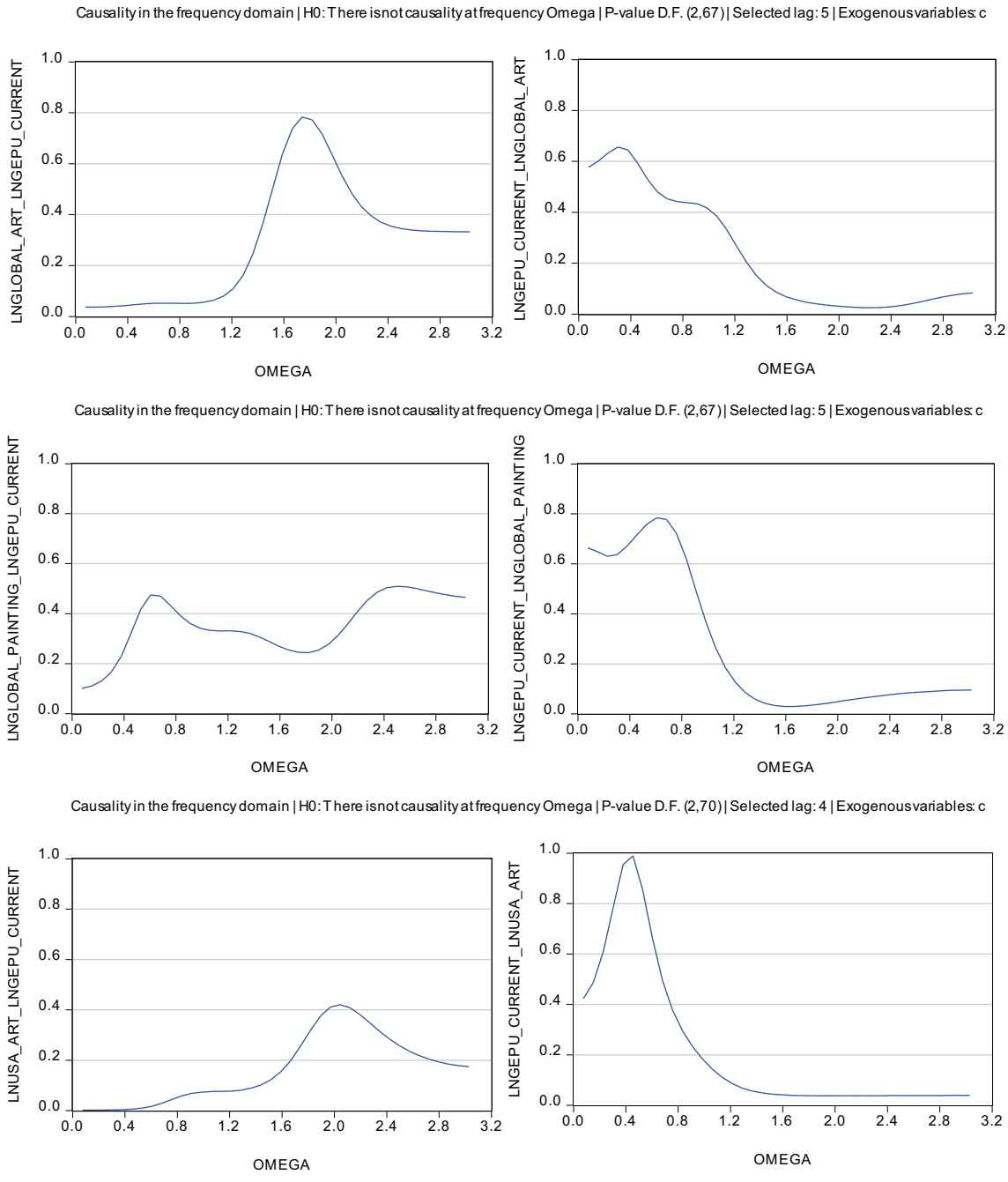


**Figure 2.** Frequency in domain Granger causality test between art markets, paintings markets and global EPU in current prices.

Assaf (2018) documents the existence of two regimes and the bubble was documented in some specific art segments before the financial crisis of 2008. After 2008, it was observed that these markets went through an adjustment process and tend to behave like financial markets. Thus, it is not surprising that EPU impact art markets and not only financial markets as advanced by Abakah et al. (2021) and Le et al. (2021). Similarly, Li et al. (2020) documented two bubbles in the periods from 2004 to 2005 and 2010 to 2011 in the Chinese art market with Bernales, Reus, and Valdenegro (2020) showing that there are speculative bubbles in artworks that tend to increase with art supply constraints, heterogeneous beliefs, and emotional value. Considering causality running from global paintings markets to GEPU in current prices, we observe that shocks from the global paintings market do not exert an impact on policy uncertainty as we failed to reject the null hypothesis

of no causality. However, we find that global policy uncertainty shocks affect the global paintings market at the levels of frequencies reflecting medium-run to long-run cycles. For Granger causality tests between U.S.A art markets and GEPU in current prices, we note once again uncertainty shocks Granger cause U.S.A art markets to reach higher frequency levels. From Figure 3, we obtain similar trends in the analysis as reported in Figure 2. Global art market Granger-causes GEPU in the short run and the causality running from GEPU in PPP to global art markets show significance at the levels of frequencies reflecting medium-run and long-run cycles. In the same vein, we observe that causality running from global paintings market does not exert impact on policy uncertainty (GEPU in PPP). That notwithstanding, we find that global policy uncertainty shocks affect the global paintings market at the levels of frequencies that reflect medium-run to long-run periods.

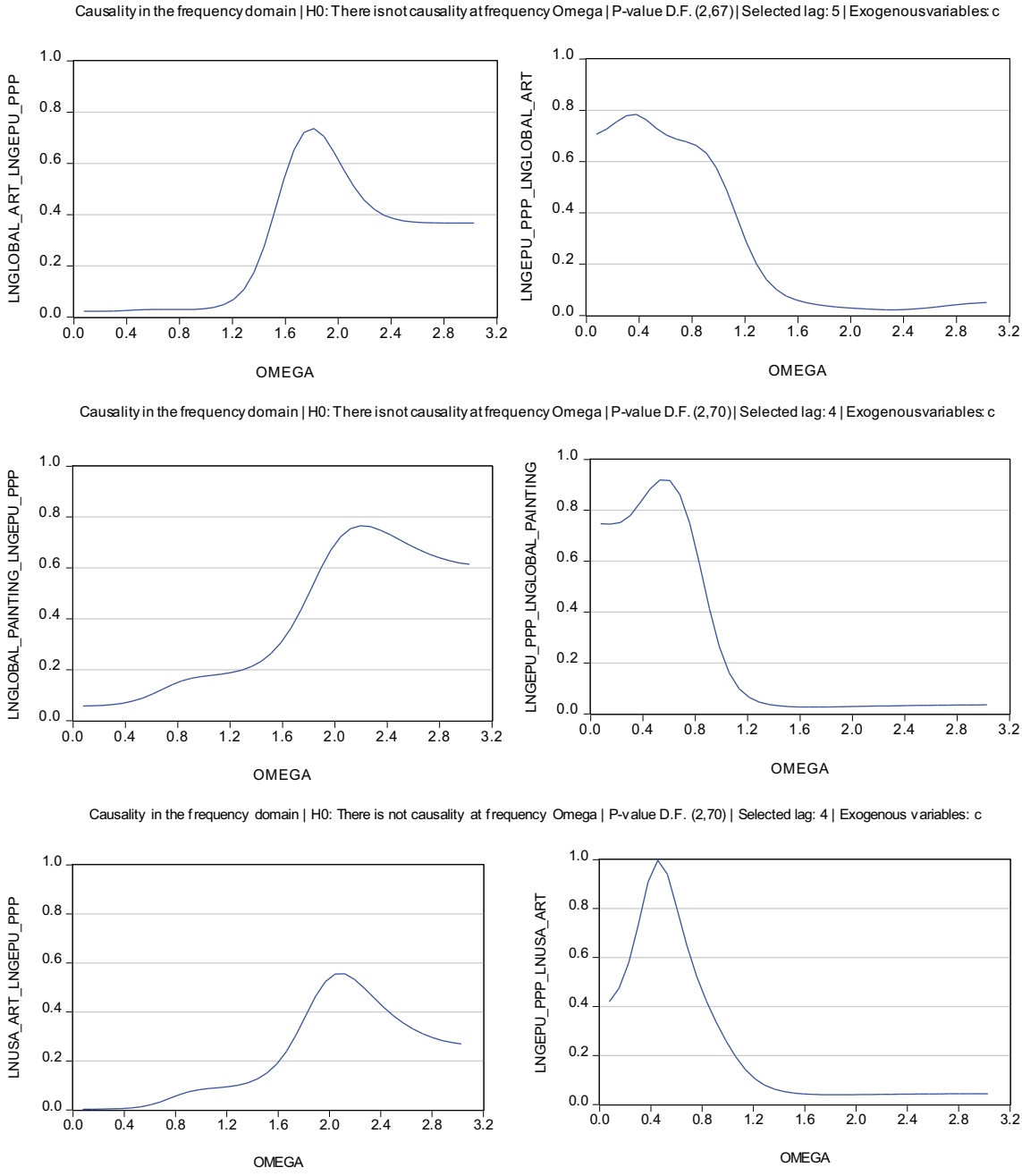


**Figure 3.** Frequency in domain Granger causality test between art markets, paintings markets and global EPU in PPP prices instead of current prices.

From the result, we confirm a significant directional causality running from policy uncertainty to the returns on global art markets and the paintings market. It is clear that shocks in policy uncertainty returns spread quickly to art and paintings market returns. The feedback effect holds good for the longer intervals. For robustness purposes, we use the index of global EPU at PPP prices instead of current prices to test the causality running from global art and paintings markets to EPU at the PPP prices and vice versa. These findings further imply that the causal relationship between policy uncertainty shocks and the returns on the art and paintings markets turns out to be robust and significant for both cases where we consider global EPU at current prices and global EPU at PPP prices.

### *Wavelet based time frequency domain analysis*

In Figure 4, we estimate the cross-wavelet spectrum between the art market and global policy uncertainty. The colour code for spectral power ranges from blue (low coherency) to red (high coherency) while the yellowish colour explains the moderate coherence that exists between the two indices (Global Art market and Global EPU).

We find that there is a strong correlation at the 95% confidence interval between Global Art and Global EPU with respect to current prices between 2006 and 2008 up to 2010 and 2016 in the short run (below period 1). Again, we find a strong correlation between 1998 and 2000 but a moderate association from 2011 to 2013 in between period 1 and 2 (short run approaching the long run). In the long run (period 2 and 3) there is a moderate correlation between Global Art and Global EPU at current prices from 2005 to 2010. The association of Global Art and Global EPU with regards to PPP shows a similar trend as that of the current prices. There is a strong correlation between 1998 and 2000, then from 2007 followed by a moderate correlation till 2011 in the short run, and then, a similar moderate correlation in the long run from 2005 to 2009 just like Global Art and Global EPU association at current prices.

For the co-movement between Global Paintings and Global EPU at current and PPP prices, we see a similar association at the 95% confidence interval. We find that there is a strong correlation between 1998 and 2000, and 2009–2010 for both prices (Current and PPP) in the short run (between period 1 and 2; and before period 1). However, there is a moderate correlation/association in the long run (between period 2 and 3) for current prices as against a low correlation/association. The association between U.S.A Art and Global EPU shows a strong correlation between the two from 1998 to 2000 and from 2002 to 2005 just before and after period 1. There is however a strong and moderate association before period 1 in 2002 and 2009 respectively. For the association between U.S.A Art and Global EPU at PPP prices we obtain findings similar to the co-movement between U.S.A art market and global EPU at current prices. Noticing the trend with which the global EPU co-moves with the U.S.A Arts market from 1998 to 2010, we cannot but agree with Taylor and Coleman (2011) that art prices may mean revert; thus, art prices are predictable.

In Figure 5, we use the pair wise wavelet coherency to check the co-movement between Art Markets and Global Economic Policy Uncertainty. Contours denote wavelet coherency; the thick black contour is the 5% significance level and the boundary affected zone is outside the thin line is. Vectors indicate the phase difference between the two series.

All the images show the coherency between two indices (Global Art market and Global EPU). When the arrow is pointing east (right hand side), it is said to be in-phase (positively correlated), that is both markets move together in the same direction. If the arrow is pointing west (left hand side), both indices are said to be anti-phase (negatively correlated), that is both move in the opposite direction. If the arrow is pointing east and downwards, Global Art market is leading Global EPU, but if the arrow is pointing upwards, the Global Art market is lagging behind Global EPU. The opposite is true if the arrow is pointing west and upwards, then the Global Art market is leading Global EPU in a negatively correlated situation, but the Global Art market is lagging behind Global EPU if the arrow is pointing downwards.

The pair wise wavelet coherency and phase plot between Global Art and Global EPU at both current and PPP prices revealed a high statistically

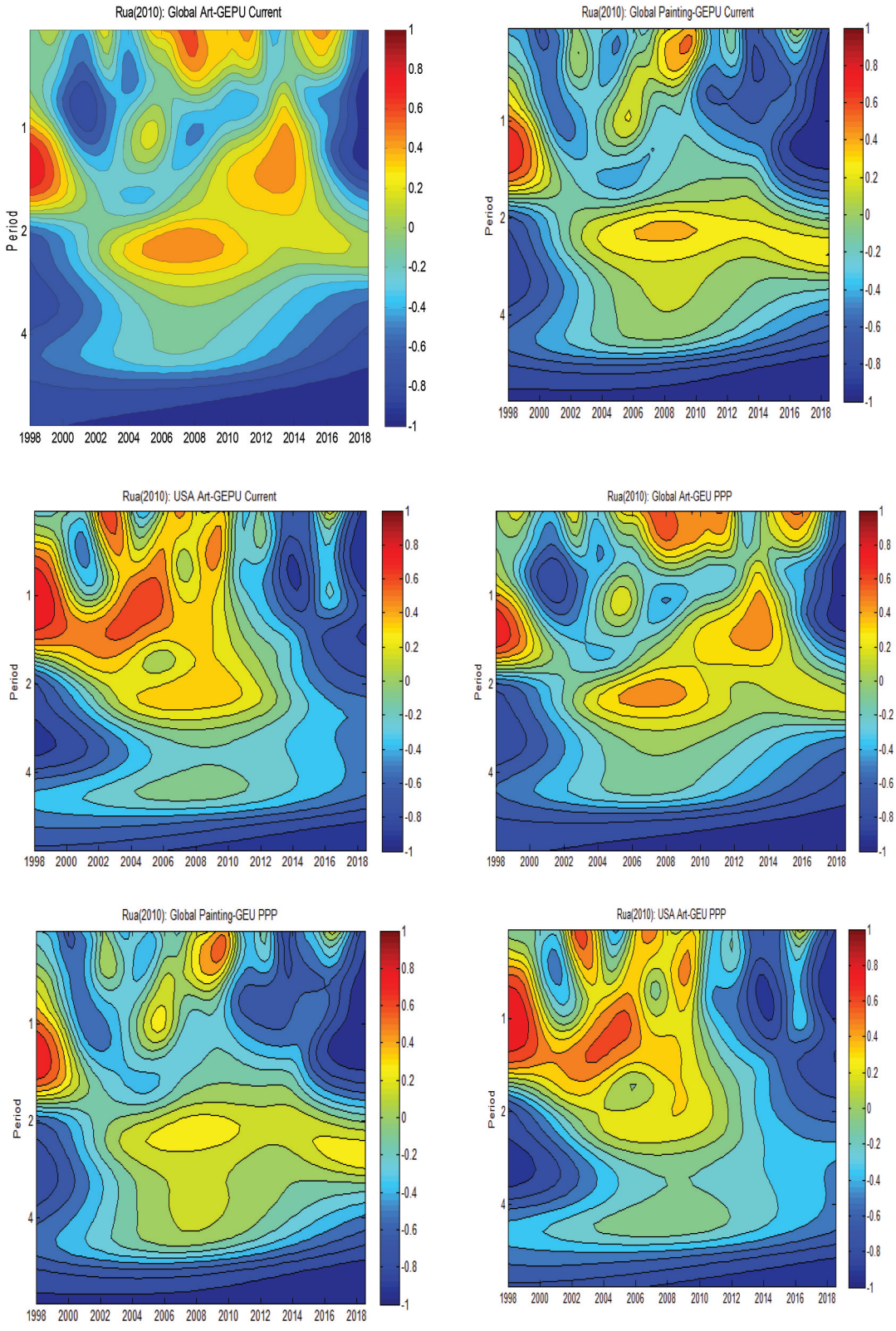


**Figure 4.** Cross-wavelet spectrum between art markets and global policy uncertainty.

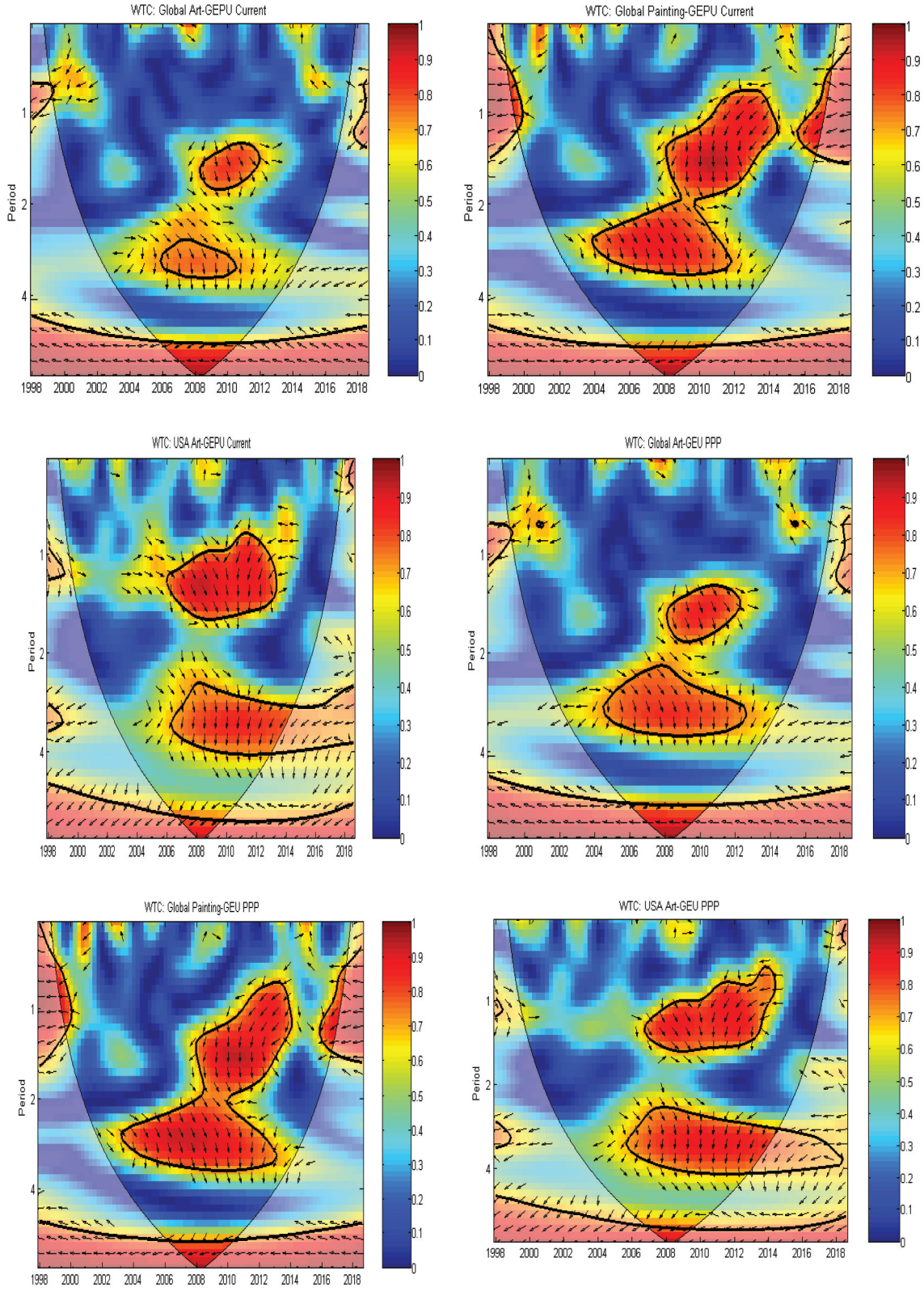


**Figure 5.** Pair wise wavelet coherency between art markets and global policy uncertainty.

significant correlation/power for the years 2006–2011 and 2005– 2012 respectively. We see the arrows as a straight line pointing right (positively correlated) and downwards between periods 1 and 2 for both current (2008–2011) and PPP (2008–2012) prices with the global art market leading global EPU. However, the arrows move downwards to the right and then point directly downward between periods 2 and 4 showing that the second time series leads the first at 90°.

Similarly, Global Paintings and Global EPU at both current and PPP prices also had a high statistically significant power for the years 2004–2015 and 2003– 2013 respectively. The direction of the arrows is initially downwards towards the left (before and after period 1), straight downwards (from period 1 to 2) and finally downwards towardss the right (between period 2 and 4). The initial movement downwards towards the left shows a negative correlation in which EPU is leading the Global Art market. The arrow movement from period 1 to 2 straight downwards shows that the second time series leads the first at 90° while the final movement downwards towards the right shows a positive correlation where global art market leads Global EPU. According to Fernandez-Villaverde et al. (2012), a higher degree of economic policy uncertainty pushes up finance cost leading to lower investment and economic slowdown in the arts and paintings market. As EPU leads in short-term time scales (periods 1 and 2), higher uncertainties distort the arts market pushing for market slowdown but as time passes, the Art market picks up creating positive price returns. Simply put, the Art market responds to uncertainty shocks within the shortest time scale but these shocks eventually diffuse as time elapses.

Finally, the US art market and the Global EPU at current prices also show a statistically significant correlation for the years 2006–2014. The movement just before period 1 through period 2 in the phase analysis shows non-homogeneity as the arrows point in different directions. This shows that the US Art market indices were not homogeneous across scales, however the movement in between period 2 and 4 from 2006 to 2013 point straight downwards showing that the second time series leads the first at 90°. Considering the connectedness between U.S.A Art market and the Global EPU at PPP prices, we find statistically strong co-movement similar to that reported in the case of U.S.A Art markets and global EPU at current prices. This shows that global economic policy uncertainties resulting from speculative bubbles influence the U.S.A Art market to a greater extent. These speculative bubbles tend to increase art supply constraints, heterogeneous beliefs, and emotional values as expounded by Bernales, Reus, and Valdenegro (2020).

## V. Conclusions

This paper investigates policy uncertainty shocks on returns from the global art and paintings markets. To study the synchronization between policy uncertainty and global art markets and the paintings markets at different periods, we employ time frequency domain Granger causality tests and wavelet coherency and wavelets spectrums based on continuous wavelet transforms. Results from the time frequency domain causality tests show that policy uncertainty shocks Granger cause global art markets, global paintings markets and U.S.A art markets at higher frequency levels. From the wavelets analysis we document strong co-movement between global EPU at current prices and art and paintings markets. For robustness, we use global EPU at PPP prices and obtain similar findings. Thus, we provide evidence of strong co-movement between EPU and arts markets.

Our results have important implications. In particular, our study has implications for several actors such as investors (both individual and institutional), collectors, traders and brokers. Indeed, clear knowledge of the influence of uncertainty on the price of art and painting markets could help them to better assess their arbitrage and the management of portfolios containing this asset. Thus our paper offers new insights and supports portfolio construction during extreme market conditions for market participants in the arts and painting industry since we document significant co-movement between uncertainty shocks and arts industry returns. To the policy makers in the arts and painting industry, our findings may help in strategy formulation during extreme market conditions to ensure a smooth recovery process

in the art industry. In addition, policy makers of countries with well-established art markets should not only be concerned on reducing the domestic sources of uncertainty but should also focus on international economic uncertainty transmission. These findings should also be considered by academics, policy makers and practitioners when building models aimed at evaluating the impact of EPU on the arts and painting industry, designing policy measures and developing investment strategies. We recommend four possible avenues for future research. A natural extension of our work would be to use alternative proxies for EPU including trade policy uncertainty, monetary policy uncertainty, exchange rate uncertainty and the entire art market indices given that our paper considered only the U.S.A and global markets. Second, another good avenue for future research relates to the role of asymmetry during volatile markets conditions including the recent COVID-19 pandemic, Russia-Ukraine war, Brexit and the subprime mortgage crisis. This extension would provide more insights into the impact of these crises on the price of artworks. Thirdly, it would be useful to analyse the consequences of these two parameters in financial and behavioural management terms with respect to the portfolio management of investors, collectors, and traders. Finally, we recommend that future studies employ additional robust methodologies such as the Markov-switching dependence model (Tiwari, Abakah, and Le 2021), quantile time frequency model (Chatziantoniou et al. 2022), dynamic connectedness (Tiwari et al. 2022) and fractional integration techniques (Gil-Alana, Abakah, and Rojo 2020a; Gil-Alana, Mudida, and Abakah 2020b) to further examine the relationship between the arts markets and other asset classes while accounting for the impact of global uncertainty and volatility factors.

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## ORCID

Aviral Kumar Tiwari http://orcid.org/0000-0002-1822-9263
Luis Alberiko Gil-Alana http://orcid.org/0000-0002-5760-3123

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