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ESG and economic policy uncertainty: A wavelet application

Keshab Shrestha [a], Babak Naysary [b,*]

[a] Business School, Sunway University, Bandar Sunway, Malaysia
[b] Business School, Birmingham City University, Birmingham, United Kingdom

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ABSTRACT

In this study, we examine the relationship between country-level EPU and MSCI ESG Leaders for the US and the UK using wavelet coherence analysis and daily data. We find a significant negative relationship between ESG indices and EPU. However, the existence of the significant negative relationship depends on certain time scales and dates. For both countries, the ESG indices lead the EPU in general. However, for certain time scales and dates, EPU leads the ESG indices.

1. Introduction

Whether corporations harm or benefit society has received increasing attention from investors, practitioners and policymakers as well as the general public. This trend has focused on the actions taken by firms in areas of Environmental, Social and Governance (ESG). Besides the direct impact of ESG actions on society, there exist many studies that look into the impact of ESG on firm performance. For example, Chava (2014) finds that cost of equity and cost of debt is higher for firms with poor environmental profiles. Similarly, Ng and Rezaee (2015) find a negative relationship between environmental (E) and governance (G) performance and the cost of equity capital, but this relationship is marginal between social (S) performance and the cost of equity capital. Goss and Roberts (2011) find that firms with greater social responsibility concerns pay higher interest rates on bank loans compared to the firms that are more socially responsible.

Due to the importance of ESG, in this study, we analyze the relationship between the ESG[1] leaders index and economic policy uncertainty (EPU).[2] There exist many studies that analyze the relationship between EPU and stock price-related issues. For example, some studies analyze the relationship between EPU and issues like stock price crash risk (Aye et al., 2015; Jin et al., 2019; and Yuan et al., 2022), stock price informativeness (Tang and Wan, 2022), stock price information efficiency (Du et al., 2023), stock price bubbles (Cheng et al., 2021), stock price synchronicity (Shen et al., 2021) and performance of stock indices (Ko and Lee, 2015; Liang et al., 2020; Ono, 2023; and Liu et al., 2023). All these studies use low-frequency data like annual, quarterly, or monthly data.

The results of wavelet coherence analysis for the country-level daily data for the US and the UK show a significant negative relationship between MSCI ESG leaders and EPU, however, this result is contingent upon certain time scales and dates. In other words,

* Corresponding author at: Business School, Birmingham City University, 15 Bartholomew Row, B5 5JU, Birmingham, United Kingdom.
E-mail address: babak.naysary@bcu.ac.uk (B. Naysary).

[1] We note that there are other ESG indices such as S&P ESG Index, however we selected MSCI ESG leaders due to availability of high frequency daily data.

[2] Defined as the presence of a non-zero probability of changes in the current economic policies that establish the framework and rules by which economic agents operate (Baker et al., 2016).

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there are dates and frequencies (time scales) for which there exists no significant relationship between these two series. For both countries, the ESG indices lead the EPU in general. However, for certain time scales and dates, EPU leads the ESG indices.

Our study contributes to the existing literature in the following ways. Firstly, to the best of our knowledge, this is the first study to analyze the relationship between EPU and ESG indices, this is particularly important to verify the reported resilience of firms with superior ESG performance in the literature. Secondly, we use higher-frequency daily data whereas most of the existing studies on EPU use monthly or lower frequency data. This provides us with a more detailed and granular view of the underlying patterns and dynamics. Finally, we use wavelet coherence analysis, which is scarce in ESG studies and allows us to capture the effects of EPU by considering intensity and duration at different frequencies. Being a multiscale analysis, it also helps in detecting dynamic relationships between EPU and ESG by capturing the temporal patterns and providing enhanced interpretability.

2. Methodology

Wavelet coherence analysis provides time-frequency information, allowing us to examine how the relationship between two time series changes over different frequency scales. This is particularly useful for identifying phase difference and the lead-lag changes in the relationship between ESG indices and EPU and determine the direction of causality and the nature of this interaction, which may not be well captured by traditional frequency domain or time domain analyses like DCC-GARCH. Wavelet coherence can also handle non-stationary time series, which is useful when dealing with financial or economic data that often show non-stationarity. We first briefly describe wavelet coherence based on Grinsted et al. (2004) and Torrence and Compo (1998). The continuous wavelet transform (CWT, $W_n^X(s)$) for a discrete time series x_n,$n = 1, \ldots, N$ with uniform time steps δt is defined as:

$$W_n^X(s) = \sqrt{\frac{\delta t}{s}} \sum_{m=1}^{N} x_m \psi_0 \left[\frac{(m-n)\delta t}{s} \right] \tag{1}$$

where $\psi_0()$ is a particular mother wavelet, s is the scaling factor (that stretches the wavelet) and n is the translation parameter (that represents the location of the wavelet). Then the cross wavelet transform ($W_n^{XY}(s)$) of two time series x_n and y_n is defined as

$$W_n^{XY}(s) = W_n^X(s) W_n^{Y*}(s) \tag{2}$$

where * denotes complex conjugation. Following Torrence and Webster (1998) we define the wavelet coherence ($R_n^2(s)$) of the two time series as

$$R_n^2(s) = \frac{\left| S\left(s^{-1} W_n^{XY}(s)\right) \right|^2}{S\left(s^{-1} \left| W_n^X(s) \right|^2\right) S\left(s^{-1} \left| W_n^Y(s) \right|^2\right)} \tag{3}$$

where $S()$ is a smoothing operator. Then. The phase difference is given by

$$\phi_n^{XY}(s) = \tan^{-1}\left(\frac{\mathrm{Im}\left(W_n^{XY}(s)\right)}{Re\left(W_n^{XY}(s)\right)} \right) \tag{4}$$

Where Im() and $Re()$ represent the imaginary and real parts of complex cross wavelet transform. The phase can be plotted using arrows where arrows pointing to the right mean the two series are in phase meaning the two series move in the same direction or are positively correlated and vice versa. The arrows pointing right-up or left-down mean the first series leads the second series. Similarly, the arrows pointing right-down or left-up mean the first second leads the first series.

3. Data and empirical results

We examine the daily prices of MSCI ESG Leaders for the US and the UK, sourced from the Refinitiv® Datastream® database. These are free float-adjusted market capitalization-weighted indices designed to represent the performance of companies that are selected from an underlying index based on ESG criteria. These criteria exclude constituents based on involvement in specific business activities, as well as ESG ratings and exposure to ESG controversies. For EPU, we use the index constructed by Baker et al. (2016). The sample period covers September 1, 2010, to December 30, 2022. Table 1 shows the summary statistics and the stationarity tests. Fig. 1 describes the data for daily ESG leaders indices for US and UK utilized in our study. Fig. 2 shows the daily EPU score for US and UK.

Figs. 3 and 4 display the wavelet coherency between EPU and ESG for the USA and the UK respectively.[3] It is clear from Fig. 3 that the two series are related only for some frequencies or time scales and some dates but not for all scales and dates. Whenever there are significant relationships, they are all negative (arrows pointing left) as expected implying higher EPU is associated with lower ESG leaders' prices.[4]

We find a significant relationship between the two series in three clusters. The first cluster covers October 2012 to August 2013 covering the time scales from 91-day to 128-day. In this cluster, ESG leads the EPU. The second cluster covers September 2014 to July

[3] Both coherencies are computed with EPU as the first series and ESG as the second series.

[4] The significance is based on the 95% confidence interval using the simulated bootstrap method.

Table 1
Descriptive statistics, goodness-of-fit, and stationarity tests.

	UK ESG	US ESG	UK EPU	US EPU
Min	776.492	63.55	0	3.32
Max	1145.919	273.287	2610.06	807.66
Mean	1013.014	138.531	319.209	122.772
Var	5194.885	2868.401	43,269.97	7587.076
Std.Dev	72.0755	53.557	208.014	87.104
Skewness	-0.752	0.731	2.447	2.398
Kurtosis	-0.195	-0.386	13.397	8.451
JB test	308.42	306.71	27,315	12,676

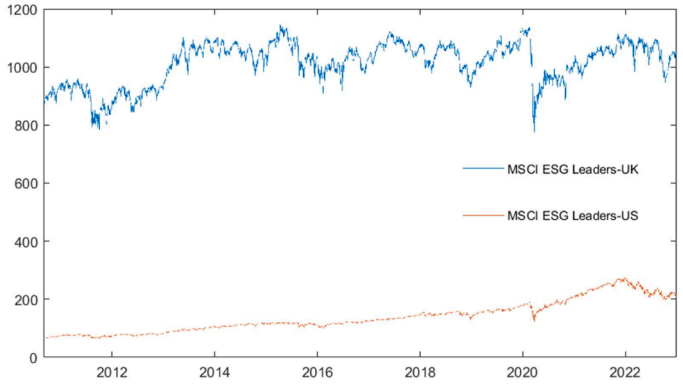

Fig. 1. Daily MSCI ESG leaders indices for US and UK.

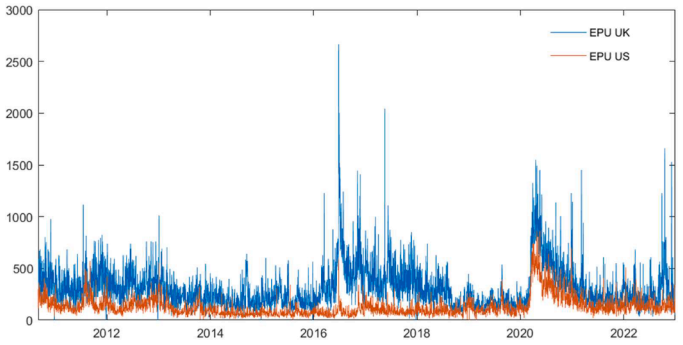

Fig. 2. Daily EPU score for US and UK.

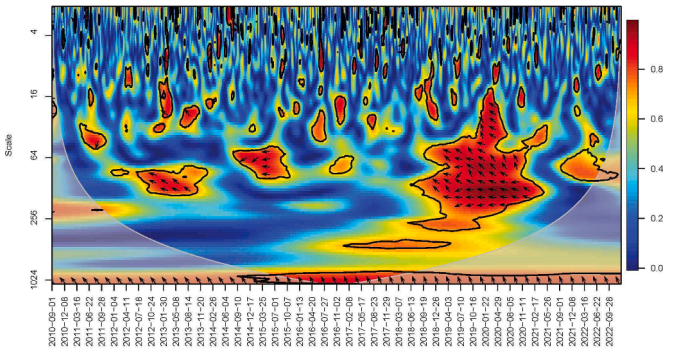

Fig. 3. Coherency between EPU and ESG index for the US.

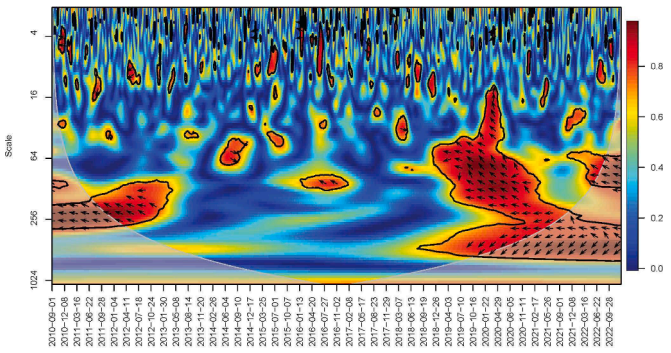

Fig. 4. Coherency between EPU and ESG index for the UK.

2015 and time scales from 54-day to 91-day. In this cluster, EPU mostly leads ESG. Finally, the third cluster starts from November 2018 to March 2021 covering time scales from 14-day to 203-day. In this cluster, ESG mostly leads EPU with some exceptions. The last cluster runs from November 2018 to March 2021 covering as low as the 14-day time scale to 203-day time scale, where ESG mostly leads EPU.

As for the relationship between EPU and ESG for the UK (Fig. 4), all the significant relationships are negative similar to the case for the USA. We find two main clusters. The first cluster or region starts as early as August 2011 and ends in November 2012 covering 152-day to 271-day cycles with ESG mostly leading EPU. The second significant region covers January 2019 to August 2021 with 13-day to 512-day time scales with ESG leading EPU for time scales lower than 242-day but EPU leading ESG for the longer time scales.

The theory of irreversible investment[5] and financial frictions[6] theory help explain the negative impact of EPU on ESG performance. EPU can create challenges for firms making investment decisions related to ESG goals, as it introduces uncertainty and potential risks associated with future policy changes. This uncertainty can lead to hesitation or delays in making long-term investments that align with sustainability goals. As for the time-varying relationship between ESG and EPU as detected by Wavelet coherence analysis, recent studies (see Birru and Young, 2022), show the amplified power of investor sentiments during the times of high uncertainty. Additionally, investor and manager sentiment measures developed by Huang et al. (2015) and Jiang et al. (2019), highlight their substantial return predictability power which outperforms most of the commonly used macroeconomic variables. Drawing upon these studies, we can infer that, investors may undervalue the ESG leader stocks when EPU is high; however, when EPU is low, the investment channel dominates the mispricing channel of investor sentiment, thus EPU-ESG relation remains significantly negative.[7]

4. Conclusion

To analyze the connection between EPU and MSCI ESG Leaders for the US and the UK, we conduct a wavelet coherence analysis using daily data from September 1, 2010, to December 30, 2022. Our findings show a significant negative relationship between the ESG indices and EPU, but the presence of this significant negative relationship is restricted to specific time intervals and dates. In other words, there are instances when there is no significant relationship between these two series, depending on the dates and frequencies (scales) involved. Overall, the ESG indices tend to lead the EPU for both countries, although, for certain scales and dates, the EPU leads the ESG indices. According to the results, EPU can create challenges for ESG investments by introducing additional risks and inhibiting long-term commitments. This has policy implications for businesses and calls for appropriate response by adopting adaptive strategies, engaging in policy advocacy, and carefully considering the potential impacts of policies on their ESG initiatives. Future studies can extend the current topic by utilizing alternative techniques and considering the implications of manager and investor sentiments in ESG stock.

[5] Irreversible investment theory is an economic concept that focuses on the idea that certain types of investments, once made, cannot be easily reversed or undone without significant costs. This theory is often applied to industries with high capital requirements, such as manufacturing plants or infrastructure projects. It suggests that firms face a trade-off when making investment decisions (Bernanke, 1983; Bloom et al., 2007). In case of EPU and ESG, on one hand, firms may want to invest in projects that align with ESG goals to enhance their sustainability performance and reputation. On the other hand, EPU can make firms more hesitant to make these investments, as they may be concerned about the potential risks and costs associated with future policy changes.

[6] Financial frictions theory, also known as the "frictional finance" or "financial market imperfections" theory, is an economic framework that highlights the existence of various obstacles and inefficiencies in financial markets that can impact economic behavior, decision-making, and outcomes. These frictions or uncertainty jumps can induce firms to simultaneously slash capital expenditures and delever (Gilchrist et al., 2014). The theory highlights how uncertainties can create obstacles in financial markets, resulting in reduced availability of funds, higher borrowing costs, and altered investment strategies. As a result, businesses might face challenges in pursuing and implementing ESG initiatives, despite their long-term benefits. Finally, a higher EPU is expected to add to the friction reducing the value of the investment in ESG related projects.

[7] We would like to thank the anonymous referee for suggesting the potential role of irreversible investment and frictional finance theory as well as the investor sentiment in explaining our empirical results.

CRediT authorship contribution statement

Keshab Shrestha: Conceptualization, Data curation, Methodology, Supervision, Software, Investigation, Validation, Writing – original draft, Writing – review & editing. **Babak Naysary:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

Authors have no competing interests to declare.

Data availability

Data will be made available on request.

References

Aye, G., Gupta, R., Hammoudeh, S., Kim, W.J., 2015. Forecasting the price of gold using dynamic model averaging. Rev. *Int. Rev. Financ. Anal.* 41, 257–266. https://doi.org/10.1016/j.irfa.2015.03.010.

Baker, S.R., Bloom, N., Davis, S.J., 2016. Measuring economic policy uncertainty. Q. J. Econ. 131 (November), 1593–1636.

Bernanke, B.S., 1983. Irreversibility, uncertainty, and cyclical investment. Q. J. Econ 98, 85–106.

Birru, J., Young, T., 2022. Sentiment and uncertainty. J. Financ. Econ. 146 (3), 1148–1169.

Bloom, N., Bond, S., Van Reenen, J., 2007. Uncertainty and investment dynamics. Rev. Econ. Studies 74 (2), 391–415.

Chava, Sudheer., 2014. Environmental externalities and cost of capital. Rev. *Manage. Sci.* 60 (9), 2223–2247. https://doi.org/10.1287/mnsc.2013.1863.

Cheng, F.Y., Wang, C.F., Cui, X., Ji, W., He, F., 2021. Economic policy uncertainty exposure and stock price bubbles: evidence from China. Rev. *Int. Rev. Financ. Anal.* 78 https://doi.org/10.1016/j.irfa.2021.101961.

Du, X.L., Ao, Z., Chai, Y.W., Ge, S.L., 2023. Economic policy uncertainty, investor attention and post-earnings announcement drift. Rev. *Int. Rev. Financ. Anal.* 87 https://doi.org/10.1016/j.irfa.2023.102615.

Gilchrist, S., Sim, J.W., Zakrajšek, E., 2014. Uncertainty, financial frictions, and investment dynamics (No. w20038). Natl Bureau Econ. Res.

Grinsted, A., Moore, J.C., Jevrejeva, S., 2004. Application of the cross wavelet transform and wavelet coherence to geophysical time series. Nonlinear Process. Geophys. 11, 561–566.

Goss, Allen, Roberts, Gordon S., 2011. The impact of corporate social responsibility on the cost of bank loans. Rev. *J. Bank. Finance* 35 (7), 1794–1810. https://doi.org/10.1016/j.jbankfin.2010.12.002.

Huang, D., Jiang, F., Tu, J., Zhou, G., 2015. Investor sentiment aligned: A powerful predictor of stock returns. Rev. Financ. Stud. 28 (3), 791–837.

Jiang, F., Lee, J.A., Martin, X., Zhou, G., 2019. Manager sentiment and stock returns. J. Financ. Econ. 132 (1), 126–149.

Jin, X.J., Chen, Z.Q., Yang, X.L., 2019. Economic policy uncertainty and stock price crash risk. Rev. *Account. Finance* 58 (5), 1291–1318. https://doi.org/10.1111/acfi.12455.

Ko, J.H., Lee, C.M., 2015. International economic policy uncertainty and stock prices: wavelet approach. Econ. Lett. 134, 118–122.

Liang, C.C., Troy, C., Rouyer, E., 2020. US uncertainty and Asian stock prices: evidence from the asymmetric NARDL model. Rev. *N. Am. J. Econ. Finance* 51. https://doi.org/10.1016/j.najef.2019.101046.

Liu, Ding, Sun, Weihong, Xu, Liao, Zhang, Xuan, 2023. Time-frequency relationship between economic policy uncertainty and financial cycle in China: evidence from wavelet analysis. Rev. *Pacific-Basin Finance J.* 77, 101915 https://doi.org/10.1016/j.pacfin.2022.101915.

Ng, Anthony C., Rezaee, Zabihollah, 2015. Business sustainability performance and cost of equity capital. Rev. *J. Corp. Finance* 34, 128–149. https://doi.org/10.1016/j.jcorpfin.2015.08.003.

Ono, H., 2023. The causal relationship between economic policy uncertainty and stock indices in OECD and non-OECD countries: evidence from time-varying Granger causality tests on a lag-augmented VAR model. Rev. *Appl. Econ. Lett.* 30 (5), 572–576. https://doi.org/10.1080/13504851.2021.1999897.

Shen, H.Y., Liu, R.X., Xiong, H., Hou, F., Tang, X.Y., 2021. Economic policy uncertainty and stock price synchronicity: evidence from China. Rev. *Pacific-Basin Finance J.l* 65. https://doi.org/10.1016/j.pacfin.2020.101485.

Tang, L., Wan, X.Y., 2022. Economic policy uncertainty and stock price informativeness. Rev. *Pacific-Basin Finance J.* 75 https://doi.org/10.1016/j.pacfin.2022.101856.

Torrence, C., Compo, G.P., 1998. A practical guide to wavelet analysis. Bull. Am. Meteor. Soc. 79, 61–78.

Yuan, M.Y., Zhang, L., Lian, Y.H., 2022. Economic policy uncertainty and stock price crash risk of commercial banks: evidence from China. Rev.. *Econ. Anal. Policy* 74, 587–605. https://doi.org/10.1016/j.eap.2022.03.018.