

£1 Million allocation to stocks over the next 3 to 5 years, using HRP clustering.

In this brief research, I attempt to construct a portfolio using stock indices to capture as much diversification as possible and define a historically stable portfolio. I supplement this quantitative exercise with personal views of where the market is heading, to define final weights for a £1M investment in stock indices or ETFs that track these indices with an investment horizon of 3 – 5 years. I use HRP, a machine learning method, to cluster my indices in uncorrelated clusters and allocate weights per cluster. I use these weights as reference and tilt them based on personal analysis.

The final allocation is as follows:

Technology index	£150,000	
Consumer discretionary index	£70,000	
Healthcare, Utilities, & Consumer Staples indices	£378,000	
<i>(amount to be divided equally between the three sectors)</i>		
Energy	£100,000	
Communication	£300,000	

The source code for the analysis is available on GitHub. <https://github.com/amentago1/HRP-stock-allocation>

Data work

The data used for analysis is for publicly available financial indices. Each index comprises several companies within a specific sector, operating in a range of 23 developed markets. The number of each index's constituents is much less than the specified range.

Below is a high-level description of each index. Please visit referenced sources for more information.

Index	Sector	Composition
MSCI World Energy Index	Energy	63.84% USA, 13.89% Canada, 10.53% UK, 4.9% France, 1.76% Australia, 5.08% Other.
MSCI World Information Technology Index	Technology	90.57% USA, 3.27% Japan, 1.78% Netherlands, 1.72% Germany, 1.14% Canada, 1.53% Other.
MSCI World Communication Services 35/20 Capped Index	Communication	83.6% USA, 5.8% Japan, 2.5% Germany, 1.4% UK, 1.2% France, 5.2% Others.
MSCI World Utilities Index	Utilities	66.4% USA, 6% UK, 5.8% Spain, 4.5% Italy, 3.1% Canada, 13.9% Others.
MSCI World Consumer Staples Index	Consumer Staples	65.1% USA, 10.3% UK, 6.4% Switzerland, 4.8% Japan, 3.9% France, 9.3% Others.
MSCI World Consumer Discretionary Index	Consumer Discretionary	73% USA, 9.4% Japan, 4.6% France, 2.4% Germany, 2.1% UK, 8.1% Others.
MSCI World Health Care	Health Care	71.7% USA, 7.6% Switzerland, 5.1% Denmark, 4.1% Japan, 3.9% UK, 7.4% Others.

Source

Energy: <https://www.msci.com/indexes/index/106796>

Information Technology: <https://www.msci.com/indexes/index/106803>

Communication: <https://www.msci.com/indexes/index/731555>

Utilities: <https://www.msci.com/indexes/index/106805>

Consumer Staples: <https://www.msci.com/indexes/index/106800>

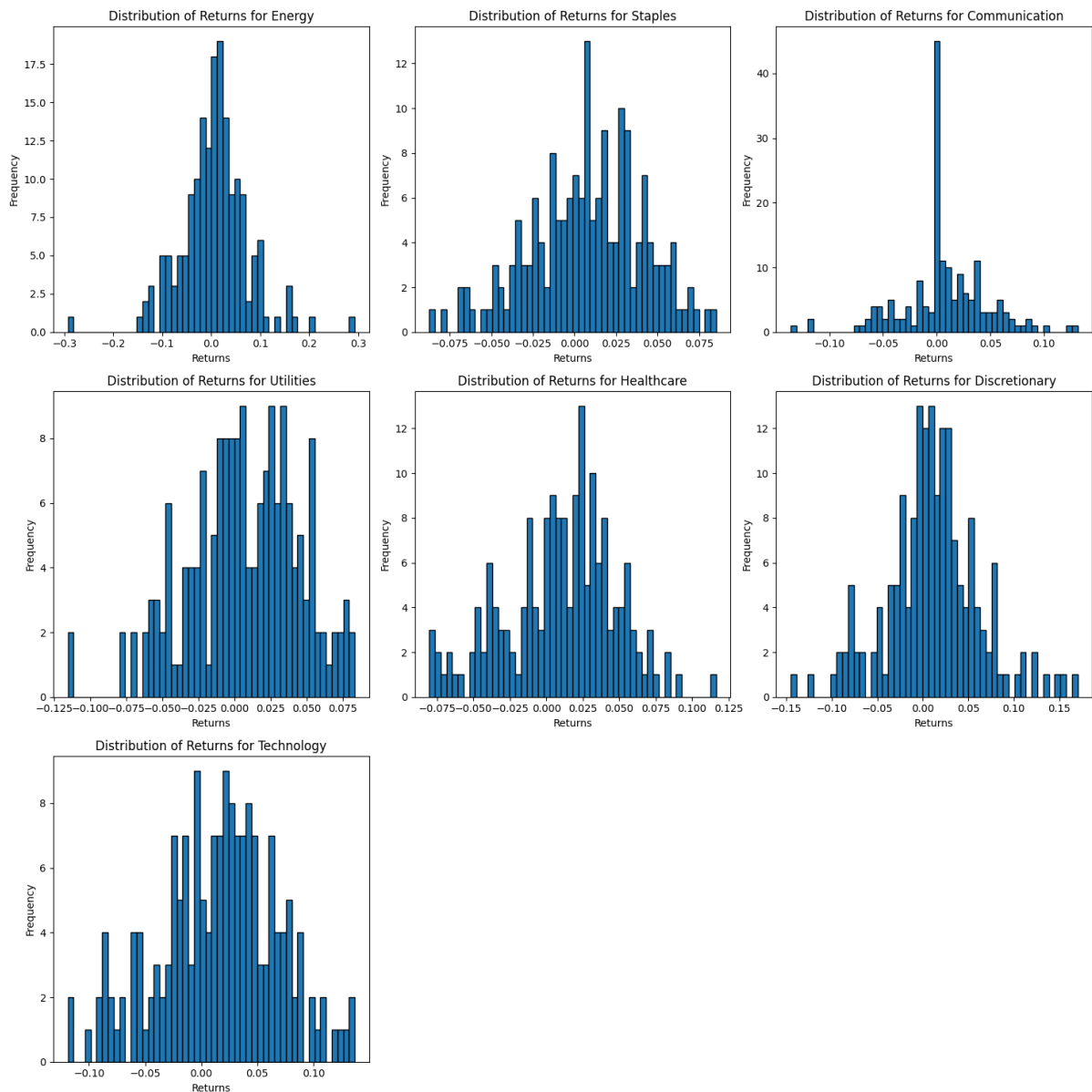
Consumer Discretionary: <https://www.msci.com/indexes/index/106799>

Health Care: <https://www.msci.com/indexes/index/106801>

All indexes are denominated in US Dollars (USD). The data spans from March 31, 2010, to October 31, 2024, approximately covering 14 years of index returns. This allows for sharp fluctuations and different phases of the business cycle to be included, since our investment horizon is within the mid-to-long term; 3 to 5 years.

Analysis

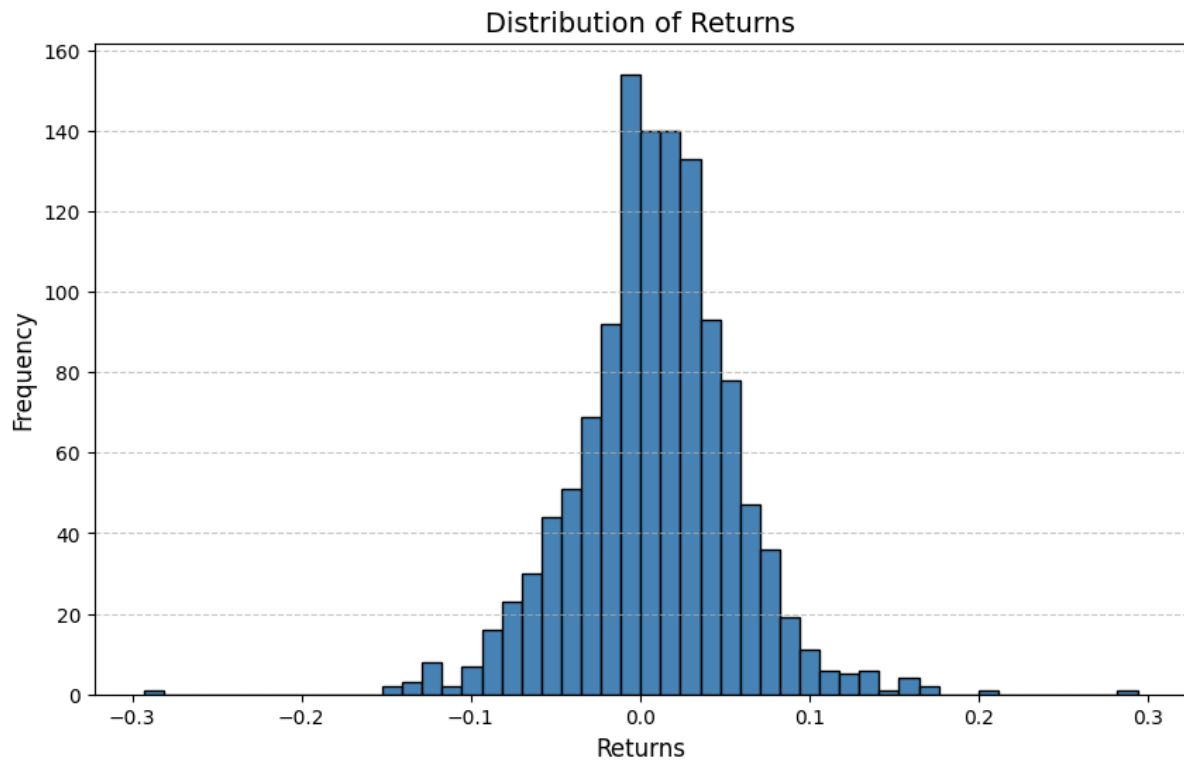
From indices base values, we calculate returns and plot their distributions as indicated in Fig. 1.

Fig.1: *Returns distributions per index.*

During the specified period of analysis, consumer discretionary and energy returns are narrow, symmetric around the mean and are much more stable over long-term investment horizons. Technology and consumer staples have wider distributions, indicating a slightly more frequent losses and gains and a higher size frequency of gains than losses. Healthcare exhibits more frequent losses than gains, utilities are the opposite, and communication's returns are near-zero. Returns from most indices is roughly symmetrical.

Fig.2 present the distribution of combined returns data, which is symmetrical around the mean with slightly more frequent small gains.

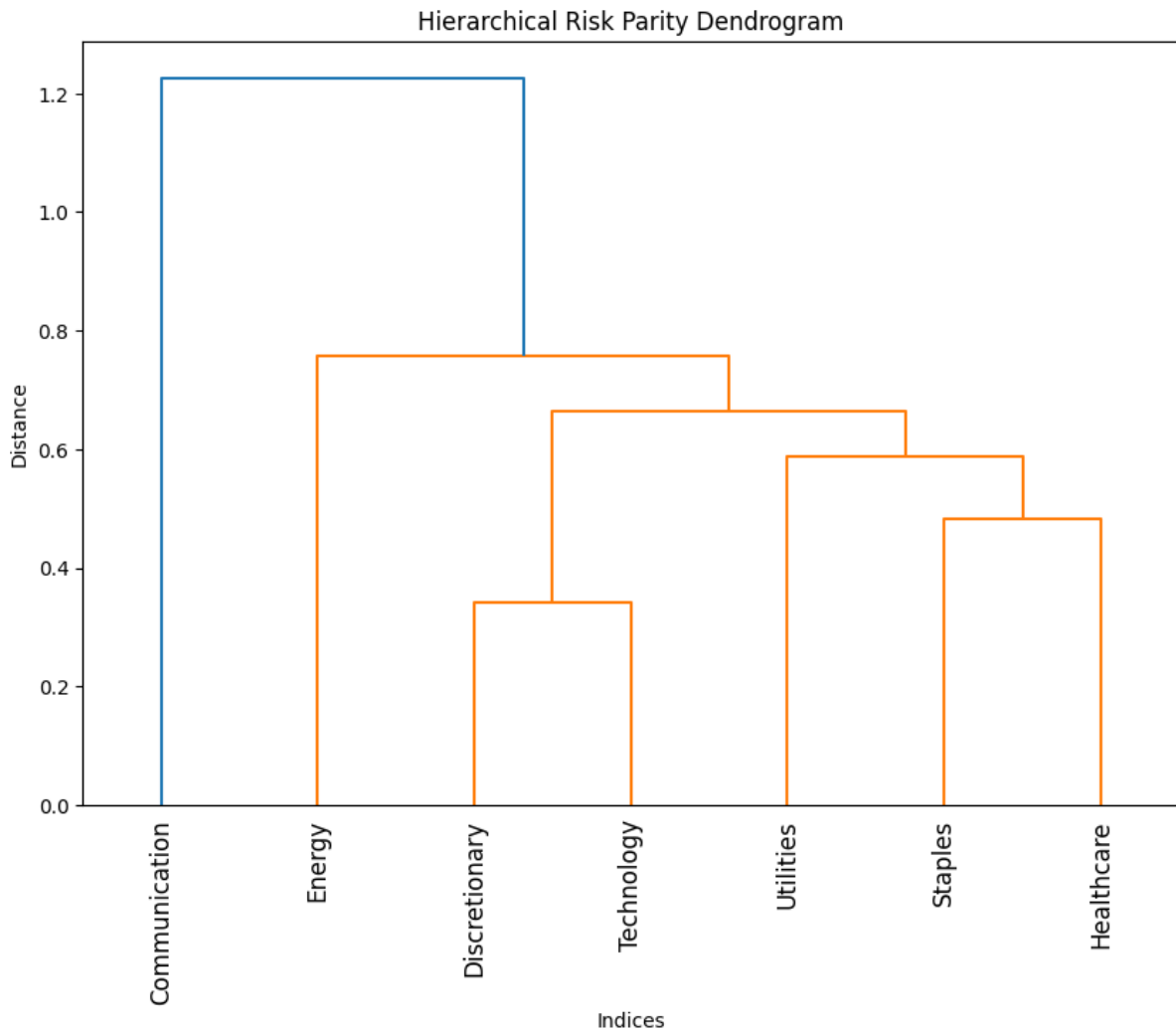
Fig. 2: *Returns distribution of combined returns.*



Clustering

I use the Hierarchical Risk Parity (HRP) machine learning technique to effectively cluster chosen indices into uncorrelated clusters. Given the returns' distributions, I set max clusters at 4 and used the correlation distance, i.e. $(1 - \text{Corr})$, as the distance metric for separating clusters.

Clusters are generally presented using a dendrogram in the case of hierarchical clustering. Fig. 3 is a dendrogram with identified relatively uncorrelated clusters.

Fig. 3: *HRP Dendrogram*.

The following are the distinct clusters and their composition.

Cluster 1: Technology, Consumer Discretionary.

Cluster 2: Healthcare, Utilities, Staples.

Cluster 3: Energy.

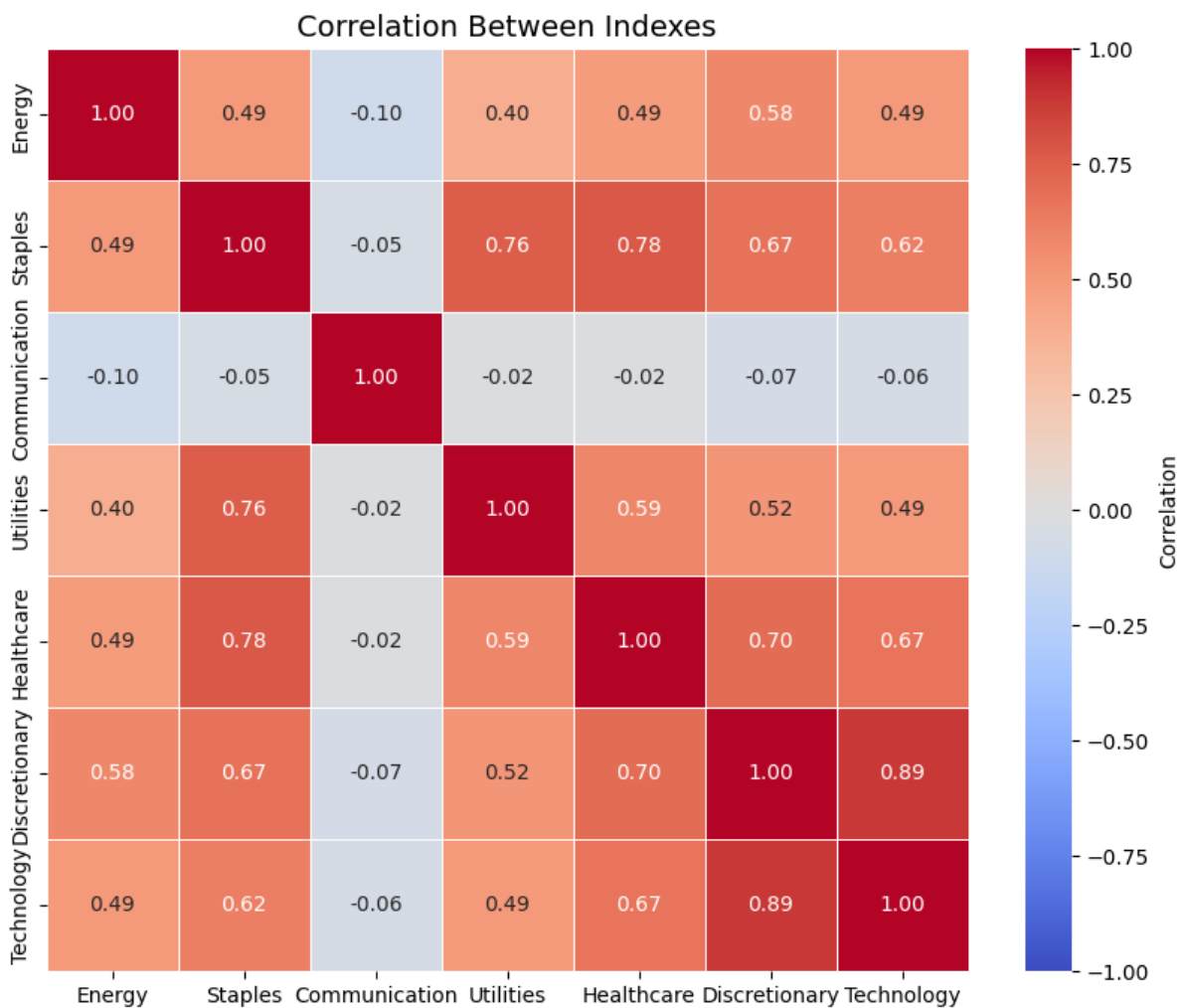
Cluster 4: Communication.

I will therefore base my stock portfolio allocation on these clusters. I will calculate each cluster's risk and return values, and then construct three different portfolios: An equal weights portfolio, a maximum Sharper ratio portfolio, and a minimum variance

portfolio. Each portfolio allocates weights to each of the 4 clusters. Within clusters, weights are allocated equally for all portfolio types.

However, prior to allocation, I must confirm uncorrelated clusters by plotting a correlation matrix of the 7 indices.

Fig. 4: *Correlation matrix.*



Communication is negatively correlated with all other sectors. Technology and consumer discretionary are positively correlated. The remaining sectors are moderately correlated.

Based solely on historical trends, a 14-year period, the following are the computed stock portfolio weights.

	Weights	Expected Return	Risk	Sharpe Ratio
Equal Weights	C1: 0.25; C2: 0.25; C3: 0.25, C4: 0.25	10.69%	8.79%	0.988
Max Sharpe Ratio	C1: 0.38; C2: 0.29; C3: 0.114; C4: 0.216	11.92%	8.74%	1.134
Minimum Variance	C1: 0.22; C2: 0.311; C3: 0.167; C4: 0.298	10.59%	8%	1.074

Historically, a minimum variance portfolio would be comprised of 22% Technology and Consumer Discretionary stocks, 31.1% Healthcare and Utilities stocks, 16.7% Energy stocks, and 29.8% Communication stocks. This composition had a mean annual return of 10.59% and a standard deviation of 8%.

The main purpose of this analysis was to define a diversified portfolio that takes normally distributed returns data as main assumption, to allocate weights to stocks in different sectors.

I use these weights as benchmarks, or anchors, to form a final view on how to invest a £1M in stocks over the next 3 – 5 years.

Discussion

Attempting to forecast whether a president is going to impose tariffs, whether the fed will continue decreasing interest rates, or whether consumers will regain trust in the economy is generally a timewasting exercise for a research analyst. Data usually has properties that link its behaviour from period to period. My attempt in this brief research piece is to uncover the long-term behaviour of the different sectors when allowed to interact with each other within a portfolio.

The question that arises is: will the next 3-5 years stock returns exhibit behaviour like the previous 14 years? No quantitative model can answer this question. However, a reasonable remedy to this issue is to target stability of returns, as the future is

uncertain, and the credibility of forecasts fades away the more forecast years you add. Now, using a stable portfolio's weights as reference, I will tilt the weights towards sectors I believe will add value over the specified forecast horizon.

It is important to note that inflation is generally stabilising in most developed economies, except in the USA where it is proving a little stubborn. This comes following 2 years of high inflation and high interest rates that slowed down growth and have resulted in increased unemployment. Central banks are shifting focus towards stimulating growth and job creation.

The following is a snapshot of Vanguard's 20225 economics forecasts.

Fig. 5: Vanguard's 20225 economics forecasts.

Country/ region	GDP Growth		Unemployment rate		Core inflation	Monetary policy		
	Vanguard 2025	Trend	Vanguard 2025	NAIRU	Vanguard 2025	Year-end 2024	Year-end 2025	Neutral rate
U.S.	2.1%	2.7%	4.4%	4.5%	2.5%	4.5%	4.0%	3.5%
Euro area	0.5%	1.2%	6.9%	6.5%–7%	1.9%	3%	1.75%	2%–2.5%
U.K.	1.4%	1.2%	4.4%	4%–4.5%	2.4%	4.75%	3.75%	3%–3.5%
China	4.5%	4.2%	5.1%	5%	1.5%	1.4%	1.2%	4.5%–5%
Japan	1.2%	1.0%	2.4%	2.5%–3%	2.1%	0.5%	1.0%	0%

The fast advancements in AI and AI deployment will undoubtedly offer competitive edge to some sectors over others. I believe the communication services sector will benefit the most from these advancements in the near term., with each of Meta and Alphabet offering their own Generative AI services within their application. For this reason, I see ~30% weight as reasonable. Moreover, technology gains have been single-handedly carried by Nvidia in the last 12 months. Substantial amounts of money are invested into this stock globally. In these situations, overreactions to company announcements can cause large losses in the event of missed earnings or supply chain disruptions. Therefore, I will keep the 22% weight for technology and consumer discretionary and tilt in-cluster weightage towards technology: 15% technology and 7% Consumer discretionary.

Allocation based on historical returns weights the energy sector at 16.7%. With reduced inflation, increased costs of green transitions and regulations, and the highly regulated nature of this industry, growth potential is severely limited. Production is often at risk given the political and regional turbulence typically affecting energy

companies. Therefore, I will reduce the allocation of 16.7% to 10% and allocate the difference to cluster 2, our defensive sector.

Utilities, consumer staples, and healthcare will receive 37.8% allocation as the portfolio's source of stability.

In conclusion, my allocation of £1M to stock investments is as follows:

Technology index:	15%;	£150,000
Consumer discretionary index:	7%;	£70,000
Healthcare, Utilities, & Consumer Staples indices:	37.8%;	£378,000
<i>(amount to be divided equally between the 3 sectors)</i>		
Energy:	10%;	£100,000
Communication:	30%;	£300,000

References:

Raffinot, T., (2018) 'Hierarchical Clustering-Based Asset Allocation', *The Journal of Portfolio Management*, 44(2), pp. 89 – 99.

Vanguard. (2024). 'Our economic and market outlook for 2025: Global summary', *Vanguard Corporate Site*. Available at:

<https://corporate.vanguard.com/content/corporatesite/us/en/corp/articles/vanguard-economic-market-outlook-2025-global-summary.html> [Accessed: 30 November 2024]