How Many Stocks Should You Own?

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EXECUTIVE SUMMARY

Conventional wisdom says that one needs to hold only 20-30 stocks in their portfolio to achieve adequate diversification, as measured by the difference between portfolio risk and market risk. However, for long-term investors, even a small gap in annualized volatility or average returns can manifest into significant divergence in terminal wealth. We illustrate this point through a historical 25-year simulation-based approach. Our results show that while portfolios of 20-30 stocks indeed have similar volatilities as the market on average, there is a wide distribution of realized returns and volatilities, creating another dimension of risk for individual investors. In order to avoid significant potential shortfalls in terminal wealth, long-term investors should hold at least 200 stocks in their portfolio to more reliably achieve the full potential of the stock market.

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Google this question and you'll find that (1) many recent articles have been written[1] on this question and (2) a consensus answer appears to form around 20-30 stocks (a few suggest 60-80 stocks). Those numbers weren't pulled out of a hat – there have been a few academic studies that suggest as few as 20-30 stocks achieve most of the benefit of portfolio diversification when investing in the stock market.[2]

When it comes to portfolio management, we believe those numbers are too low. By a lot. We'll provide evidence of this in a moment. But first, it's instructive to walk through the equity portfolio math that suggests so few stocks are needed to achieve the benefits of investment diversification. The basic idea relies on a simple theoretical market model to estimate the volatility of an equal-weighted portfolio across n stocks and compute over a wide range of n. A highly simplified model that assumes annualized market volatility is 15%, stocks have stock-specific volatility of 45%, and every stock has identical statistical properties yields the following equation for portfolio volatility:

$$\sigma_n = \sqrt{15^2 + \frac{45^2}{n}}$$

We plot this portfolio volatility estimate across n = 1, 2,...,100 in **Figure 1** (see below).

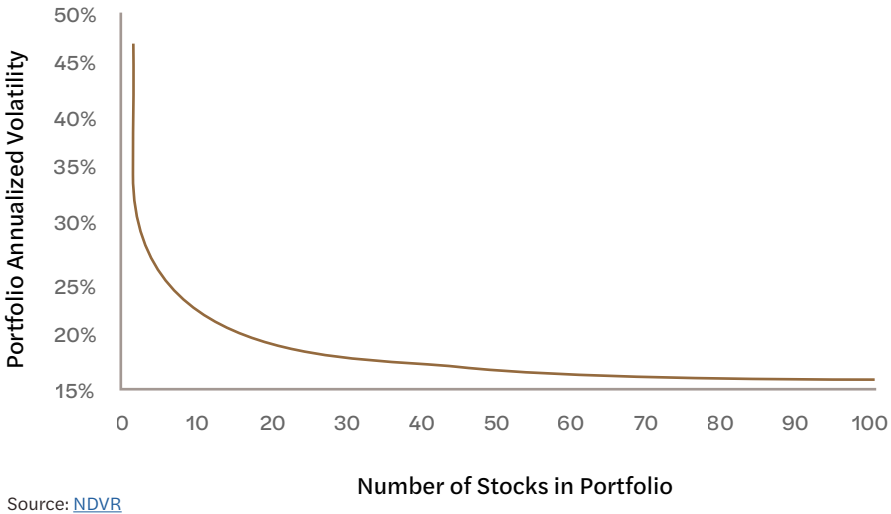
Absent some other information, there's no optimal point on this graph. Portfolio volatility always declines as the number of stocks increases in the model. Increasing the number of stocks always reduces portfolio volatility in this model. This is the power of stock diversification. The question is when has volatility been reduced enough such that the marginal benefit of an additional holding is immaterial. Most studies use the fully diversified portfolio as a benchmark and then derive that a portfolio of 20-30 stocks achieves a 'similar' risk profile as the target portfolio. One can optically see from **Figure 1** that the rate of volatility reduction has slowed down significantly once a portfolio has more than a couple dozen holdings. We challenge this conclusion and show that convergence in volatility at this level is an insufficient criterion from a long-term investor's perspective.

To demonstrate the effect of portfolio diversification, we follow some earlier studies and use a simulation-based approach (O'Neal, 1997; Lhabitant and Learned, 2002). Here's the exercise we run. An investor has a 25-year time horizon. They invest in a portfolio that holds n stocks, each of which is picked at random, and is rebalanced to equal weights at the end of each month. We are interested in three statistics for this portfolio: (1) the Terminal Wealth Multiple (TWM) at the end of 25 years[3], (2) the distribution of annual volatilities under different portfolio sizes and (3) the distribution of annualized returns under different portfolio sizes.

Specifically, we are interested in the distribution of potential outcomes for these statistics for each possible selection of n names held. For each $n \geq 10$, we build and track 5,000 monthly rebalanced portfolios over a 25-year period. Stock dividends are reinvested in the rebalanced portfolio. Our 25-year analysis covers the period December 31, 1994, through December 31, 2019. Our universe of stocks is the top 1,000 stocks by market capitalization on December 31, 1994. On December 31, 1994, n stocks are selected at random. When a stock is delisted, it is replaced by another randomly selected stock at the end of the month of its delisting. After constructing a portfolio of n stocks, we compute its respective TWM, annualized volatility, and annualized return.

Diversification intends to reduce the role of luck in performance outcomes. If we invest in a portfolio of say 25 stocks, we could be lucky or unlucky in terms of which 25 stocks we pick to represent

FIGURE 1
Portfolio Annualized Volatility



Source: NDVR

our diversified portfolio. If 25 stocks provide sufficient diversification, either a positive or negative outcome should not deviate too much from the broad market portfolio. To visualize the difference, focusing specifically on the unlucky outcomes, we plot the 10th and 25th percentile outcomes for TWM across n = 10, 25, ..., 400, 500 in **Figure 2**.

Figure 2 plots the 10th and 25th percentiles of TWM over the 25-year period. First, this was a great time to be an equity investor! Even unlucky highly diversified investors (500 names) 18x'ed their wealth over the 25 years. Concentrated investors also achieved good outcomes, although significantly less good. Unlucky investors in 10 stocks "only" 9x'ed their wealth over 25 years. Not bad, but they achieved only half the end wealth of their unlucky diversified counterparts. Can investors eliminate most of the downside risk by holding more than 10 stocks, say 20-30 stocks, as suggested by the stock diversification model?

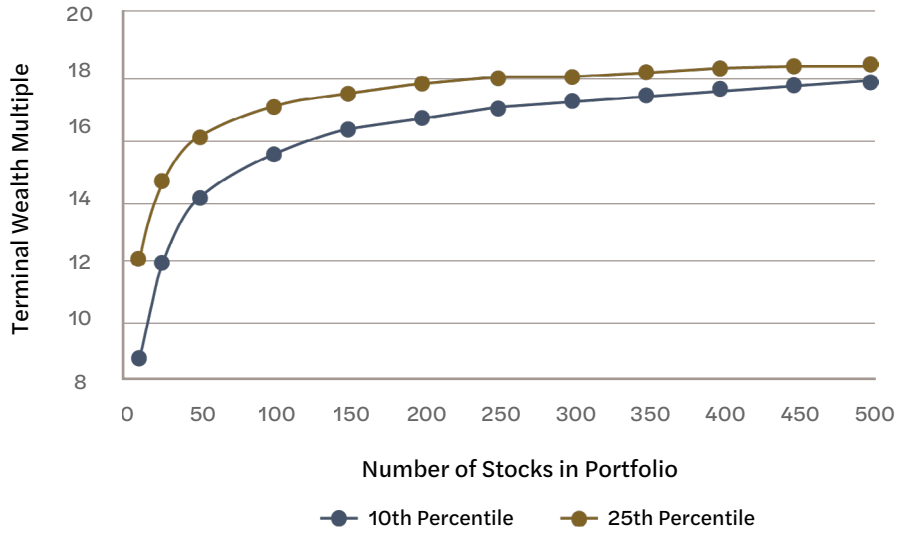
Contrary to the volatility graph in **Figure 1**, TWM clearly does not converge around 20-30 stocks. In **Figure 2**, the slope remains steep until around 250 stocks, meaning there is still a lot of room for improvement at 20-30 stocks. Indeed, while on average these portfolios have delivered 19x TWM over 25 years, an investor with just 25 stocks had a 1-in-10 chance of receiving less than a 12x TWM. This represents forfeiting 36% of their expected end wealth! On the other hand, a portfolio with 250 stocks had a 1-in-10 chance of achieving less than a 17x TWM, only 10% below the expected outcome. The unlucky 250-stock investor ended up with about 40% greater end wealth than the unlucky 25-stock investor. This surely feels surprising to the long-term investor since, by the argument in **Figure 1**, these portfolios should have 'similar' risk profiles.

Why does the conclusion from this analysis diverge so much from the original model? Three reasons come to mind. The first reason is that it's easy to misinterpret what **Figure 1** actually tells us about portfolio risk. If individual stocks have 45% of idiosyncratic volatility, then a portfolio of 25 stocks has 9% of idiosyncratic volatility. That's still a ton of stock-specific risk. Aggregate 9% annualized idiosyncratic volatility over 25 years and you're right back to having 45% of total accumulated idiosyncratic volatility. An unlucky selection of 20-30 stocks can massively underperform other luckier choices over 25 years. To mitigate that risk, a long-term investor should be more aggressive in diversifying the portfolio and hold more stocks than the number suggested by a static one-period risk model.

The second reason is that the model focuses on the average risk profile of these portfolios without paying attention to the distribution. **Figure 3** illustrates this point by plotting the distribution of portfolio volatilities across the simulations. As other studies point out, the average volatilities (proxied by the peaks of these graphs) indeed converge slowly when increasing the number of holdings – for example, the difference is only ~1% between a typical portfolio of 25 stocks to a portfolio of 100 stocks. However, while the expectation is that these portfolios should have similar risk profiles, a portfolio of 25 stocks is much more likely to become a lot riskier than what the model predicts on average since its distribution is much wider. If you want to reduce the potential impact of holding such a high-risk "atypical" portfolio, you need more stocks.

Finally, another important metric is missing from the model: expected returns. The model ignores them completely. We might not know in advance which stocks have high average returns and which have low average returns, but that doesn't mean they are in fact the same. Imagine a coin toss that determines each stock's expected return: heads and the expected return is 12%, and tails and the expected return is 2%. But we don't get to see the coin. From our point of view, the stock's expected return is 7%, but, in reality there's a 50:50 chance it's either 2% or 12%. And because individual stocks are so volatile, it's nearly impossible to identify

FIGURE 2
Portfolio Terminal Wealth Multiple from Dec 31, 1994 through Dec 31, 2019



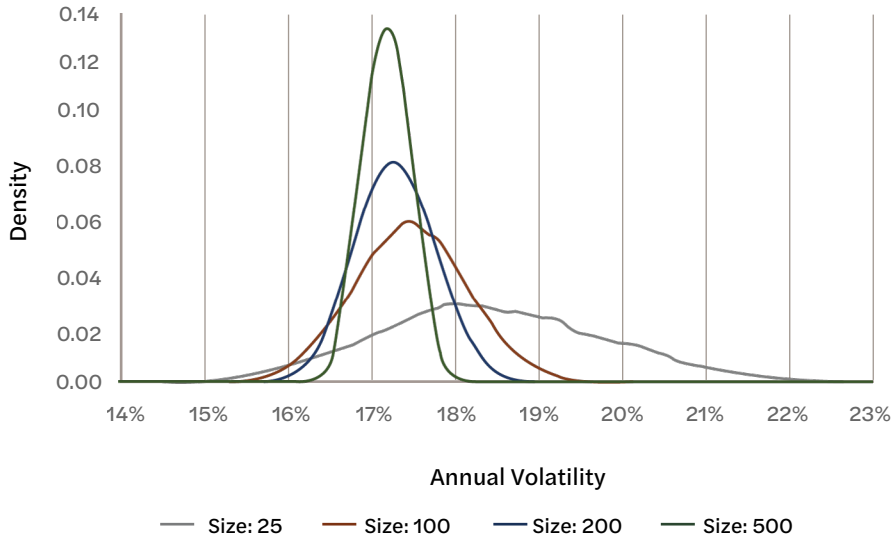
Source: NDVR, Center for Research in Security Prices

which stocks fall into one category or the other. We might get unlucky in our selection of 20-30 stocks and pick a portfolio of stocks that flipped a bunch of tails.

As illustrated in **Figure 4**, while all these portfolios have the same unconditional average returns, the distribution of average realized return is much wider for a portfolio of 25 stocks. If a 25-stock portfolio happens to fall into the left end of the grey curve, that is really going to hurt over time. Note that the risk of holding some sub-par stocks in the portfolio is distinct from the portfolio risk described in **Figure 1**, which focuses on year-to-year variation around the portfolio's expected return. But if the expected returns themselves differ so much among the portfolios, the final wealth of long-term investors will diverge even further due to compounding, regardless of how similar these portfolios' risk profiles are. Like before, if you want to reduce the impact of such bad luck, you need more stocks.

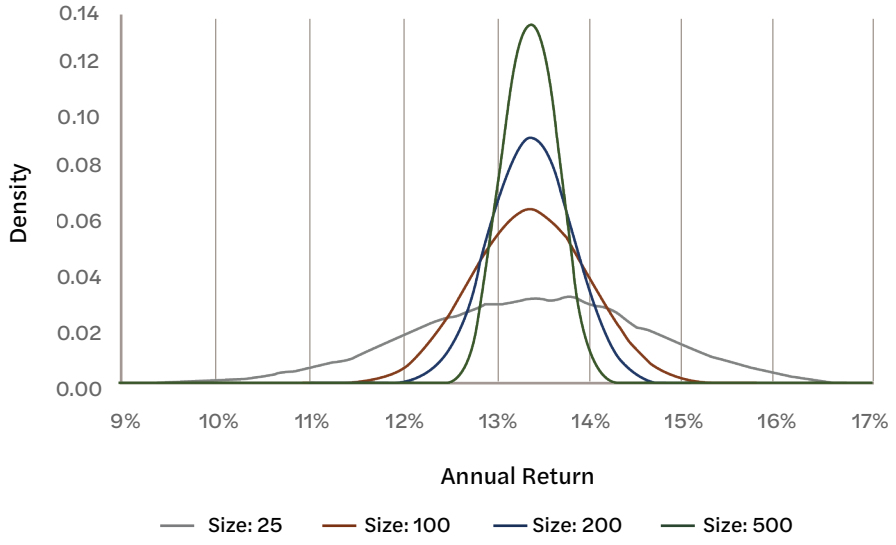
So... how many stocks should you own? There's no magic number for the ideal number of stocks. From the portfolio diversification point of view, more should always be preferred. There might be other practical considerations that limit the number of stocks. However, our analysis demonstrates that, whether you own ETFs, mutual funds, or a basket of individual stocks, a well-diversified portfolio requires owning more than 20-30 stocks.

FIGURE 3
Portfolio Volatility Distribution from Dec 31, 1994 through Dec 31, 2019



Source: NDVR, Center for Research in Security Prices

FIGURE 4
Portfolio Average Annual Return from Dec 31, 1994 through Dec 31, 2019



Source: NDVR, Center for Research in Security Prices

FOOTNOTES

[1] A recent article in Time online magazine nicely summarizes current conventional wisdom on the topic. Another recent article in Business Insider shares the conclusion that "While there is no 'perfect' portfolio size, the generally agreed upon number is 20 to 30 stocks." There are additional articles written in Kiplinger, The Motley Fool, Money, SoFi, Forbes, The Street, and USA Today.

[2] See Zaimovic, Omanovic and Arnaut-Berilo (2021) for a review of the topic.

[3] TWM is defined as the wealth after 25 years per $1 Investment. In "Is Multi-Manager Diversification Worth It?", Corey Hoffstein from Newfound Research uses the same metric to quantify the benefits of diversification from combining multiple managers together. As the author argues: "If we build a portfolio of 30 stocks and you build a portfolio of 30 stocks, the portfolios may have nearly identical levels of volatility, but we almost assuredly will end up with different realized results." Similarly, William Bernstein from Efficient Frontier also views Terminal Wealth Dispersion as the most important dimension of portfolio risk beyond standard deviation.

[4] Investing in index funds is a popular investment strategy. Index funds are designed to closely track the market returns of a defined benchmark across various market conditions, typically at a low cost. Exchange-Traded Funds (ETFs) and mutual funds are the most widely held index fund investment products for retail investors. Although there are drawbacks to investing in collective funds, such as a lack of personalization and additional administrative expenses, when compared to investing directly in the underlying securities, there can also be benefits. For example, some index funds provide greater liquidity than investing in individual stocks, especially if they are small cap.

[5] Although our work focuses on equities, the same portfolio theory is applicable to an allocation to other asset classes such as bonds, which are exposed to risks such as changes in credit quality and interest rates, and real estate.

DISCLOSURE

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