Axiom: "an indemonstrable proposition that must be accepted"

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Modern portfolio theory tells us that the return from an asset is simply the remuneration of the risk attached to holding the asset.

Therefore, an asset that is considered risky should yield a higher return than a less risky asset.

Modern portfolio theory, developed in 1952 by the winner of the Nobel Prize in Economic Sciences, Harry Markowitz, today constitutes the academic foundation upon which a great many portfolios of financial assets are built.

As part of this study, we will take this axiom as a starting point and create portfolios of securities that are not selected based on fundamental criteria or criteria of momentum, but solely based on risk criteria.

In this way, we will be able to verify if a portfolio's performance is indeed directly related to its risk.

We will attempt to provide a rational explanation of our results, knowing full well that market finance and "absolute truth'' are not always compatible.

Methodology

The performance simulations that will be presented in this study are based on the period from January 1, 2000 to October 31, 2014.

It therefore covers two phases of pronounced economic downturn (2000–2003 and 2007–2009) and two phases of significant upswings (2003–2007 and 2009–2014).

Our benchmark stock index is the Stoxx Europe 600 Index (dividends reinvested).

Our performance simulation procedure has been drawn up such that the results presented are completely unbiased, particularly in terms of survivorship bias and data anticipation.

For each of the selection criteria that we will study, we will limit our investment universe to securities in the Stoxx Europe 600 Index with annualized volatility (calculated over 120 days) of between 10 and 50%.

We will apply a transaction fee of 0.25% to the total transaction amount.

Each month, we will select securities for inclusion in our portfolio that are in the first decile of our universe as per the criterion studied.

We will limit the number of securities held in the portfolio to 50.

Securities previously included in the portfolio will only be excluded from the portfolio if they are no longer in the first third of our universe as per the criterion studied or if they are ranked below 80th place in our universe, as per the criterion studied.

By proceeding in this way, we limit the total number of transactions carried out and the negative impact on overall performance caused by transaction fees.

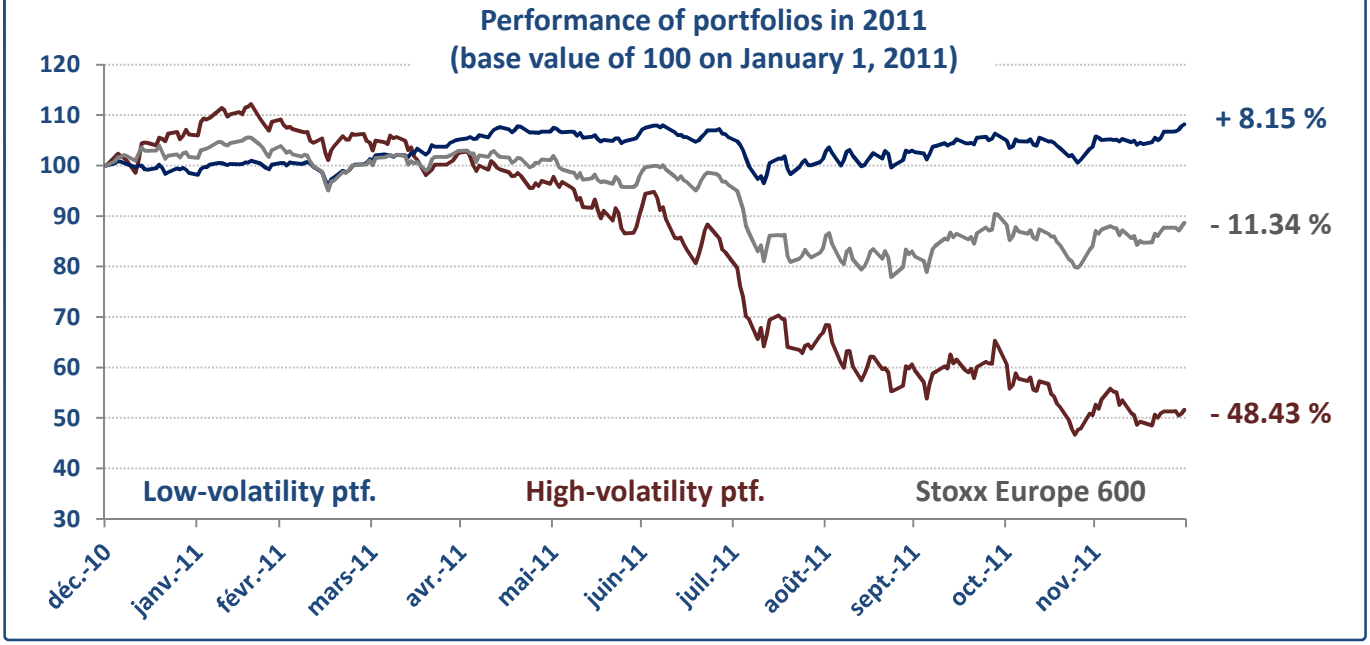
The price data and fundamental data used in the performance simulations are taken from Bloomberg and adjusted for all securities transactions that may have influenced share prices (dividend payment, splits, bonus share allocations, etc.).

1 – Our measure of risk: volatility

For the past four years – 2011, 2012, 2013 and 2014 – we will create two portfolios.

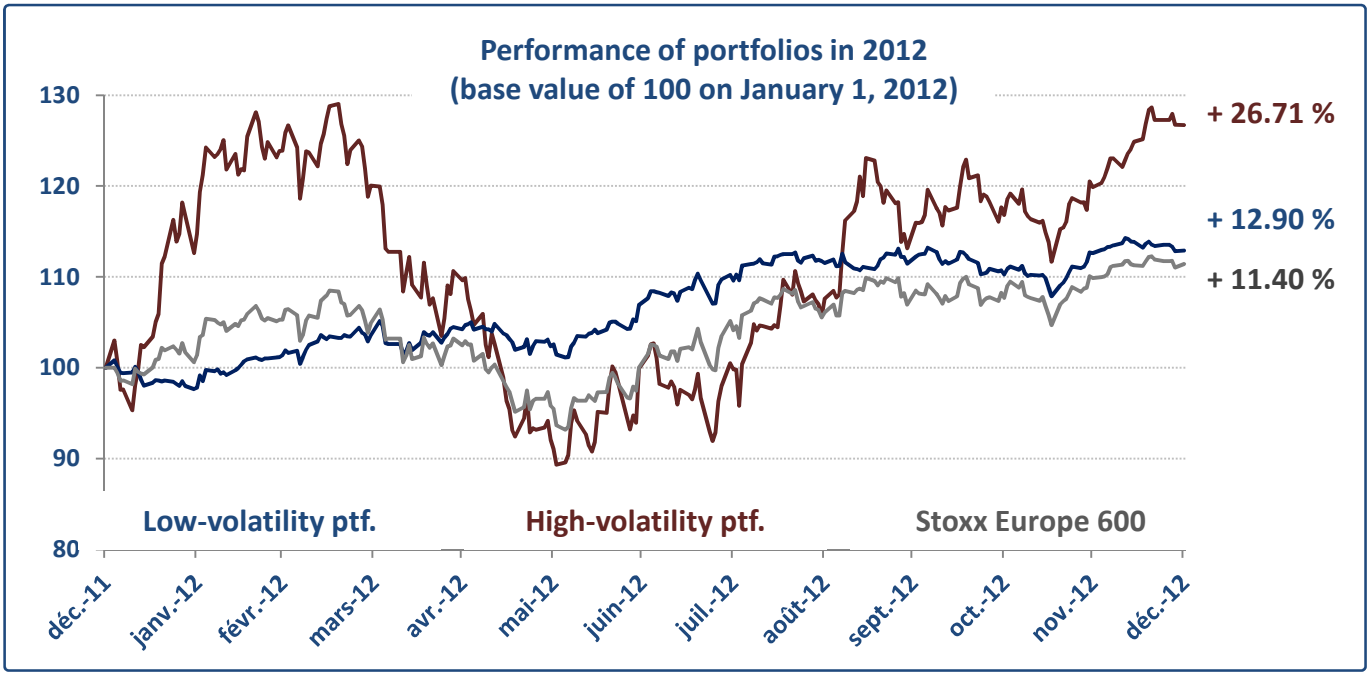
The first portfolio will comprise the first decile of **the least volatile** securities over the year preceding the creation of the portfolio.

The second portfolio will comprise the first decile of **the most volatile** securities over the year preceding the creation of the portfolio.



	Low-volatility ptf.	High-volatility ptf.	Stoxx Europe 600
Return over the period	+ 8.15 %	- 48.43 %	- 11.34 %
Annualized volatility	12.24 %	37.52 %	21.87 %
Risk/reward	0.67	- 1.29	- 0.52

The low-volatility portfolio significantly outperforms, with an overall performance in 2011 of +8.15% versus -11.34% for the Stoxx Europe 600 Index and -48.34% for the high-volatility portfolio

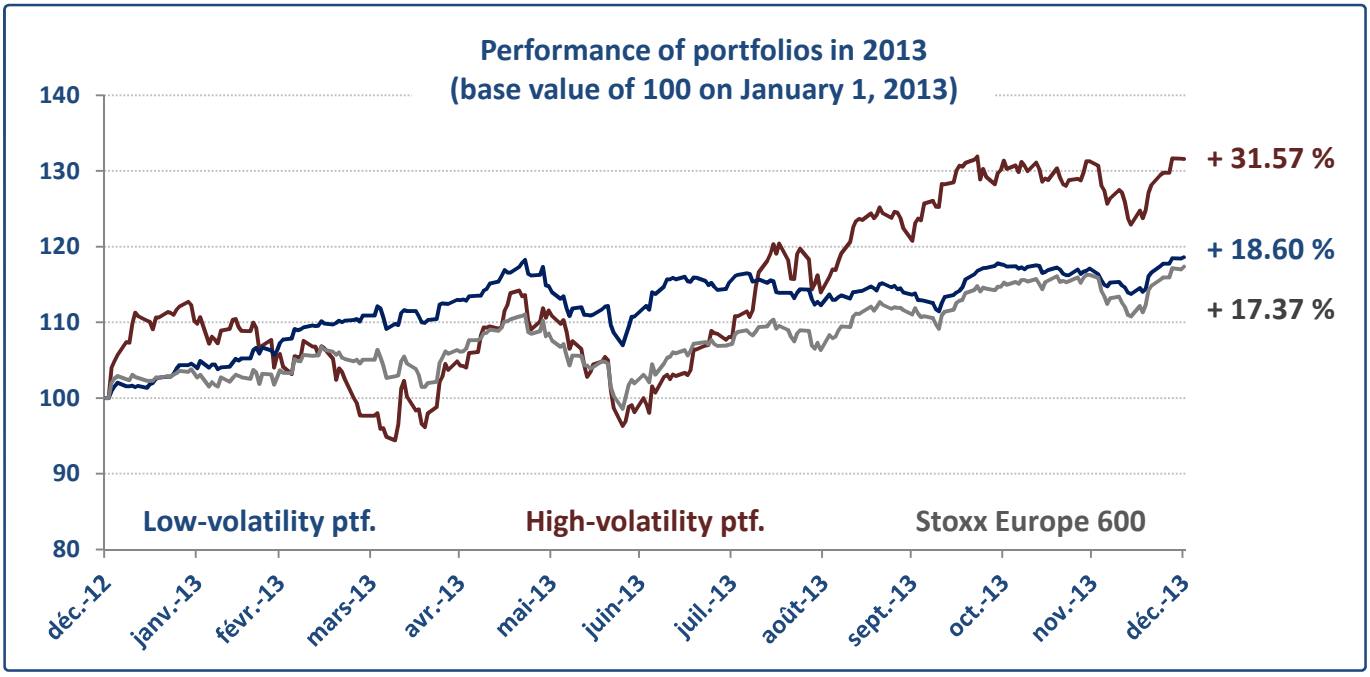


	Low-volatility ptf.	High-volatility ptf.	Stoxx Europe 600
Return over the period	+ 12.90 %	+ 26.71 %	+ 11.40 %
Annualized volatility	8.90 %	29.49 %	21.87 %
Risk/reward	1.45	0.91	0.78

- The portfolio comprised of volatile securities is best in terms of total performance

- However, in terms of the ratio of the performance achieved versus the risk taken, the portfolio comprised of **low-volatility** securities is vastly superior. This can be seen in the overall performance for 2012 of 12.90%, with a lower volatility of 8.90%, versus a performance of 26.71% for the **"high-volatility"** portfolio and a volatility that is three times as high at 29.49%

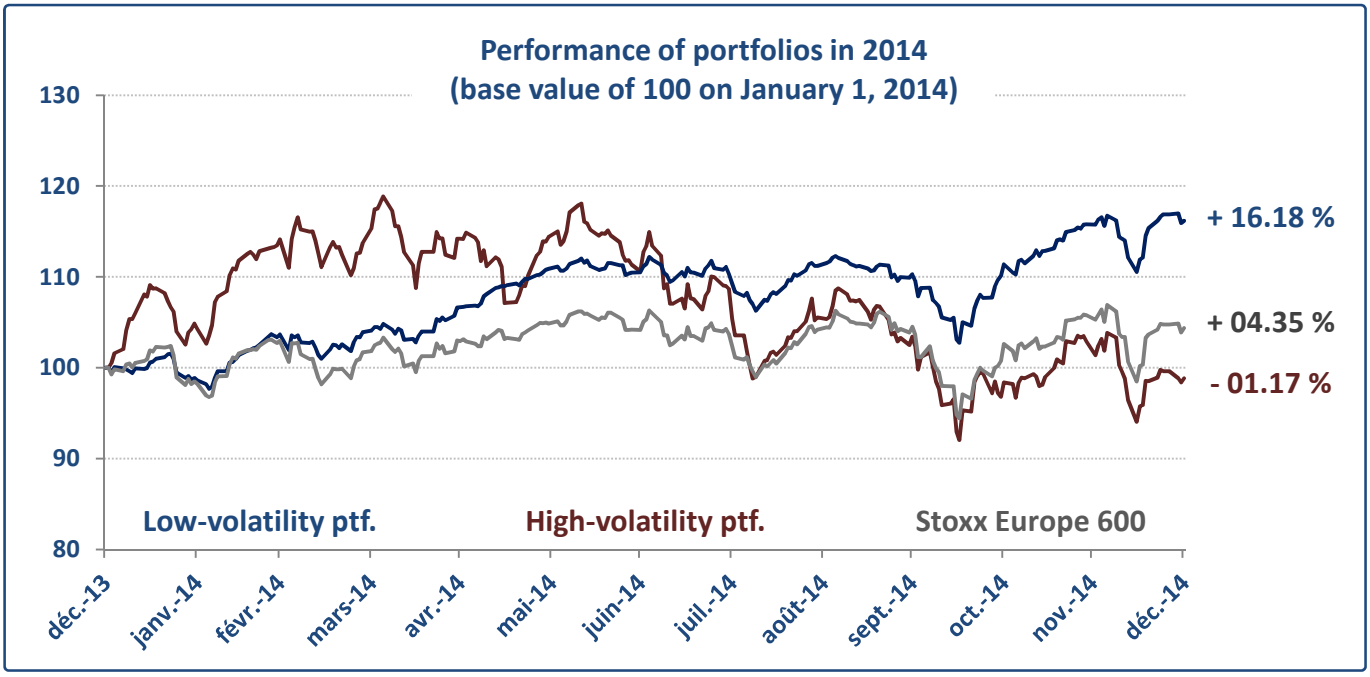
- At an equivalent risk, investors holding the **"low-volatility"** portfolio in 2012 would have received a reward in respect of the risk incurred that was 1.5 times higher than investors holding the **"high-volatility"** portfolio



	Low-volatility ptf.	High-volatility ptf.	Stoxx Europe 600
Return over the period	+ 18.60 %	+ 31.57 %	+ 17.37 %
Annualized volatility	9.03 %	20.35 %	11.93 %
Risk/reward	2.06	1.55	1.46

Once again, the **"low-volatility"** portfolio records a far higher remuneration of the risk borne by the investor

Although in terms of total performance, the **"high-volatility"** portfolio is better, it is important to note that it is subject to a risk that is more than twice as high as that of the **"low-volatility"** portfolio and of the Stoxx Europe 600 Index



	Low-volatility ptf.	High-volatility ptf.	Stoxx Europe 600
Return over the period	+ 16.18 %	- 01.17 %	+ 04.35 %
Annualized volatility	9.54 %	19.04 %	13.20 %
Risk/reward	1.70	- 0.06	0.33

As in 2011, 2012 and 2013, the low-volatility portfolio once again records the better risk/reward ratio

It is also superior in terms of total performance, recording **+16.18%** versus **– 01.17 %**

Although we cannot draw a definitive conclusion at this stage, there seems to be an emerging trend here

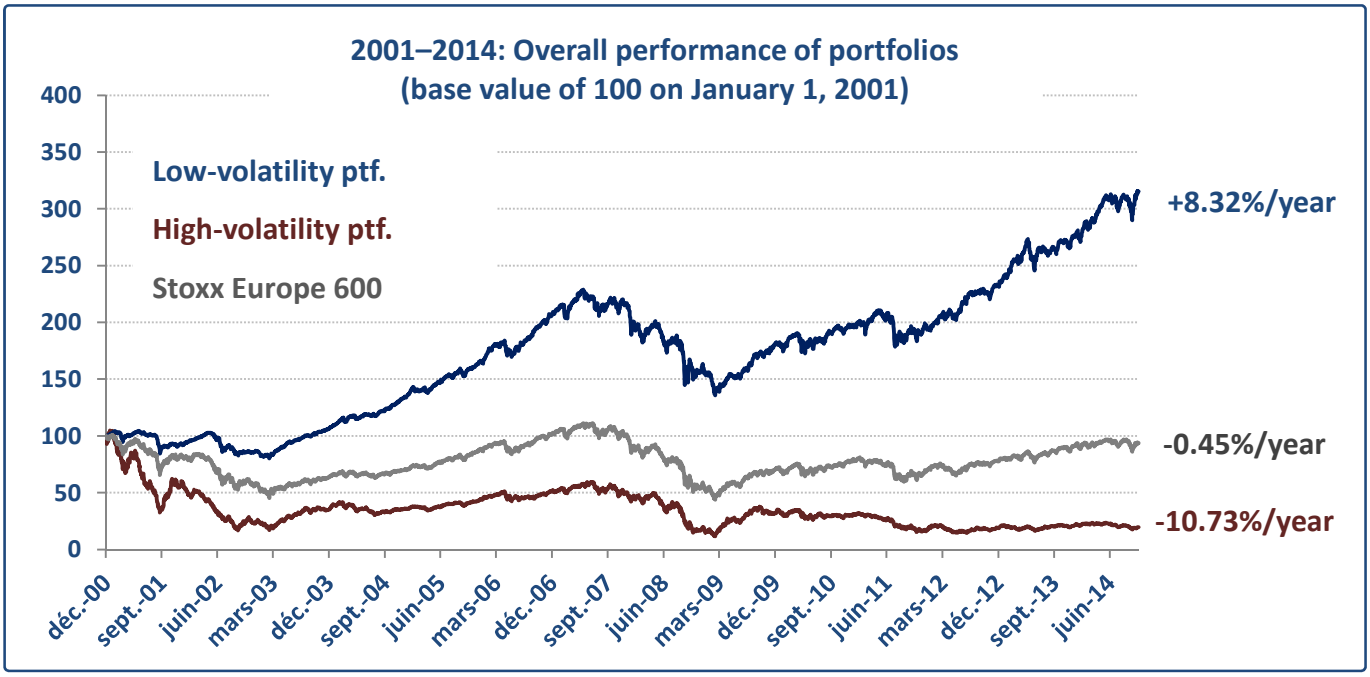
The risk/reward relationship seems far less clear than our starting axiom would suggest

2 – Generalization of our initial observation

For the period from January 1, 2001 to October 31, 2014, we will create a portfolio for each quarter comprising the first decile of the least volatile securities over the last six months.

Conversely, we will also create a portfolio for each quarter comprising the first decile of the most volatile securities in our investment universe, the Stoxx Europe 600 Index.

As a reminder, the exact methodology of our portfolio simulation procedure is described on page 2 of this study.

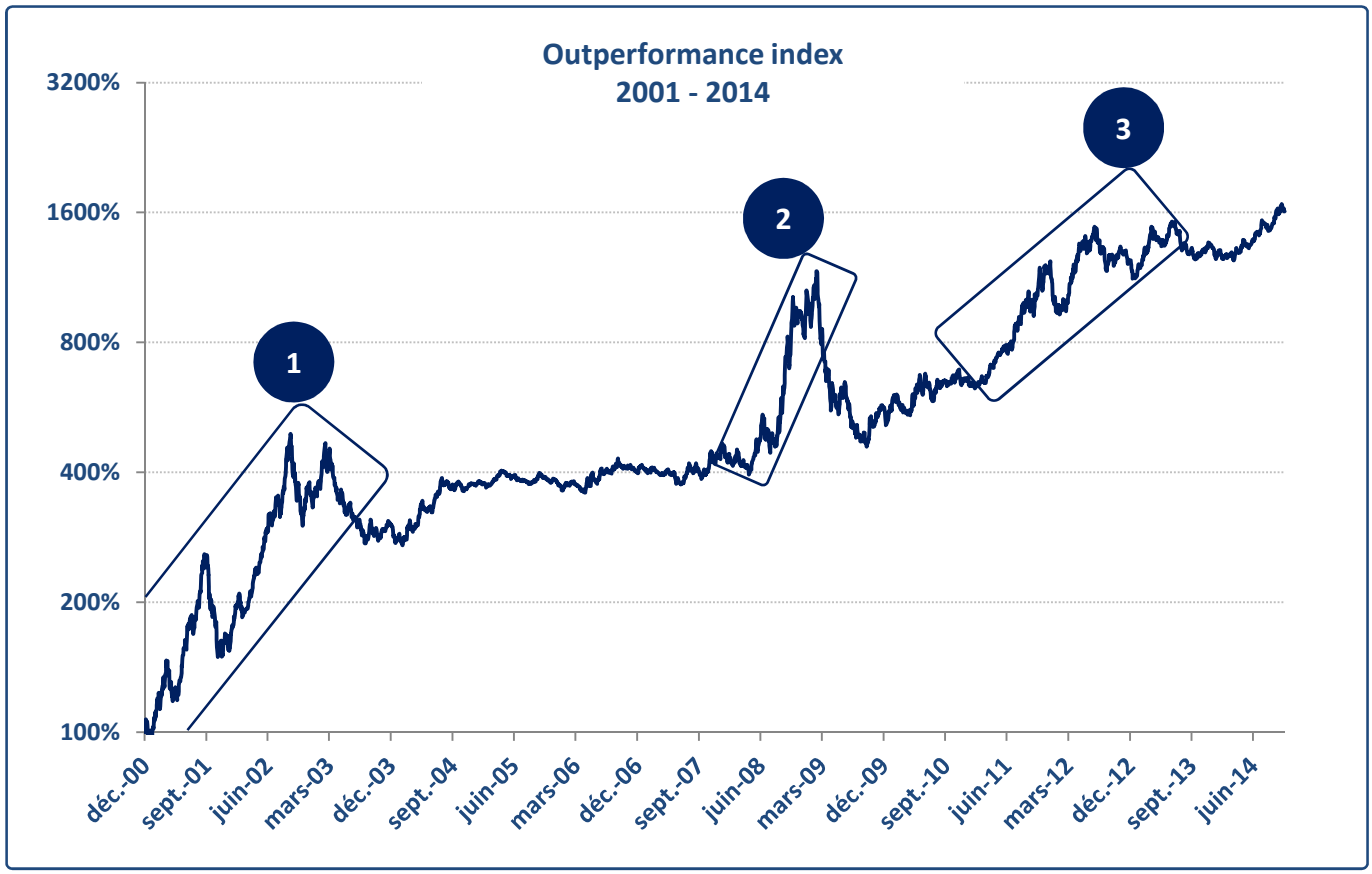


	Low-volatility ptf.	High-volatility ptf.	Stoxx Europe 600
Annualized return	+ 8.32 %	- 10.73 %	- 0.45 %
Annualized volatility	11.25 %	32.19 %	19.95 %
Risk/reward	0.74	- 0.33	- 0.02

Here we observe a massive outperformance by the **"low-volatility"** portfolio and perfect symmetry in our results: **"low volatility"** > **Stoxx Europe 600** > **"high volatility"**

3 - Outperformance analysis

$$\text{Outperformance Index}_{j} = \frac{\text{Base value of 100 of the low–volatility portfolio j}}{\text{Base value of 100 of the high–volatility portfolio j}}$$



1 **January 2001–March 2003**: dot-com bubble bursts

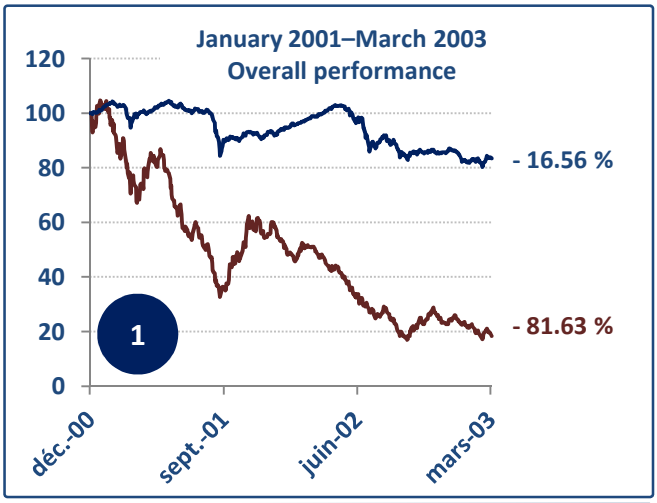
2 **January 2008–March 2009**: subprime crisis

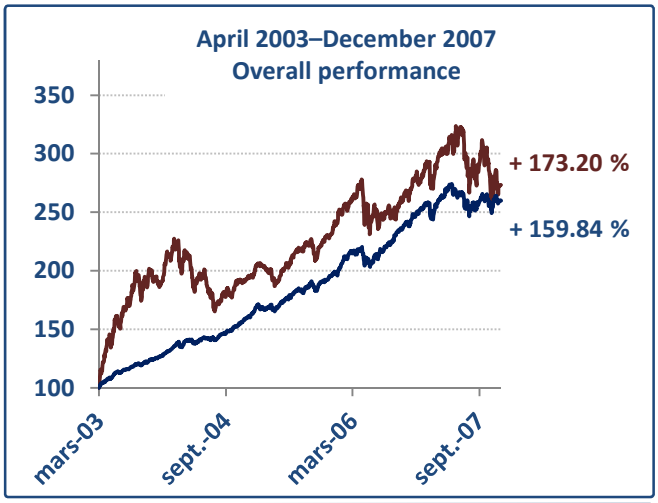
3 **January 2011–July 2012**: European sovereign debt crisis

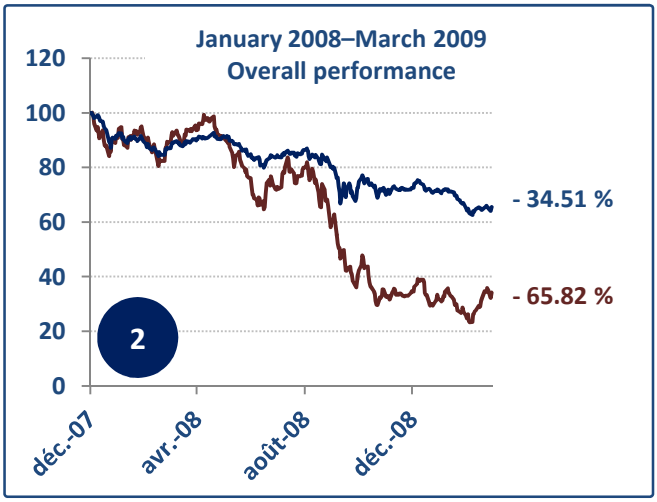
The outperformance of the ‘‘low-volatility’’ portfolio is significant during phases of market stress

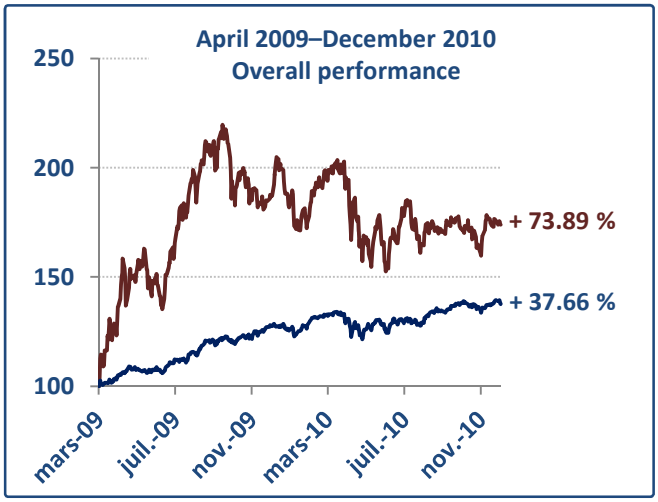
In a normal market situation, this capacity to outperform is significantly less evident

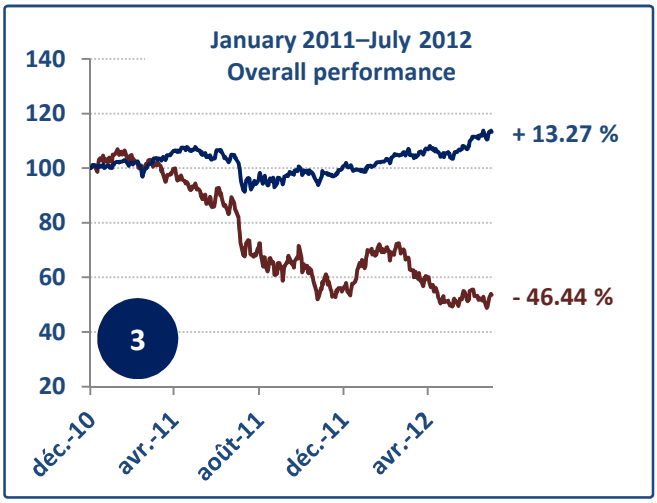
Sequential analysis: "low-volatility" portfolio *vs.* "high-volatility" portfolio

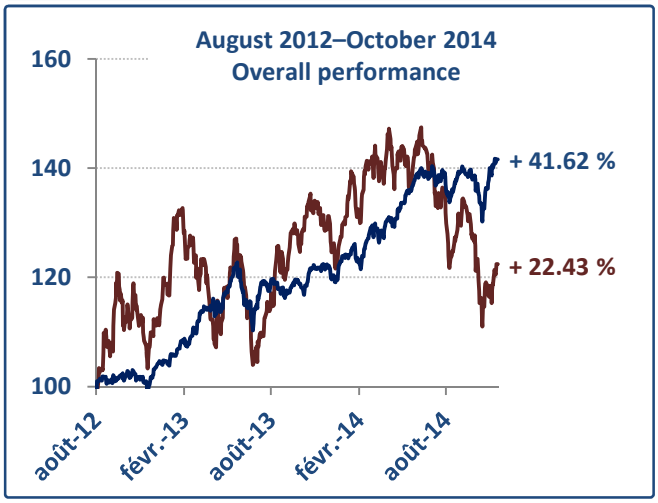












4 – What causes this outperformance in times of market stress?

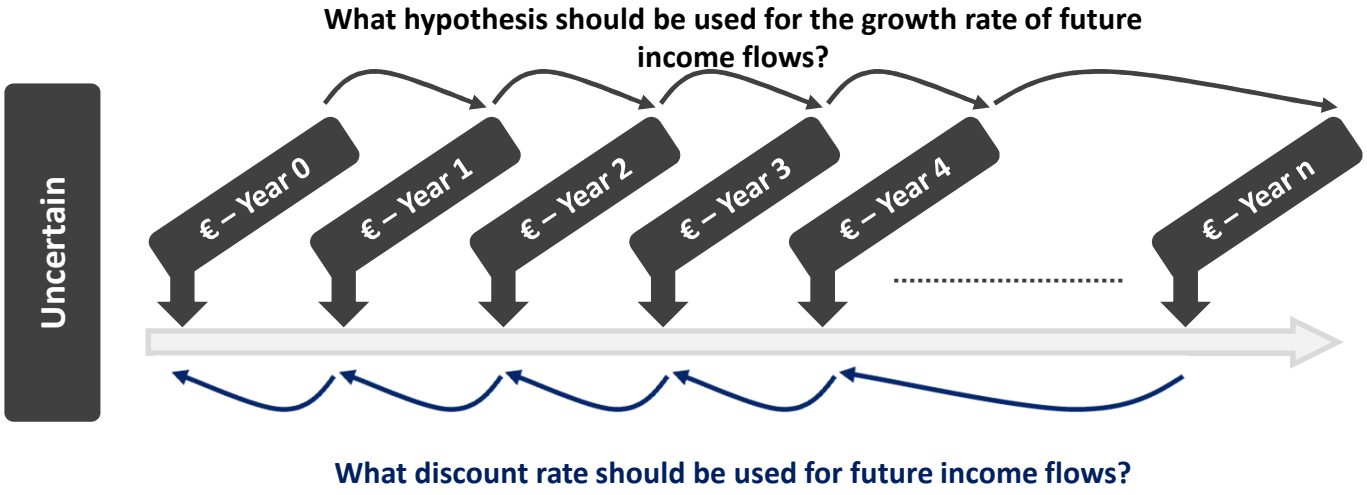
Without claiming to have a definitive answer, here we will attempt to provide the reader with an explanation of the phenomenon observed.

Our aim is to establish an explanation grounded in common sense, with concrete and simple principles.

When an investor invests in the capital of a company, they primarily acquire two things:

Certain	**shareholders' equity + an economic asset – debts**
Uncertain	**a flow of income generated by business**

Although it is relatively simple to assess a company's economic assets, reliably estimating future income flow is more of a matter of trial and error; constantly readjusting initial hypotheses based on the current prevailing economic conditions, or "*t*":



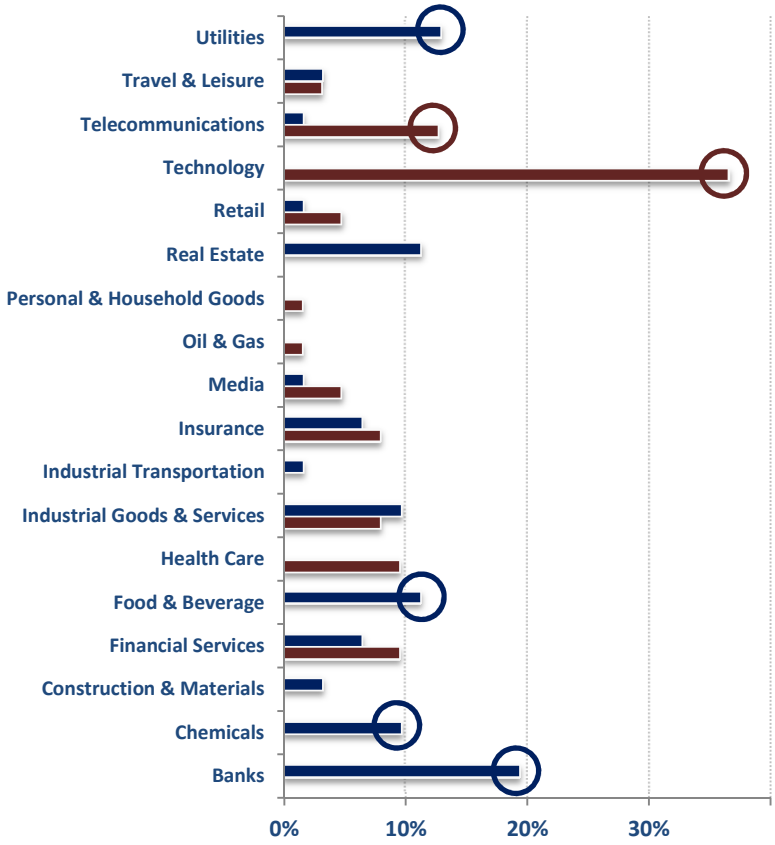
We believe that the main source of volatility for stock market securities is precisely this difficulty in establishing hypotheses of future income flow growth and choosing a discount rate that accurately reflects the risk linked to a company's business, which is the primary source of a security's volatility.

5 – Portfolio analysis

To confirm this intuition, we will analyze the composition of both our **"low-volatility"** portfolio and **"high-volatility"** portfolio over three periods of stock market stress that we previously identified:

1 **January 2001–March 2003**: the bursting of the dot-com bubble

Sectorial exposure of portfolios as the dot-com bubble burst

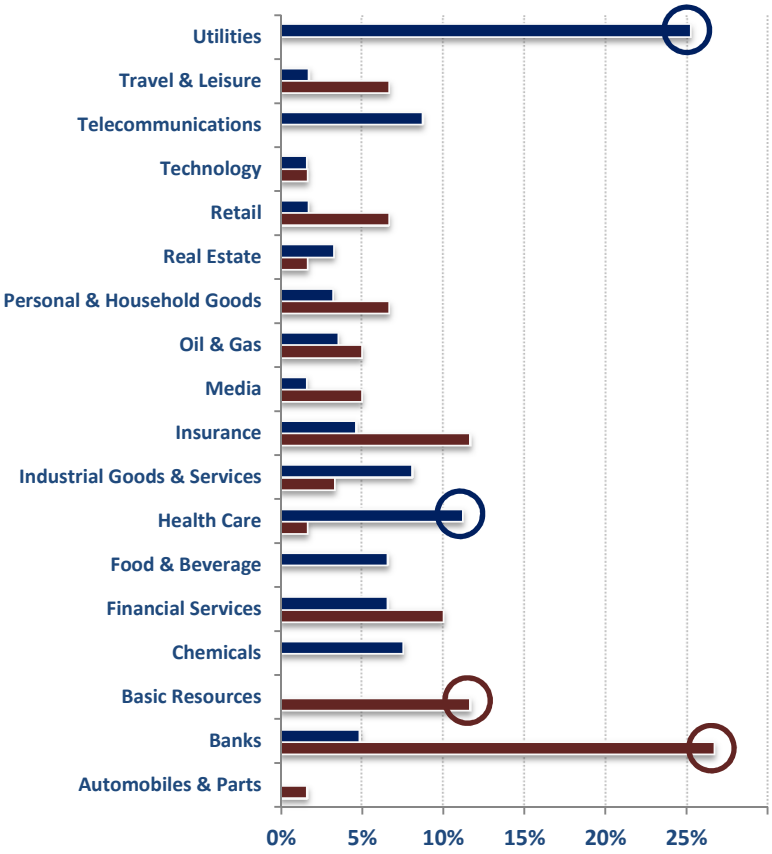


- The public utilities, food & beverage, chemicals, and banking securities sectors* accounted for more than 50% of the **"low-volatility"** portfolio
- The technology sector was entirely absent from the **"low-volatility"** portfolio
- Conversely, this sector had the highest weighting in the **"high-volatility"** portfolio
- Between them, the technology and telecommunications sectors accounted for more than 50% of the **"high-volatility"** portfolio

**** Until 2008, banking securities were considered defensive stocks***

2 **January 2008–March 2009**: subprime crisis

Sectorial exposure of portfolios during the subprime crisis



- The **"low-volatility"** portfolio was heavily invested in the public utilities sector, which was considered relatively stable in terms of future income flows
- Likewise, the pharmaceutical sector was heavily weighted in the **"low-volatility"** portfolio
- Unsurprisingly, the banking sector was the most heavily weighted in the **"high-volatility"** portfolio
- In 2008, investors were shocked to discover that even the all-powerful bank Lehman Brothers could go bankrupt

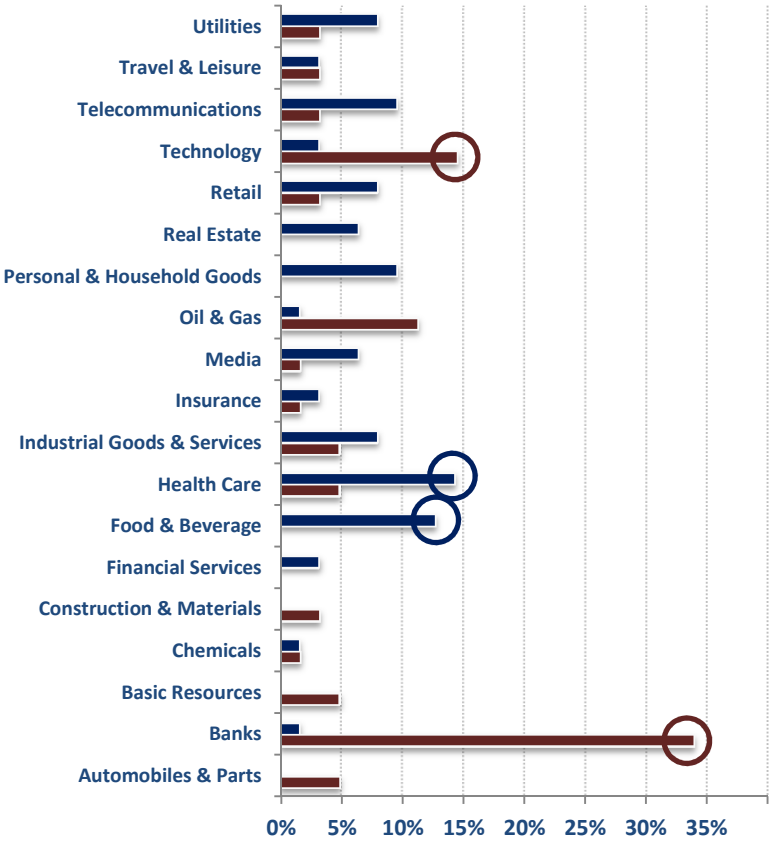
→ At this stage in our analysis of the sectorial composition of our two portfolios, our initial intuition seems to be confirmed

→ When the dot-com bubble burst, securities related to the technology and telecommunications sectors were the Achilles' heel of our **"high-volatility"** portfolio. Once the euphoria of the end of the 90s and the unrealistic profit expectations had passed, many of these companies simply vanished for lack of a viable business model

→ In 2008, the shock wave that hit the banking sector had a significant impact on the status of banking equities as defensive stocks, with investors coming to realize the complexity of analyzing the business of financial institutions

3 **January 2011–July 2012**: European sovereign debt crisis

Sectorial exposure of portfolios during the European sovereign debt crisis



- Once again, the **"high-volatility"** portfolio would suffer due to the substantial weighting of the banking sector
- Leaving the winning formula unchanged, the **"low-volatility"** portfolio would benefit from the heavy weighting of the food & beverage and pharmaceutical sectors

Conclusion

Significant uncertainty about future income flows → **Analysts must regularly readjust their expectations** → **Significant volatility of returns**

- We can conclude from our analysis of a market stress situation that our portfolio, based on risk criteria (historic annualized volatility), allows us to hold securities belonging to sectors that can be analyzed relatively easily by the financial community

- The readability of these business sectors translates into holding lower-volatility equities in our portfolios

- This lower uncertainty regarding the future income flows of these companies seems to justify a safe-haven status in times of market stress, hence the outperformance of our **"low-volatility"** portfolio under the same conditions