Portfolio Optimisation across All Asset Classes: from Money Market to Crypto Assets — Asset Classes, Optimisation Methods, Market Entry, and Sustainability

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Abstract

This paper develops portfolio construction across the full spectrum of asset classes: money market instruments (savings deposits, time deposits, overnight and call money), bonds from government paper through corporate, high-yield, emerging market and supranational issues to convertible and warrant bonds — including remaining maturity versus duration, a complete duration calculation by the present value method, convexity, credit quality, and currency effects —, equities with their implementation vehicles (single stocks, funds, ETFs, thematic and sector funds) and strategies (sector, country, momentum, value, style rotation, quantitative, and thematic approaches), non-traditional investments (hedge fund styles, private equity with exit channels and the illiquidity premium, microfinance), real estate and commodity funds, crypto assets, and derivatives as steering instruments.

On this basis, the paper compares the optimisation methods: naive 1/N diversification (DeMiguel, Garlappi, and Uppal, 2009), Markowitz optimisation over expected returns, volatilities, and correlation matrices with the efficient frontier, tangency portfolio, and CAPM (Markowitz, 1952; Tobin, 1958; Sharpe, 1964), its estimation error problem (Chopra and Ziemba, 1993), and the practice-relevant refinements Black-Litterman, resampling, shrinkage, risk parity, and mean-CVaR. A fully worked three-class example quantifies the methods. Chapters on market entry and timing (staggered entry in tranches, cost averaging, the timing evidence) and on sustainability (ESG approaches, return evidence, greenwashing including the largest fines imposed) complete the management cycle.

The findings: diversification across asset classes is the only reliable return contribution without additional risk; optimisation delivers discipline and structure, not precision — robust methods beat point estimates; staggered entry is statistically inferior but behaviourally valuable; and sustainability can be integrated return-neutrally as long

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as it preserves diversification and avoids label fraud. The paper is intended as a didactic synthesis, not as an investment recommendation.

Keywords: Portfolio optimisation · asset classes · duration · Markowitz · efficient frontier · CAPM · Black-Litterman · diversification · market entry · ESG · greenwashing.

JEL codes: G11, G12, G17, G23, Q56.

Non-Technical Summary

How does one build a good portfolio from the entire offering of the capital markets — from the savings account to crypto assets? This paper answers the question in four steps: it first presents all asset classes with their properties, then compares the methods that turn them into optimal mixes, addresses the right moment of entry, and finally shows how sustainability can be built in without sacrificing return.[2]

Among the asset classes, the arc runs from the money market (savings deposits, time deposits, overnight money) through the large family of bonds — here the paper explains in detail the difference between remaining maturity and duration and works out how strongly bond prices react to interest rate changes: a 30-year bond loses almost a third of its value when rates rise by two percentage points, a 2-year bond barely four percent. Equities follow with their strategies (value, momentum, themes such as AI or robotics), hedge funds, private equity with its illiquidity premium, microfinance, real estate and commodity funds, crypto assets, and derivatives.

The core message of optimisation: the mix matters more than the selection. Even the naive equal weighting diversifies surprisingly well; Markowitz optimisation uses correlations to find the mixes with the lowest risk per unit of return — in the fully worked example, the optimised three-class mix lifts the risk-adjusted return by almost a quarter compared with the classic 60/40 equity-bond portfolio. At the same time the paper warns against blind trust: the optimiser is highly sensitive to estimation errors, which is why robust variants and sensible ranges are superior in practice.

On entry, the rule is: no one finds the perfect moment reliably — the evidence against market timing is overwhelming. Those investing large amounts statistically fare best on average with a lump-sum investment, but sleep better entering in several tranches: the staggered purchase reduces the risk of catching the worst moment, and cost averaging ensures that, when prices fluctuate, more units are automatically bought at low prices.

On sustainability, the research shows: ESG integration on average costs no return — as long as it does not destroy diversification and does not fall for labels. The paper documents the largest greenwashing fines of recent years (first and foremost against the fund company DWS) and draws the pragmatic conclusion: a portfolio need not be one hundred percent green — but sustainability should flow in wherever return does not suffer.

[2] No optimisation replaces the basic rules: spread broadly, keep costs low, know one's own investment horizon, and carry only risks that can be sustained through a crisis.

Contents

1 Introduction

The most important decision an investor makes is not the choice of a stock or a fund but the division of wealth across the asset classes: studies since Brinson, Hood, and Beebower (1986) show that the strategic allocation explains the overwhelming share of the variation in outcomes. A discussion of portfolio optimisation must therefore begin with the components — the asset classes with their return, risk, and liquidity properties — and only then about the methods that shape them into promising asset allocations. This paper does both in a single arc: from the savings account to crypto assets, from naive equal weighting to Black-Litterman, from the moment of entry to the integration of sustainability.[3]

The scientific foundation is modern portfolio theory: Markowitz (1952) made correlation the central quantity of investing and defined the efficient frontier of attainable return-risk pairs; Tobin (1958) added the risk-free asset and with it the capital market line, and Sharpe (1964), Lintner (1965), and Mossin (1966) derived from this the Capital Asset Pricing Model. Practice learned the limits: estimation errors in expected returns dominate outcomes (Chopra and Ziemba, 1993), unconstrained optimisers produce extreme portfolios (Michaud, 1989), and simple equal weighting beats optimisation out of sample surprisingly often (DeMiguel, Garlappi, and Uppal, 2009). The answers are Bayesian methods (Black and Litterman, 1992), shrinkage estimators (Ledoit and Wolf, 2004), constrained optimisation (Jagannathan and Ma, 2003), and risk budgeting approaches (Maillard, Roncalli, and Teïletche, 2010). For the asset classes themselves, the paper draws on the respective specialist literature — from Fama and French (1993) and Jegadeesh and Titman (1993) for equity styles through Kaplan and Schoar (2005) for private equity to Liu and Tsyvinski (2021) for crypto assets — and, for sustainability, on the meta-evidence of Friede, Busch, and Bassen (2015) as well as the more recent capital market research (Pástor, Stambaugh, and Taylor, 2021; Bolton and Kacperczyk, 2021).

The contribution of this paper lies in the integrated presentation of the entire decision path: it first presents all asset classes systematically — including a complete duration calculation by the present value method and the interest rate risks by maturity —, then develops and compares the optimisation methods in a fully worked three-class example, subsequently addresses market entry and timing including the staggered purchase in tranches, and finally integrates sustainability with approaches, return evidence, and the consequences of the major greenwashing cases. All examples are hypothetical and serve as illustration.

[3] All worked examples in this paper are hypothetical, calculated before taxes and transaction costs, and constitute no investment, legal, or tax advice; the returns and risk figures cited are stylised long-term quantities, not forecasts.

The paper is organised as follows. Section 1 (the present section) introduces the question and situates the literature. Section 2 explains the basic concepts of return, risk, and correlation. Sections 3 to 9 present the asset classes: money market instruments (Section 3), bond types (Section 4), interest rate and credit risks of bonds including duration and convexity (Section 5), equities with vehicles and strategies (Section 6), non-traditional investments from hedge funds through private equity to microfinance (Section 7), real estate, commodities, and crypto assets (Section 8), and derivatives as steering instruments (Section 9). Section 10 develops the optimisation methods from naive diversification through Markowitz, the efficient frontier, and the CAPM to Black-Litterman and further robust methods. Section 11 covers market entry and timing, Section 12 the integration of sustainability including greenwashing, and Section 13 condenses everything into the overall process of portfolio construction. Section 14 closes with the conclusion and an outlook.

2 Basic Concepts: Return, Risk, Correlation

2.1 The Coordinate System of Investing

Every asset class in this paper can be described in three coordinates: expected return, risk — measured as the range of fluctuation (volatility) and as loss potential in bad phases — and liquidity, i.e. the question of how quickly and at what discount the investment can be converted back into cash. The three cannot be maximised simultaneously but stand in a trade-off: more expected return is durably paid in capital markets only for bearing more risk or giving up liquidity. A comparison of the asset classes in the following sections is therefore always a comparison of risk premiums: the term premium for maturity, the credit premium for default risk, the equity premium for entrepreneurial risk, the illiquidity premium for capital lock-up.[4]

The fourth coordinate is the most important and at the same time the least visible: correlation — the co-movement of an investment with the rest. Markowitz (1952) showed that what matters for the portfolio is not how risky an investment is on its own but what it contributes to overall risk: a volatile investment that moves independently of the rest can lower portfolio risk; a low-volatility one that moves in lockstep does little. Diversification is therefore not a side effect of broad spreading but the deliberate combination of incompletely or lowly correlated return sources — the only thing capital markets reliably give away for free.

[4] The measurement foundations — moments, quantiles, value at risk, expected shortfall — are developed in Rupprechter (2026g); here the essentials suffice.

2.2 Return Sources: the Premium Map

Behind the asset classes of the following sections stands a manageable number of return sources, and it is worth naming them upfront. The term premium rewards lending over long horizons — it sits in the yield curve and grows with duration. The credit premium rewards bearing default risk — from the covered bond to the high-yield segment in increasing doses. The equity premium rewards entrepreneurial risk and is the most productive source over the long run. The illiquidity premium rewards capital lock-up — the business model of private equity and parts of real estate investing. The style premiums (value, momentum, quality) reward systematic positioning within the equity universe. And the insurance premiums of the options markets reward taking on tail risks — the terrain of Rupprechter (2026h).[5]

This map disciplines product scrutiny: every investment product — however packaged — contains a mixture of these premiums, net of costs. The assessment of a new product therefore consists in assigning it to this taxonomy and in three questions: which premiums it contains, in what magnitude, and at what cost — together with the check whether they are not already held more cheaply in the portfolio. Many supposed innovations turn out, under this test, to be expensively packaged standard premiums.

2.3 Risk Capacity and Risk Appetite

Before the first allocation calculation comes the determination of financial resilience and willingness to take risk, with their independent dimensions. Risk capacity is objective: what losses can the wealth absorb without endangering life goals, payment obligations, or the investment horizon? It depends on horizon, income security, liquidity needs, and the question of whether one can buy in crises or must sell. Risk appetite is subjective: what fluctuations can the investor bear without breaking the plan? The binding constraint is always the lower of the two — a bearable risk that the nerves cannot endure will be unwound at the worst moment and is therefore no capacity at all.[6]

In practice, both are translated into a loss limit ("more than X percent decline endangers the plan or the sleep") and the equity and risk quota is chosen so that historical and simulated crises stay within the limit. This single number achieves more than any fine-tuning — it decides whether the portfolio survives the crises in which returns are earned.

[5] The premiums are long-term averages with considerable variation over time; none is an entitlement, each is the compensation for a risk that becomes real in bad times.
[6] The loss limits can be made precise with the metrics from Rupprechter (2026g) — value at risk and expected shortfall translate an intuitive risk assessment into measurable magnitudes.

3 Money Market Instruments: the Liquidity Base

3.1 Savings, Time Deposits, Overnight and Call Money

At the short end of the investment universe stand the money market instruments: the savings deposit as the classic form, available daily or subject to notice; the time deposit with a fixed term from weeks to years and a fixed rate; overnight money with a variable rate and daily availability; and call money, originating in the interbank market — funds callable daily, which remunerate cash holdings in institutional business. Common to all: no price risk, income near the policy rate level, credit risk solely with the bank — and hence the central role of deposit insurance and, for larger amounts, of spreading across several institutions.[7]

In the portfolio, the money market fulfils three tasks: it is the liquidity reserve for expenses and margin calls (Rupprechter, 2026g and 2026h, show why this reserve is vital for survival), the parking place for capital not yet invested — for instance during the staggered entry of Section 11 — and the risk-free anchor of portfolio theory: the money market rate is the reference point from which the capital market line of Section 10 evaluates all risky mixes. What the money market does not deliver is long-term wealth accumulation: after inflation and taxes, its real return over long periods is regularly near zero or negative — it preserves solvency, not purchasing power.

3.2 Money Market Funds and the Rate Environment

Between the bank deposit and the bond market stand money market funds and money-market-like ETFs: they bundle overnight rates and short-dated government and bank paper and pass on the policy rate level almost without delay — attractive relative to savings and overnight deposits, where banks stretch the pass-through, and practical for larger amounts beyond the deposit insurance limits, because fund assets are insolvency-protected as segregated assets. The price is a minimal market and construction risk instead of the bank credit risk.[8]

The rate environment determines the strategic role: in high-rate phases, the money market is a serious return component and the hurdle that risky investments must first clear; in zero and negative rate phases it becomes a pure parking place with real loss of purchasing power — the years 2015 to 2021 showed how this situation drives investors up the risk ladder. The

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[7] In the EU, statutory deposit insurance covers 100,000 euros per customer and institution; beyond that, partly voluntary protection schemes of the banking associations exist.

[8] Money-market-like ETFs replicate overnight rates via collateralised swap constructions or short-dated paper; their credit and construction details belong to product scrutiny.

lesson for allocation: the cash quota must be justified (reserve, staggering, tactical powder for adding at falling prices) — not felt.

3.3 The Rate Ladder for Cash

Larger cash balances with partly plannable needs are organised by the rate ladder: the balance is distributed across overnight money and time deposits of staggered maturities (say three, six, twelve months); at each maturity a fresh decision is made — spend or roll at the current rate. This secures ongoing availability, captures the higher rates of longer commitment, and averages the reinvestment risk over time. Combined with money market funds for the unplannable part, the result is cash that works without ever jamming — and the spreading rule across several institutions from Section 3.1 can be taken care of at the same time.[9]

4 Bonds I: the Fixed Income Family

4.1 From Government to Supranational Bonds

Bonds are securitised loans: the buyer lends the issuer capital in exchange for coupon and repayment. The family is ordered most simply by the debtor. Government bonds of developed countries form the foundation — with their own currency and central bank they are considered (nominally) default-free and supply the risk-free yield curve against which everything else is measured. Bank bonds range from the collateralised covered bond through the classic bearer bond and the bank certificate of deposit to subordinated instruments whose creditors can be drawn on to bear losses in resolution. Corporate bonds pay the credit premium of the respective business model; supranational bonds — World Bank, European Investment Bank, EU — combine top credit quality with a slight yield pick-up over Bunds.[10]

4.2 High-Yield, Emerging Market, and Hybrid Bonds

Beyond the investment-grade universe begins the high-yield segment: bonds of debtors rated below BBB–, whose markedly higher coupons compensate for the higher default probability and the equity-like price reaction in crises — high yield therefore diversifies an equity portfolio only to a limited extent. Emerging market bonds come in two guises: in hard currency (dollar/euro), where the investor bears the country's credit risk, and in local currency, where

[9] The ladder is the money market variant of the bond ladder of Section 4.4 — the same principle, shorter rungs.

[10] Bank certificates of deposit (Kassenobligationen) are medium-term, mostly unlisted bank debt securities (widespread in Austria); covered bonds (Pfandbriefe) are bank bonds secured by cover pools with their own statutory basis.

the emerging country's interest rate and currency risk are added — with correspondingly higher premium and fluctuation.[11]

A group of their own are the hybrids of bond and equity. The convertible bond securitises, besides coupon and repayment, the right to convert into shares of the issuer — economically a bond plus a call option: it participates in rising share prices in dampened form and retains the bond floor on the downside (as long as credit quality holds). The warrant bond separates the two: bond and warrant trade separately. For portfolios, convertibles are a suitable component of asymmetric return profiles — at the price of increased complexity in valuation and analysis. Table 1 orders the bond family.

Table 1: The bond family at a glance

Type	Debtor / feature	Typical rating	Main risks	Role in the portfolio
Government bonds (DM)	Developed countries, own currency	AAA–A	Rates, inflation	safe anchor, duration
Supranationals	World Bank, EIB, EU	AAA	Rates	anchor with a small pick-up
Covered bonds	Banks, secured by cover pool	AAA–AA	Rates, spread	collateralised rate component
Bank bonds / bank CDs	Banks, unsecured to subordinated	AA–BBB	Rates, credit, bail-in	yield pick-up over covered bonds
Corporate bonds	Industrial and service companies	AA–BBB	Rates, spread	credit premium, broad spreading
High yield	Debtors below investment grade	BB–CCC	Default, liquidity	high premium, equity-like in crises
Emerging markets	Sovereigns/companies of emerging countries	BBB–B	Default, currency, politics	premium plus diversification
Convertible/warrant bonds	Bond plus equity option	BBB–BB	Rates, equity, valuation	asymmetric profile

Source: Own compilation with ratings (S&P/Moody's scale) as typical ranges.

4.3 Features: Coupon Types and Embedded Rights

Orthogonal to the debtor question stands the design. The fixed coupon is the normal case; the zero coupon (zero bond) pays everything at the end and therefore carries the maximum duration of its maturity; the variable coupon (floater) is tied to the money market rate and has almost no interest rate duration — but full spread sensitivity. Inflation-linked bonds (linkers) tie coupon and repayment to the price index and are the only bond form that secures real purchasing power — their break-even inflation rate is at the same time a market signal

[11] Convertible and warrant bonds are economically combinations of bond and equity option; their valuation follows the building-block principle of Rupprechter (2026h).

for inflation expectations. Embedded rights change the profile further: issuer call rights cap the price potential when rates fall, subordination clauses shift the place in the insolvency ranking.[12]

For portfolio construction this means: a bond is not a bond — with coupon type and embedded rights the investor chooses precisely which risk to bear. Floaters for rising-rate phases, linkers for inflation protection, zero bonds for targeted duration steering, classic fixed coupons for carry — the bond family is a spectrum, not a uniform product.

4.4 Implementation: Single Bonds, Funds, or ETF

With bonds, too, the choice of instrument shapes the experience. Single bonds give the investor the maturity promise: holding to repayment realises — solvency of the debtor permitting — the yield fixed at purchase, and interim price losses are book values; the price is minimum denominations, trading spreads, and concentration risks per debtor. Bond ETFs and funds spread broadly and trade liquidly, but hold duration constant: there is no maturity date on which everything comes right — if rates rise, the price loss stands until higher reinvestment yields have earned it back over the duration.[13]

A classic aid is the bond ladder (laddering): single bonds or fixed-maturity ETFs staggered over several years, so that capital regularly falls due and can be reinvested at the then-current rate — a built-in cost averaging effect on the rate side, plannable liquidity, and a profile that many investors intuitively sustain better than the infinite horizon of the ETF.

4.5 Judging Credit Yourself: beyond the Rating

A material allocation to corporate bonds requires analysis beyond the rating. Three ratios carry the quick analysis: leverage relative to earnings power (net debt to EBITDA — below two to three times comfortable, industry-dependent), interest coverage (operating result to interest expense — the higher, the larger the buffer), and the maturity structure (do refinancing waves loom in weak years?). Added to this, the qualitative question from Rupprechter (2026e): how cyclical is the business model that has to earn the coupons?[14]

The market price of this analysis is the credit spread: it compensates expected defaults plus a risk premium. The approximation rule from Rupprechter (2026h) — spread ≈ default

[12] With callable bonds, the investor in effect sells the issuer an option; the higher coupon is option premium, not a gift — the valuation thinking of Rupprechter (2026h) applies here too.
[13] Fixed-maturity ETFs (iBonds and the like) bundle bonds of one maturity year and dissolve at the date — they combine ETF spreading with the hold-to-maturity profile of the single bond.
[14] The ratio analysis follows the concept from Rupprechter (2026e); ratings are opinions with a delay, not guarantees — the market regularly runs ahead of them via the spreads.

probability times loss given default — permits the plausibility test: a spread of 200 basis points at a 40 percent expected loss per default prices in a good three percent annual default probability ; investors who consider that excessive are compensated for holding, while those who share it avoid the paper. Thus rating consumption turns into a credit opinion of one's own.

4.6 The Weighting of High Yield and Emerging Market Bonds

The high-return bond segments invite misjudgement: high yield and emerging market bonds sit in the account under "bonds" but in crises behave partly like equities — their spreads widen when equities fall. Clean construction therefore books them into the risk budget: the safety block of the portfolio consists of prime government and corporate bonds plus money market; high yield and EM are return components whose quota must be weighed against the equity quota — as a guideline, together rarely more than a quarter of the bond block.[15]

Within the segments, the spreading rule applies with added force: single-name risks are existential in the high-yield space, the fund solution is almost always the right one here — and the cost scrutiny of Section 6 applies accordingly. A countercyclical weighting of the segments (higher when spreads are wide; less when they are tight) uses the spread analysis of Section 5.5 as the basis for calibration within the ranges.

5 Bonds II: Duration, Convexity, Credit, and Currency

5.1 Remaining Maturity Is Not Duration

The remaining maturity of a bond says when the last money flows — not when the capital comes back on average. That is exactly what duration measures: the present-value-weighted average commitment period of all payments. A ten-year coupon bond pays coupons every year; a substantial part of the capital is therefore back earlier than in year ten, and duration lies correspondingly below the remaining maturity. The distinction is not a subtlety but the key to interest rate risk: not the remaining maturity but the duration determines how strongly the price reacts to rate changes. Equations (1) and (2) define both via the present value method:[16]

$$P = \Sigma_t \, CF_t \,/\, (1 + y)^t \tag{1}$$

[15] The crisis correlation decides the classification: what falls along in equity crises belongs in the risk budget of the equity side, not in the safety block.

[16] Duration goes back to Macaulay (1938); Fisher and Weil (1971) generalised it for non-flat yield curves. For coupon bonds the duration is always shorter than the remaining maturity; only the zero bond has duration equal to maturity.

Equation (1): The bond price P is the sum of the payments CF_t (coupons and repayment) discounted at the yield y. For the running example — par value 100, coupon 3 percent, five years, yield 3 percent — the present values of the five payments are 2.91, 2.83, 2.75, 2.66, and 88.85; their sum is the price of 100.00 (par).

$$D = \Sigma_t\ t \cdot [CF_t/(1+y)^t] \,/\, P \tag{2}$$

Equation (2): The Macaulay duration D weights each payment date t with the present value share of the corresponding payment. In the example: (1·2.91 + 2·2.83 + 3·2.75 + 4·2.66 + 5·88.85)/100 = 4.72 years — the five-year bond ties up the capital, on a present value average, for only 4.72 years, because the coupons flow back early.

5.2 Interest Rate Risk: the Duration Calculation in Action

From duration follows the price reaction directly. Equation (3) delivers modified duration as price sensitivity, Equation (4) the rule-of-thumb formula for interest rate risk:[17]

$$D_{mod} = D \,/\, (1 + y) \tag{3}$$

Equation (3): Modified duration translates the Macaulay duration into a price sensitivity. In the example: 4.72/1.03 = 4.58 — the price changes by around 4.58 percent per percentage point of rate change.

$$\Delta P/P \approx -D_{mod} \cdot \Delta y \tag{4}$$

Equation (4): If the yield of the example bond rises by one percentage point, the price falls by about 4.58 percent (exactly: 4.45 percent); at two percentage points the approximation says 9.16 percent loss, exactly it is 8.66 — the growing deviation is explained in Section 5.3. Interest rate risk thus grows with both: the size of the rate change and — via duration — the maturity. Table 2 shows the full range.

Table 2: Interest rate risk by maturity (coupon 3 percent, initial yield 3 percent)

Remaining maturity	Modified duration	Price change at +1 %-point	Price change at +2 %-points
2 years	1.91	–1.89 %	–3.72 %
5 years	4.58	–4.45 %	–8.66 %
10 years	8.53	–8.11 %	–15.44 %
30 years	19.60	–17.29 %	–30.74 %

Source: Own calculation according to Equations (1) to (4), exact revaluation.

[17] The approximation holds for small rate changes and parallel curve shifts; for curve twists, practitioners use key rate durations.

Table 2 is the most important lesson of the bond part: the same rate move that barely touches a two-year bond costs the thirty-year almost a third of its value. Long duration is not a safety feature but a levered rate bet — valuable as a diversifier against equity risks in downturns, dangerous as a supposedly conservative core investment in rate rises, as the year 2022 demonstrated worldwide.

5.3 Convexity: the Curvature Helps the Creditor

Duration is a straight line fitted to a curved relationship: the true price-yield relationship is convex, and the approximation of Equation (4) overstates losses and understates gains — in the example of Section 5.2 it predicted a 9.16 percent loss at +2 percentage points where exactly 8.66 occur. Equation (5) adds the curvature term:[18]

$$\Delta P/P \approx -D_{mod} \cdot \Delta y + \tfrac{1}{2} \cdot K \cdot (\Delta y)^2 \qquad (5)$$

Equation (5): Convexity K (26.2 in the five-year example) corrects the duration approximation; with it the estimate hits the exact value almost to the basis point (−8.64 instead of −8.66 percent at +2 percentage points). Economically, convexity is an asset of the creditor: the more convex the bond, the more it gains when rates fall compared with what it loses when they rise. Figure 1 shows curve and tangent.

[18] Formally, convexity is the second derivative of the price with respect to the yield, normalised by the price; it is the bond counterpart to the gamma of the options world.

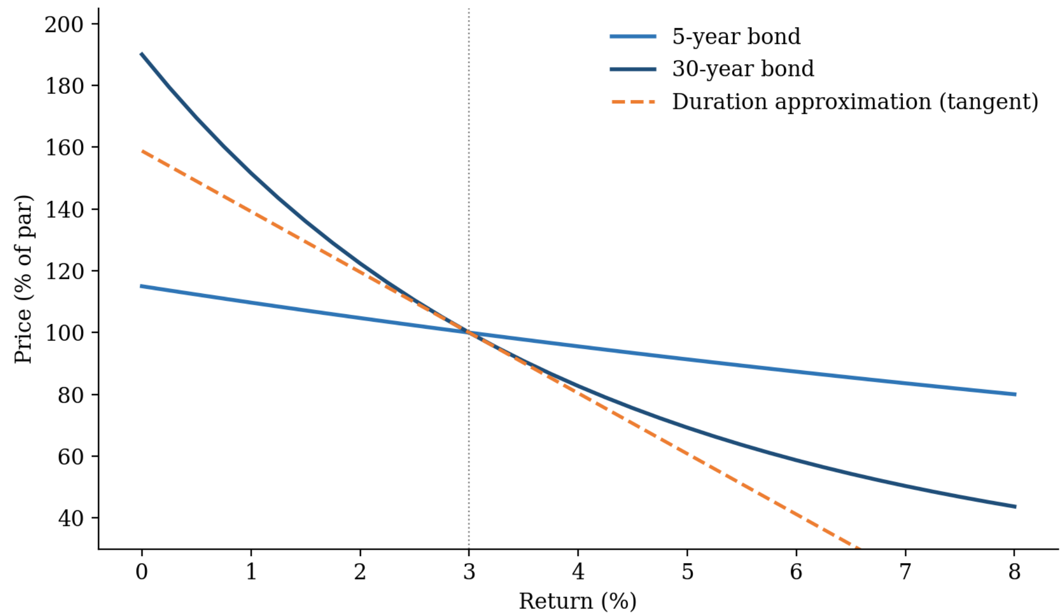

Figure 1: Price-yield relationship of a 5-year and a 30-year coupon bond (coupon 3 percent) and the duration approximation as tangent to the 30-year; the curvature is the convexity.
Source: Own calculation according to Equation (1).

5.4 Credit and Currency: the Further Risk Dimensions

Besides the rate, every bond carries the credit quality of its debtor. Ratings condense it into letter scales whose most important dividing line runs between investment grade (down to BBB–) and high yield — not because the world changes abruptly there, but because investment guidelines and regulation switch at this boundary, and downgrades below it (fallen angels) can trigger forced sales. For the portfolio, the spread duration from Rupprechter (2026g) matters: it measures how strongly the price reacts to changes in credit spreads — in crises, spreads widen across all debtors, and the credit premium then shows its kinship with equity risk.[19]

Currency, finally, can dominate all other effects: a prime dollar bond is, for the euro investor, an exchange rate investment with an interest supplement — the annual fluctuation of the exchange rate exceeds that of an investment-grade bond several times over. The consequence from Rupprechter (2026g, 2026h) applies here too: for bond investors, foreign currency bonds belong in the portfolio currency-hedged as a rule; the hedging costs correspond to the interest rate differential and are part of the return calculation.

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[19] The scales of the major agencies (S&P/Fitch: AAA to D; Moody's: Aaa to C) separate the investment from the speculative universe at BBB– and Baa3 respectively; the boundary steers the regulatory investment limits of many investors.

5.5 Reading the Yield Curve: Carry and Roll-Down

The yield curve is not only a source of risk but a return landscape. With a normally rising curve, a bond earns twice: the running yield advantage of longer maturities (carry) and the roll-down — with every year the bond moves down the curve, its remaining-maturity yield falls, its price rises. Both components together explain why bond portfolios can systematically earn more than the coupon even without a rate forecast — and why flat or inverted curves make this source dry up: then the curve no longer pays for maturity risk, and short duration becomes attractive on the return side as well.[20]

For the allocation a simple assessment follows: the steepness of the curve and the level of credit spreads say where in the fixed income universe the premiums currently lie — maturity or credit. This assessment replaces no forecast, but it prevents the most common error: buying maturity risk when it pays nothing, and avoiding credit risk when it is rewarded royally — or vice versa.

5.6 Worked Example: Portfolio Duration

Durations add up market-value-weighted — that makes the metric the steering variable of the entire bond block. An example: a bond portfolio holds one third each in the 2-, 10-, and 30-year issues of Table 2. Its duration is $(1.91 + 8.53 + 19.60)/3 = 10.0$ — the portfolio reacts like a single ten-year bond: a rate rise of one percentage point costs around ten percent. Lowering the duration to 5 is achieved by shifting weights to the short end — or uses the interest rate derivatives from Rupprechter (2026h), which accomplish the same shift without rebuilding the holdings.[21]

The same calculation carries the liability side from Rupprechter (2026g): where future expenses have a known time structure, the duration of the bond block can be matched to the duration of the expenses (immunisation) — rate changes then hit assets and liabilities in the same direction, and the purpose remains funded. For foundations and drawdown portfolios this is perhaps the most useful application of the entire duration calculation.

5.7 Worked Example: Currency Hedging

How expensive is the currency protection of Section 5.4 in concrete terms? The hedging costs of a dollar bond correspond in essence to the interest rate differential between the dollar and

[20] The cyclical signalling effect of the yield curve — inversion in particular — is treated in Rupprechter (2026f); here its return mechanics are at issue.

[21] The additivity holds for the market-value-weighted modified duration; for large rate moves, the convexity of the individual components is added.

euro money markets. An example: if the US bond yields 4.8 percent, the dollar money market stands at 4.0 and the euro money market at 2.0 percent, then the rolling forward hedge costs around two percentage points — 4.8 percent dollar yield becomes roughly 2.8 percent hedged euro yield. The apparent yield advantage of the foreign market has frequently vanished after hedging: it was an interest differential, not a value differential.[22]

From this follows the test rule for every foreign currency bond: the hedged yield is compared with the domestic alternative of equal credit quality and duration — only an advantage after hedging costs is genuine added value (for instance from spread differences between markets). Unhedged foreign currency bonds, by contrast, are deliberate currency bets and belong in the tactics budget of Section 10.7, not in the safety block.

5.8 What Bonds Do in the Mixed Portfolio — and What Not

The strategic role of prime bonds in the mixed portfolio is threefold: they deliver plannable income, they dampen fluctuation, and they typically rise when equities fall in growth crises — the flight to safety makes duration a built-in crisis offset. This negative crisis correlation is the real reason the classic equity-bond pairing has carried portfolios for a century — not the bond return itself.[23]

The limit of the possible showed in 2022: when inflation rises, equities and bonds fall together, and the offset fails exactly when both blocks suffer. The consequence is not a turn away from bonds but the broadening of instruments that this paper undertakes: linkers, commodities, short duration, and trend following cover the inflation scenario that the classic mix leaves open. Bonds remain the stabilising component of the portfolio, though with a known uncovered risk dimension.

6 Equities: Vehicles and Strategies

6.1 Implementation Routes: Single Stocks, Funds, ETFs, Thematic Funds

Equities are the growth engine of most portfolios, and the first step is the choice of vehicle. Single stocks offer full control and no running product costs, but demand analysis and enough names for genuine spreading. Actively managed equity funds delegate the selection to

[22] The hedging costs correspond, under covered interest parity, to the interest differential of the money markets plus a variable basis; the mechanics of the forward hedge are shown in Rupprechter (2026h).

[23] The protective effect presupposes that the crisis acts deflationarily (growth fear); in inflation crises it fails — the reason for the inflation components of Section 8.4.

professionals — for fees whose hurdle the majority of managers do not beat over the long run (Sharpe, 1991; French, 2008). Exchange-traded index funds (ETFs) deliver the market return of broad indices at minimal cost and have therefore established themselves as the core instrument. Thematic and sector funds — for example artificial intelligence, future mobility, robotics, automation, urbanisation, water, health, and energy — bundle stocks along a narrative: concentrated positions with strong inflows in fashion phases and the structural risk that the valuation already contains the narrative by the time the fund is launched.[24]

For portfolio construction, the core-satellite logic is recommended: a low-cost, broadly diversified core (global ETFs or core funds) and measured satellites for convictions — themes, sectors, regions, styles. Diversification is thus preserved, and the bets are deliberately sized rather than accidentally grown.

6.2 The Strategy Landscape: from Value to Momentum

Within equity investing, strategy families compete that can be organised by their ordering dimension. The country approach allocates by markets and exploits the differing cycles and valuations of the regions; the sector approach orders by industries, whose cyclical sensitivity differs greatly. The style strategies start from stock characteristics: value buys lowly valued substance (Fama and French, 1992, 1993), momentum buys the winners of recent months (Jegadeesh and Titman, 1993), quality prefers profitable, solid balance sheets. Style rotation attempts to switch cyclically between these styles — demanding, because it requires timing at the style level (Barberis and Shleifer, 2003). Quantitative strategies, finally, implement rules systematically: from rule-based factor portfolios to long/short constructions that buy attractive names and short unattractive ones, thus trading market risk for pure selection return. The thematic approach of Section 6.1 completes the palette with the stories behind the trends. Table 3 condenses the landscape.[25]

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[24] Sharpe (1991) formulated the arithmetic of active management: before costs, the average of all active investors is the market; after costs it lies below — the cost question is therefore no side issue.

[25] The style premiums are empirically documented but cyclical: every strategy knows decades of strength and weakness — the most important success factor is perseverance, not discovery.

Table 3: Equity strategies at a glance

Strategy	Ordering principle	Classic evidence	Main risk
Country approach	Regions/markets	avoid home bias	currency and political risks
Sector approach	Sectors	exploit cyclical sensitivity	sector concentration
Value	Valuation (P/B, P/E)	Fama and French (1992, 1993)	long dry spells (value winters)
Momentum	Price strength 6–12 months	Jegadeesh and Titman (1993)	sharp reversals (crashes)
Style rotation	cyclical style switching	Barberis and Shleifer (2003)	double timing problem
Quantitative / long-short	rule-based factors	Carhart (1997)	model risk, crowding
Thematic approach	structural narrative (AI, robotics, mobility)	—	valuation already contains the story

Source: Own compilation based on the data of Fama and French (1992), Jegadeesh and Titman (1993), and Carhart (1997).

Two findings across all strategies: first, the documented premiums are averages over decades, not annual guarantees, and mixing styles rather than switching between them harvests the premiums with less demand on persistence. Second, the attribution logic of Rupprechter (2026g) applies: factor premiums can be replicated cheaply; active fees are earned only by strategies that deliver more than packaged factors.

6.3 ETF Mechanics: Replication, Costs, Limits

The ETF has revolutionised equity investing, and its mechanics therefore deserve a close look. Physical replication holds the index names (fully or optimised), synthetic replication swaps in the return; quality is measured by tracking accuracy (tracking error) — the actual return gap to the index is the more honest cost figure than the stated expense ratio. The creation and redemption mechanism via authorised participants keeps the exchange price at the fund value and makes the liquidity of the ETF, at its core, the liquidity of its constituents — an ETF on narrow markets remains an investment in narrow markets, even if it trades by the second.[26]

The limits belong in the picture: market-capitalisation-weighted indices automatically buy more of what has risen — in bubble phases the largest indices concentrate substantially in a few names and sectors; holding the market portfolio means holding its concentrations as well. That does not argue against ETFs, but for a look at the actual composition and for spreading across regions and, where appropriate, equal-weighted or factor-based variants.

[26] With synthetic replication, a swap counterparty delivers the index return against collateral; the counterparty thinking from Rupprechter (2026g) applies accordingly.

6.4 Regions and Home Bias

The regional question decides more than most stock questions. The world equity market is distributed roughly across the United States (well over half of market capitalisation), the other developed markets, and the emerging markets — a global core replicates this and avoids the best-documented allocation error of private investors: home bias, the overweight of one's own familiar market. For German-speaking investors it is doubly risky, because labour income, property, and portfolio then hang on the same economic area.[27]

Emerging markets deserve a deliberate quota: higher expected returns and diversification against higher political and currency risks — the logic of the EM bonds from Section 4.2 in equity form. In practice, market capitalisation proves itself as the starting point together with deliberate, justified deviation — not the unplanned drifting into overweights.

6.5 Dividends and Quality: Yield Is Not Yield

Dividend strategies are the most popular style variant of the German-speaking world: stocks with high, stable payouts as a substitute for the vanished interest rate. The sober view: the dividend yield alone is no seal of quality — very high yields often signal price decline or cut risk rather than strength (Rupprechter, 2026e, names the pitfalls). The approach becomes viable in combination with quality: solid balance sheets, reliable cash flows, payout ratios with buffer — the dividend strategy is then in effect a quality-value blend with built-in payout discipline.[28]

For drawdown portfolios, the psychological function is real: running distributions make perseverance easier because they finance consumption without a sell decision. Economically, total return remains decisive; withdrawal via unit sales (total return approach) is more flexible and more diversified than a portfolio concentrated in a few sectors for the sake of the dividend level.

6.6 Selecting Active Funds: the Checklist

Where active funds are to complement the core, a selection is needed that tests more than stars and ranks. Four essential questions arise: first, how high are the costs? They are the most reliable return predictor (French, 2008). Second, can the strategy be explained in two sentences, and does the portfolio match it? A value fund full of trend growth stocks has already

[27] For equities — unlike bonds — currency hedging is of secondary importance over the long run and partly counterproductive; the currency spread diversifies along.

[28] For tax and economic purposes, total return counts; a dividend is not interest but a distribution that reduces the price accordingly.

lost its credibility. Third, how strongly the portfolio deviates from the index: a portfolio close to the index cannot outperform it after costs. Fourth, the attribution test according to Rupprechter (2026g): did the excess return come from the advertised source (stock selection) or from packaged factors and luck?[29]

And the sell discipline should be defined at the outset: an active fund is replaced when process, team, or independence break — not because two years lie below benchmark; conversely, a strong track record offers no protection either when the process erodes. Manager selection thus remains a process bet, not an outcome bet.

6.7 Quantitative in Practice: Rule-Based versus Discretionary

The difference between rule-based and discretionary is less mathematics than discipline architecture. The rule-based approach defines selection, weighting, and trading rules in advance and executes them mechanically — its strengths are verifiability, freedom from emotion, and testability against history; its weaknesses are the rear-view-mirror danger (rules fit the past, not necessarily the future) and crowding, when many trade the same signals. The discretionary approach permits judgement in the individual case — and thereby opens exactly the behavioural traps against which this paper builds rules.[30]

The practical synthesis has proved itself: rules for everything recurring (rebalancing, tranches, ranges, sell discipline), judgement for the rare (strategy change, new asset classes, manager replacement) — and for both the attribution control according to Rupprechter (2026g), which shows whether rule or judgement earned the result.

7 Non-Traditional Investments: Hedge Funds, Private Equity, Microfinance

7.1 Hedge Funds: the Main Styles

Hedge funds are not an asset class but a contractual form: lightly regulated investment vehicles with free strategies, short selling, leverage, and performance-based compensation. The main styles: equity long/short buys attractive and sells unattractive stocks and thus steers market risk; global macro bets across all markets on macroeconomic developments; event driven invests in special situations such as takeovers (merger arbitrage) and restructurings; relative

[29] The persistence research warns: past top ranks hardly repeat reliably (Carhart, 1997); the process is more testable than the track record.

[30] Crowding denotes the danger that many quantitative investors trade the same signals — in stress moments their like-directed adjustments reinforce one another.

value exploits price relationships between related instruments (such as convertible arbitrage); managed futures/CTAs follow trends via futures markets and historically deliver positive contributions precisely in equity crises (Fung and Hsieh, 2001). Table 4 summarises the styles.[31]

Table 4: Hedge fund main styles

Style	Basic idea	Market dependence	Typical role in the portfolio
Equity long/short	stock selection long and short	reduced, steerable	equity substitute with lower beta
Global macro	macro bets across all markets	low, opportunistic	crisis diversifier
Event driven	takeovers, restructurings	medium, event-driven	independent premium source
Relative value	price relationships, arbitrage	low — until liquidity snaps	steady income, tail risks
Managed futures / CTA	trend following via futures markets	uncorrelated, crisis-positive	hedge-like component

Source: Own compilation based on the data of Fung and Hsieh (1997, 2001).

For inclusion in the portfolio, what counts is less the industry's average return — unexciting after costs — than the dispersion: worlds lie between the styles and within the styles, manager selection is half the return, and the fee load (classically two percent fixed plus twenty percent of profits) must first be earned. Without access to above-average managers, the diversifying properties can nowadays be replicated — of trend following in particular — through liquid, rule-based vehicles.

7.2 Private Equity: Illiquidity as Price and Premium

Private equity invests in unlisted companies — from venture capital for young firms to buyouts of mature mid-sized companies (the mechanics are shown in Rupprechter, 2026i). The capital is typically locked up for ten years and longer: the fund calls it during the investment phase, develops the companies, and returns it via the exit channels — sale to strategic buyers (trade sale), resale to other financial investors (secondary buyout), or stock market flotation (IPO). A sale before the end of the term is possible only through the secondary market for fund interests — frequently at a discount.[32]

[31] Hedge fund return series are embellished by smoothing and backfill biases (Getmansky, Lo, and Makarov, 2004); published indices overstate the risk-adjusted attractiveness.

[32] Kaplan and Schoar (2005) additionally document the exceptional persistence of manager quality: successor funds of successful houses perform above average — the access question is more important in private equity than in any liquid class.

This illiquidity is not a flaw but the business foundation: locked-up capital permits protracted restructurings that orderly exchange trading does not tolerate, and the investor demands the illiquidity premium for it — a return pick-up over comparable listed investments. The empirical record counsels sobriety: after costs, average buyout funds lie moderately above the equity market (Harris, Jenkinson, and Kaplan, 2014), the dispersion between managers is enormous (Kaplan and Schoar, 2005), and the smoothed valuations understate the true risk — the de-smoothing argument of Rupprechter (2026g). Private equity therefore belongs in portfolios that can carry the lock-up, have access to good managers, and do not confuse the premium with sham stability.

7.3 Microfinance: Return with a Double Bottom Line

Microfinance investments refinance, via specialised funds, institutions that extend small loans to households and micro-enterprises in developing and emerging countries (Morduch, 1999). For the portfolio they offer steady, bond-like income with remarkably low correlation to the major capital markets — the repayment rates of the end borrowers hang on local realities, not on Wall Street (Krauss and Walter, 2009). Against this stand restricted liquidity (mostly monthly to quarterly redemption), currency and political risks, and the responsibility for the social impact — over-indebtedness crises in individual markets have shown that growth at any price destroys returns here too. As a small admixture, microfinance combines diversification with measurable impact — a natural component of the sustainability integration of Section 12.[33]

7.4 Access and Weighting: Vehicles of the Alternatives

In accessing the alternatives space there is a marked distance between what is economically sensible and what is practically available. Classic hedge and private equity funds open only from high minimum subscriptions; funds of funds bundle several target funds for a second fee layer; secondaries funds buy existing fund interests at a discount and smooth the J-curve; and the new generation of semi-liquid vehicles — first and foremost the reformed ELTIF — brings private credit, infrastructure, and private equity into regulated structures with periodic redemption windows. The basic rule across all vehicles: the liquidity of the wrapper must not over-promise the illiquidity of the contents — redemption promises the contents cannot cover

[33] Krauss and Walter (2009) show the low correlation of microfinance institutions with global capital markets; the investment nonetheless carries country, currency, and political risks.

are a crisis construction (the open-ended real estate funds of 2008 remain the documented case).[34]

On weighting: illiquid investments belong only in the part of wealth that is dispensable over the entire cycle — as a guideline, liquid reserves and foreseeable obligations remain untouched, and the alternatives quota grows with wealth size and horizon. Harvesting the illiquidity premium requires genuinely carrying the illiquidity; otherwise it is sold back at the worst moment at a discount on the secondary market.

7.5 Spreading over Time: Vintage Years and Commitment Planning

Private equity is diversified not only across managers but across time: fund outcomes hang strongly on the launch year (vintage) — funds that invest in crises buy cheaply and harvest above average, boom vintages the reverse. Since no one can time the vintages, the tranche principle of Section 11 applies here writ large: even subscriptions over several years build a programme that contains all market phases.[35]

Added to this is the cash logic of capital calls: subscribed capital is called over years while earlier funds are already paying back — a steady-state programme increasingly finances its calls from its own distributions. Until then, committed but not yet called capital belongs in liquid, safe investments; backing commitments with equities risks a forced sale at the bottom when calls and price losses coincide.

7.6 Private Debt: the Young Credit Class

Between the bond and private equity, a class of its own has grown over the past fifteen years: private debt — corporate loans extended directly by funds that fill the gap banks left after the financial crisis. For investors the class offers floating-rate loans with a palpable yield pick-up over comparable bonds — the combination of illiquidity and complexity premium — packaged in funds with multi-year lock-ups or semi-liquid structures along the lines of Section 7.4.[36]

The test points resemble those of the high-yield segment, sharpened by the opacity: without market prices, the valuation shows artificially smoothed returns (the de-smoothing argument applies in full), the manager's credit selection is almost the entire return, and the

[34] The European ELTIF (in its reformed version since 2024) opens regulated access for private investors to private equity, infrastructure, and private credit — with redemption windows that promise no daily liquidity.
[35] The J-curve denotes the typical course of a private equity engagement: capital calls and costs depress the early years, distributions carry the late ones.
[36] The credit quality of private loans shows itself only in the downturn; the class's short history does not yet contain a complete credit cycle of great breadth.

floating rate protects against rate rises but not against their effect on the debtors. As a measured complement to the bond block in a suitable vehicle form, private debt is a legitimate premium source — as a supposedly fluctuation-free bond substitute, a labelling error.

7.7 Liquid Alternatives: Strategies in a Fund Wrapper

Between the hedge fund and the retail fund stand the liquid alternatives: alternative strategies — trend following, long/short, market-neutral approaches — in a regulated fund wrapper with daily or weekly liquidity. Their promise is access without lock-up; their price is twofold: the liquid wrapper excludes the illiquid premiums, and the strategy dilution (leverage limits, liquidity requirements) costs return relative to the original vehicles. The category's record is correspondingly mixed.[37]

They are sensibly deployed where the strategy itself is liquid — trend following via futures is the best example and effective as a crisis diversifier even in the wrapper. The test rule remains that of the premium map: which return source, how strongly diluted, at what cost — and does the package beat the simple combination of core components?

7.8 The Fee Arithmetic of the Alternatives

The classic compensation of alternative vehicles — two percent fixed plus twenty percent of profits — deserves a sober calculation. If a fund achieves ten percent gross return, around 6.4 percent remains with the investor after 2/20 — more than a third of the return flows into the structure; at six percent gross, barely more than half remains. The performance fee moreover works asymmetrically: it participates in gains, not in losses — without a hurdle rate and high-water mark, the investor even pays for the mere recovery of their own losses.[38]

From this follows no blanket rejection but a threshold: alternative vehicles must be so much better before costs than the liquid alternative that they remain superior after costs — the net mindset that starts from the illiquidity and manager premiums of Sections 7.2 and 7.5. Where access to above-average managers is lacking, the low-cost liquid replication of the premiums is usually the better choice.

[37] The daily wrapper disciplines the strategy selection: what it cannot tolerate (illiquids, high leverage) stays out — and with it part of the premiums of the classic vehicles.

[38] Hurdle rate (minimum return before performance participation) and high-water mark (performance fee only above the previous peak) are the most important investor-friendly contract clauses.

8 Real Assets and New Classes: Real Estate, Commodities, Crypto

8.1 Real Estate Funds

Real estate delivers rental income and inflation proximity and is accessible via three routes: open-ended real estate funds with appraisal-based valuation and (after the experiences of 2008) statutory holding and notice periods; closed-end funds with multi-year commitment to individual properties or portfolios; and listed REITs, which make real estate portfolios tradable in equity form. The international evidence attests to real estate an independent diversification contribution in the mixed portfolio (Hoesli, Lekander, and Witkiewicz, 2004) — with the caveat that the smoothed statistics of open-ended funds understate the risk and REITs show equity character in the short run. In practice: real estate belongs in the picture of total wealth (owner-occupied property often dominates anyway), and the vehicle determines liquidity and measured risk more strongly than the asset class itself.[39]

8.2 Commodity Funds

Commodities — energy, industrial and precious metals, agriculture — are accessible via funds and ETCs almost exclusively as a futures market investment: the fund holds futures and rolls them continuously, so that the return consists of spot price change, roll yield, and interest on the collateral — in contango phases the roll component takes a palpable bite (on the mechanics: Rupprechter, 2026h). Historically, broad commodity baskets offered equity-like premiums with low correlation and inflation protection (Gorton and Rouwenhorst, 2006), though composition and roll rules disperse the results widely (Erb and Harvey, 2006). Gold occupies a special role: yieldless, but a crisis and currency hedge with a long history. As an admixture of a few percent, commodities diversify inflation scenarios that hit equities and bonds simultaneously — the 2022 scenario is the most recent documented case.[40]

8.3 Cryptoassets

Cryptoassets — first and foremost Bitcoin and Ether, accessible via exchange-traded products and regulated custody solutions — are the youngest and most contested class. Capital market research situates them: their returns follow factors of their own (network growth, attention,

[39] The valuation of open-ended funds follows appraisals and smooths the true fluctuation; listed REITs show the market volatility more honestly, but trade with the equity market in the short run.

[40] Physical replication exists in practice only for precious metals; broad commodity baskets run via futures, whose roll mechanics are developed in Rupprechter (2026h).

momentum) and are largely decoupled from equity, interest rate, and commodity factors (Liu and Tsyvinski, 2021) — genuine diversification candidates, then, but with extreme properties: volatilities around four to six times the equity market, recurring drawdowns of 70 to 80 percent, and at times a high co-movement with risky assets in stress phases. Added to this are operational risks (custody, exchanges) and a still-young legal framework.[41]

For portfolio construction, what follows is not ideology but arithmetic: at such high volatility, an admixture of one to a few percent already does the diversification work; larger quotas shift the overall risk palpably towards a single, young factor. Where the class is included, it is treated as a satellite with a narrow range and rebalancing discipline — precisely because its rallies otherwise multiply the quota unnoticed.

8.4 Inflation Protection Compared

Because inflation is the common enemy of all nominal investments, a cross-comparison of the protective instruments is worthwhile. Inflation-linked bonds secure purchasing power contractually — precise, but attractive only to the extent of the real yield. Commodities react fastest to inflation surprises (they are often their cause), but fluctuate strongly and cost roll yield in calm phases. Real estate protects via indexed or renegotiable rents — sluggish, but substantial, as long as the rate side does not dominate. Equities protect over the long run as real assets with pricing power, but suffer in the short run when the fight against inflation hits rates and hence valuation levels. Gold, finally, is less inflation protection than protection of confidence and against crisis.[42]

The year 2022 demonstrated the ranking: commodities and short duration protected, linkers helped in real terms, nominal bonds and long-duration growth stocks suffered together — the rare phase in which the classic equity-bond pairing loses simultaneously. A portfolio meant to withstand such scenarios needs at least one instrument that carries then.

8.5 Infrastructure: the Real Asset with Contractual Income

Between real estate and private equity stands infrastructure: networks, transport routes, generation and storage facilities, digital infrastructure — real assets whose income frequently rests on long-term, often indexed contracts or regulated tariffs. The profile: stable, inflation-proximate cash flows with low cyclical sensitivity — attractive as the link between bond

[41] In regulatory terms, the EU has created a framework with MiCAR; cryptoassets are held via regulated custodians or — with one's own key risk — in self-custody.
[42] No single asset class protects in all inflation scenarios; the mixture of linkers, real assets, and short duration is the most robust protection.

stability and real asset protection, and one of the growth areas of private investment in the course of the energy transition and digitalisation.[43]

The risks are specific: regulation (tariffs are set politically), rate sensitivity (long, stable cash flows carry high duration in the economic sense), and project risks in construction. The vehicle rules of Section 7.4 apply — as does honesty about the statistics: unlisted infrastructure looks smoother than it is.

8.6 Currencies: Asset Class or Side Effect?

Foreign currencies accompany almost every international investment — does that make them an asset class of their own? The sober answer: for the core allocation, no. Currencies, as pairs, pay no systematic long-run return — what one side gains the other loses — and their fluctuation is, for the private investor, predominantly a side effect of the regional choice. From this follows the division of labour of this paper: with bonds the currency is hedged (Sections 5.4 and 5.7); with globally spread equities it may run along as an additional diversification factor — over the long run the effects largely even out, and hedging would continuously cost the interest differential.[44]

As deliberate positions, currencies remain reserved for the tactics budget — a dollar quota as a crisis anchor, a targeted emerging market local currency position as a premium source. Both are justification-requiring bets in the sense of Section 10.7, not basic equipment; their control runs through the currency line of the risk report.

9 Derivatives in the Portfolio: Steering instead of Speculation

9.1 The Role of Derivatives in the Overall Allocation

Derivatives are, in this paper, not a return source of their own but the instruments of allocation control: futures implement allocation decisions within minutes and capital-efficiently, options shape return profiles (protection via puts, additional income via covered calls, ranges via collars), swaps steer interest rate and currency profiles, and overlays keep the duration, currency quotas, and equity quota of the total portfolio within the target bands without moving the underlying holdings. Rupprechter (2026h) develops the mechanics and worked examples; here the construction principle counts: derivatives change the distribution of

[43] Access routes are listed infrastructure stocks and funds (liquid, but equity-correlated) and unlisted vehicles up to the ELTIF (illiquid, but closer to the contractual income).
[44] Professional currency strategies (carry, momentum, value at the currency level) exist, but belong in the category of the quantitative strategies of Section 6 — not in the core allocation.

portfolio returns — they shift, cap, or insure — and every such change has a price that must be set against the benefit to the overall allocation.[45]

With this, the presentation of the asset classes is complete: Figure 2 places all the asset classes presented into the risk-return diagram with which the optimisation of the following section works. The diagram shows stylised long-term figures — not forecasts, but the starting coordinates of portfolio construction.

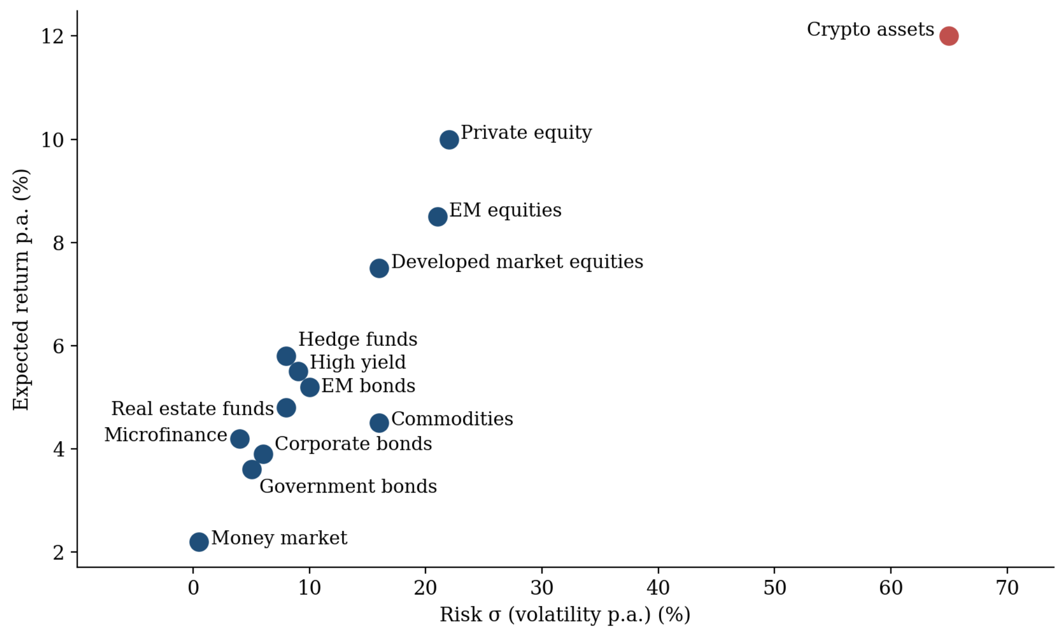

Figure 2: Risk-return map of the asset classes (stylised long-term figures; volatility and expected return per year, cryptoassets with strongly elevated volatility).
Source: Own presentation following J.P. Morgan Asset Management, Long-Term Capital Market Assumptions 2026 (estimates as of 30 September 2025); microfinance and cryptoassets: own estimate.

9.2 Structured Products: Combined Payoff Profiles

Between the direct investment and the derivative stand the structured products of the retail market: discount, bonus, express certificates and capital protection products. In the allocation logic of this paper they are not an asset class of their own but packaged combinations of instruments already presented — a bond plus sold or bought options — augmented by the issuer risk of the issuing bank and the costs of the packaging. Their return profiles can therefore always be traced back to the map of Section 2.2: a discount certificate collects the option

[45] Forms, pricing, margining, and application calculations of derivatives are developed at length in Rupprechter (2026h).

premium of the covered call sale, a capital protection product buys the protection with a return sacrifice.[46]

The portfolio rule is therefore: decompose first, then decide. Where the profile of a certificate is desired, it should be checked whether the direct combination (ETF plus option, bond plus premium strategy) delivers the same profile more cheaply and without issuer risk; frequently it does. Structured products earn their place where the packaging creates genuine access or operational simplicity is being paid for — not as a return promise the instruments cannot cover.

9.3 Hedge or Endure? The Strategic Answer

The most tempting derivatives application is the permanent hedge of the equity block — and over the long run it is the most expensive: rolling put protection costs, via the option premiums and the volatility surcharge, a substantial part of precisely the equity premium for which one holds equities. The strategic answer of this paper is therefore a different one: the investor's loss limit belongs in the equity quota, not in a permanent insurance programme: where a 20 percent decline cannot be borne, fewer equities are held rather than insured ones.[47]

Hedges have their place as time-limited instruments of defined situations: the transition phase of a staggered exit, a concentrated single risk ahead of a known date, the bridge to a planned reallocation. Time-limited, quantified, budgeted — thus insurance remains a means and does not become the permanent conduit through which the equity premium drains away.

10 Optimisation: from Naive Diversification to Black-Litterman

10.1 Naive Diversification: the Underrated 1/N Rule

The simplest diversification distributes the capital in equal parts — 1/N. Its effect is explained by Equation (6): portfolio risk falls with the number of holdings, but only down to the floor set by the average correlation.[48]

$$\sigma_P^2 = \sigma^2 \cdot [1/N + (1 - 1/N) \cdot \bar{\rho}] \tag{6}$$

[46] The valuation logic — decomposition into bond and option components, issuer risk, costs of the packaging — is developed by Rupprechter (2026h) in the chapter on certificates.
[47] The cost accounting of the permanent hedge — premiums, skew, forgone equity premium — is set out by Rupprechter (2026h) in the chapter on the hedging variants.
[48] DeMiguel, Garlappi, and Uppal (2009) compared fourteen optimisation variants across seven data sets: none beat the 1/N rule reliably after estimation errors and costs.

Equation (6): With N equally weighted investments of average volatility $\bar{\sigma}$ and average correlation $\bar{\rho}$, the asset-specific part of the risk shrinks with 1/N, while the common part $\bar{\rho}\cdot\sigma^2$ remains. With $\bar{\sigma} = 20$ percent and $\bar{\rho} = 0.3$, portfolio volatility falls from 20 percent (one name) to 12.2 percent at ten and 11.4 percent at forty names — against the floor of 11.0 percent. Figure 3 shows both diversification effects: via correlation and via number.

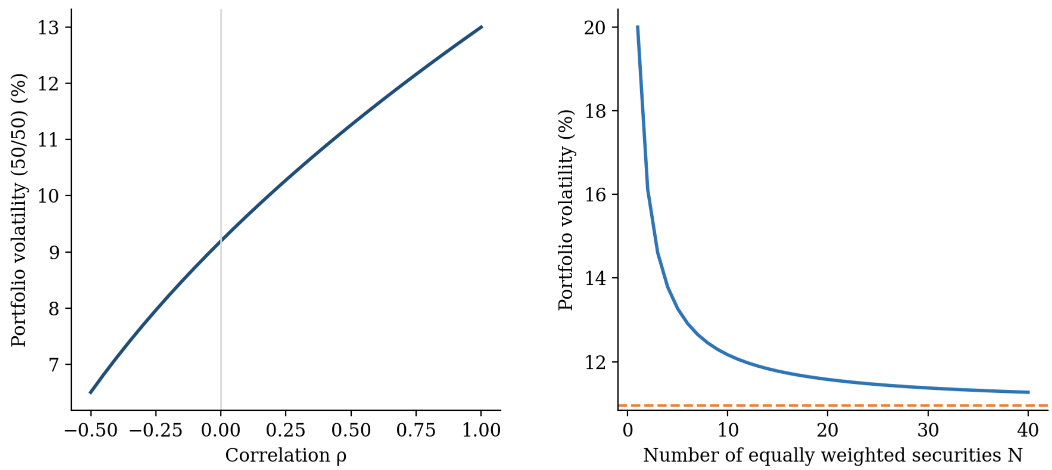

Figure 3: Diversification twice over: portfolio volatility of a 50/50 mix as a function of correlation (left) and the effect of the number of names at average correlation 0.3 with the diversification floor (right, Equation 6).
Source: Own calculation.

The 1/N rule is more than a footnote: DeMiguel, Garlappi, and Uppal (2009) show that out of sample it beats sophisticated optimisation surprisingly often — not because optimisation is wrong, but because its inputs (expected returns) are so error-prone that simple equal weighting is more robust. That is the benchmark against which every method of this section must be measured.

10.2 Markowitz: Correlation Matrix, Efficient Frontier, Tangency Portfolio

Markowitz (1952) formalised what Section 2 sketched: from expected returns, volatilities, and the correlation matrix of all investments follows, for every weighting, the portfolio risk according to Equation (7), and the optimisation seeks, for each return target, the risk-minimal mix:[49]

[49] The capital market line arises from combining the risk-free asset with the tangency portfolio (Tobin, 1958); all points on it dominate the frontier of risky assets alone.

$$\sigma_P^2 = \Sigma_i \Sigma_j \; w_i \cdot w_j \cdot \sigma_i \cdot \sigma_j \cdot \rho_{ij} \tag{7}$$

Equation (7): Portfolio risk bundles all pairwise covariances; the correlation matrix ρ is the centrepiece — it decides which combinations destroy risk. The set of all non-improvable (optimal) mixes is the efficient frontier: for each risk the highest attainable return, for each return the lowest risk.

$$Sharpe = (\mu_P - r_f) \,/\, \sigma_P \tag{8}$$

Equation (8): The Sharpe ratio (Sharpe, 1966) measures the excess return per unit of risk. With a risk-free asset, the portfolio with the highest Sharpe ratio becomes the tangency portfolio: the straight line from the risk-free rate through this point — the capital market line — dominates the entire frontier, and risk appetite then determines only the mix of money market and tangency portfolio (Tobin, 1958).

10.3 The Three-Class Example

A fully worked example with three asset classes — global equities, investment-grade bonds, and a diversified alternatives basket — makes the machinery concrete. Table 5 shows the results: the minimum variance portfolio is bond-dominated (equities practically zero) and achieves 3.8 percent return at only 4.6 percent risk. The tangency portfolio mixes 15 percent equities, 58 percent bonds, and 27 percent alternatives and lifts the Sharpe ratio to 0.48 — almost a quarter above the classic 60/40 equity-bond portfolio (0.39), at only a good half of its fluctuation. The naive one-third split sits in between at 0.44: worse than optimisation with true parameters, better than the two-class convention. Figure 4 locates all portfolios on the frontier.[50]

[50] The inputs are stylised long-term figures (global equities: 7.5 percent return, 16 percent volatility; bonds: 3.5 and 5; alternatives basket: 5.5 and 10; correlations 0.15/0.45/0.10; money market 2 percent).

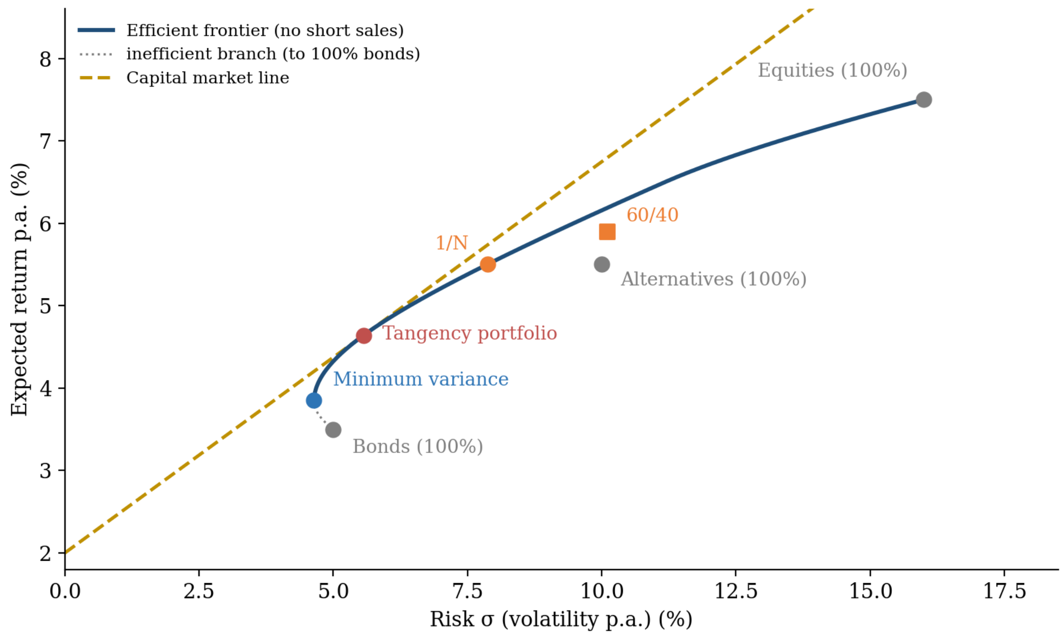

Figure 4: Efficient frontier of the three-class example with capital market line, tangency and minimum variance portfolio, plus the 1/N and 60/40 equity-bond mixes for comparison. *Source*: Own calculation.

Table 5: Three-class example: portfolios compared (money market rate 2 percent)

Portfolio	Equities / bonds / alternatives	Return	Volatility	Sharpe ratio
Minimum variance	0 / 83 / 17	3.8 %	4.6 %	0.40
Tangency portfolio	15 / 58 / 27	4.6 %	5.6 %	0.48
1/N (one-third split)	33 / 33 / 33	5.5 %	7.9 %	0.44
Classic 60/40	60 / 40 / 0	5.9 %	10.1 %	0.39

Source: Own calculation according to Equations (7) and (8) with the inputs of the footnote; weights rounded.

The message of Table 5 is not the specific weighting — it hangs on the inputs — but the pattern: the path to more risk-adjusted return runs through the third, lowly correlated return source, not through more equity quota. That is precisely the core of portfolio optimisation across all asset classes.

10.4 CAPM: from Portfolio to Pricing Model

If all investors optimise as in the preceding chapter, an equilibrium arises: the tangency portfolio becomes the market portfolio, and the expected return of every investment follows the Capital Asset Pricing Model of Sharpe (1964), Lintner (1965), and Mossin (1966) according to Equation (9):[51]

$$E(r_i) = r_f + \beta_i \cdot (E(r_M) - r_f) \tag{9}$$

Equation (9): Only systematic risk β — the contribution to market risk — is paid, not the diversifiable individual fluctuation. An example: with a 2 percent risk-free rate and a 7 percent market return, a stock with $\beta = 1.2$ expects a return of $2 + 1.2 \cdot 5 = 8$ percent. For portfolio construction, the CAPM delivers two lasting insights: diversifiable risk is not rewarded, so that carrying it yields no compensation, and the basic mix of market portfolio and money market is the reference point that every deviation must justify.

For practice, beta is moreover the simplest aggregation measure of the equity sleeve: it adds up in proportion to weights. A sleeve of 70 percent world index (beta 1.0), 20 percent defensive quality names (beta 0.8), and 10 percent emerging markets (beta 1.3) carries a beta of $0.70 + 0.16 + 0.13 = 0.99$ — market-neutral in systematic risk despite three equity classes. Where style deviations are taken, this small calculation shows whether an unintended market position has been built up alongside.

10.5 The Limits: Estimation Error and Extreme Portfolios

Between textbook and practice lies the estimation problem. The optimisation needs expected returns, volatilities, and correlations — and reacts most sensitively to the quantity that is hardest to estimate: small changes in return expectations tip the weights dramatically (Chopra and Ziemba, 1993), and the unconstrained optimiser produces extreme portfolios that Michaud (1989) aptly described as error maximisers: it rewards exactly those investments whose parameters were estimated too optimistically. The volatility and correlation estimation is more benign but carries the regime problem from Rupprechter (2026g): correlations rise in crises — the matrix of the calm years does not describe the hours for which one diversifies.[52]

The practical answer is threefold: constraints (upper and lower bounds per asset class act as implicit error control; Jagannathan and Ma, 2003), robust estimators (shrinkage covariances following Ledoit and Wolf, 2004), and some modesty about returns — which is where the next section begins.

[51] As a pricing model the CAPM is empirically assailable (the flat beta-return relationship is well documented); as a framework for systematic versus diversifiable risk it remains indispensable.

[52] Chopra and Ziemba (1993) quantify the ranking: errors in expected returns weigh about ten times more heavily than errors in the variances and around twenty times more heavily than errors in the correlations.

10.6 Black-Litterman and the Robust Methods

The most elegant way out of the return estimation problem is offered by the method of Black and Litterman (1992). Instead of estimating returns freely, it starts from the equilibrium returns that justify the market portfolio; absent an own view, the market portfolio results. One's own assessments (views) flow in measured, weighted by the confidence in them, according to the Bayesian blending rule in Equation (10):[53]

$$\mu_{BL} = \mathit{weighting}(\mu_{\mathit{equilibrium}},\ \mathit{views};\ \mathit{confidence}) \tag{10}$$

Equation (10): The Black-Litterman return is the precision-weighted middle path between equilibrium returns and one's own assessments — formally a Bayesian update, practically a continuous weighting by degree of conviction: strong conviction shifts the portfolio palpably, weak conviction barely. The results are well-diversified portfolios close to the market that implement opinions in a controlled way instead of tipping over on estimation noise — the reason the method became the standard of tactical allocation in institutional practice.

Alongside it, methods have established themselves that manage entirely without return estimation: risk parity weights so that every asset class makes the same risk contribution (Maillard, Roncalli, and Teïletche, 2010) — the consistent application of the risk budgeting logic of Rupprechter (2026g) to the allocation; minimum variance optimises only the benignly estimable risk side; and mean-CVaR replaces variance with the tail measure expected shortfall where skewed — that is, non-symmetric — distributions (options, credit, alternatives) mislead the variance. The choice of method follows the data situation: the more uncertain the return estimate, the closer the optimal method moves to 1/N, risk parity, or the market — optimisation is discipline, not precision.

10.7 From Model to Investment Policy

The result of the optimisation is not the portfolio but the investment policy. It translates the model weights into target quotas with ranges (say equities 35 percent, band 30 to 40), defines the permissible instruments per asset class, the currency and sustainability rules, the rebalancing regime, and the reporting variables. The ranges are no subversion but the honest answer to the estimation problem of Section 10.5: within the band, every position is model-conforming — only the band breach forces action. Thus arises a system that disciplines without enforcing sham precision.[54]

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[53] Further families: Michaud's resampling averages optimisations over simulated samples; mean-CVaR replaces the variance with the expected shortfall (Rupprechter, 2026g; Rockafellar and Uryasev, 2000).

[54] The investment policy statement is at the same time the audit document against which an investment committee or advisory board measures the implementation — the governance logic of Rupprechter (2026g).

For tactical deviations an explicit budget is recommended — say: at most five percentage points of deviation per asset class, justified, time-limited, documented. Opinion thus gets its place without hijacking the strategy; the Black-Litterman logic of Section 10.6 supplies the appropriate weighting, and the attribution calculation according to Rupprechter (2026g) measures afterwards whether the tactics earned their budget.

10.8 How Many Classes Does a Portfolio Need?

More is not automatically better. The diversification gain of additional asset classes falls steeply: from one to three lowly correlated classes the leap is enormous (the example of Section 10.3 lives on exactly this), from six to ten mostly cosmetic — unless the new class brings a genuinely new return source with low correlation. At the same time the complexity costs grow: more classes, more fees, more monitoring, more error sources — and the temptation to replace oversight with activity.[55]

As a rule-of-thumb architecture, the core of three to five load-bearing classes proves itself (global equities, investment-grade bonds, money market reserve, plus, depending on size, real estate and an alternatives instrument) plus measured satellites. Every further class must pass the entrance examination of Section 2.2: which premium, which correlation, which costs — and what is removed in exchange? A portfolio is also optimised when nothing more can be left out.

10.9 When Correlations Break: Optimising for the Crisis

The correlation matrix of the calm years describes the normal state only: in crises, risky assets close ranks — equities, high yield, real estate equities, commodities, and crypto fell largely together in 2008 as in 2020 (autocorrelation), and the diversification the optimisation promised was thinner in the hour of its deployment than calculated.[56] That does not devalue the optimisation but demands the second calculation run: the same portfolio, evaluated with a crisis matrix (high correlations of the risk assets, flight into government bonds) — the stress test logic of Rupprechter (2026g) at the allocation level.[57]

The consequence for construction: genuine crisis diversifiers are rare — prime government bonds (as long as inflation is not driving the crisis), money market, partly gold and trend-following strategies. A portfolio needs enough of these few that the loss limit holds in the crisis

[55] The marginal utility calculation follows Equation (6): the diversification gain of additional asset classes falls as soon as their correlation to the existing holdings is no longer low.
[56] In financial crises, the tendency of many mutually lowly correlated asset classes towards a correlation of 1 increases.
[57] In practice the double calculation proves itself: optimisation with normal parameters, testing with the crisis matrix — the portfolio must pass both.

matrix as well — that is the real test of every optimised allocation, not the Sharpe ratio of the backtest.

11 Market Entry and Timing: Buying and Adding

11.1 The Evidence against Timing

Before any entry technique stands the empirical evidence: systematically successful market timing is not documented. Sharpe (1975) quantified early that a timer would have to be right in well over half of all cases to beat buy-and-hold; Jeffrey (1984) showed the asymmetry — missed upswings weigh more heavily than avoided declines — and Barber and Odean (2000) documented that the most active private investors earn the worst returns. Dichev (2007) added the most uncomfortable number: capital-weighted — that is, measured by when the money was actually invested — investors earn palpably less than the indices, because inflows come after good phases and outflows after bad ones. Timing is not merely difficult; on average it is practised the wrong way round.[58]

11.2 Entering in Tranches

How is a large investment amount — inheritance, company sale, bonus — best invested over time? Statistically, the expected value argues for the lump sum: because markets rise on average, waiting costs return on average. But the average is no comfort in the bad individual case, and this is where entering in tranches comes in: the amount is invested in three to twelve equal steps over weeks to months. That limits the regret risk of having invested everything at the worst moment and uses the cost averaging effect according to Equation (11):[59]

$$\bar{P}_{entry} = n \,/\, \Sigma_i \,(1/P_i) \tag{11}$$

Equation (11): With a fixed amount invested per tranche, more units are automatically acquired at low prices and fewer at high ones; the average entry price is the harmonic mean of the purchase prices — and thus always lies below their arithmetic average. In the numerical example of Rupprechter (2026b): purchase prices from 50 to 60 with average 45.33, entry price 43.50.

[58] The numbers from Rupprechter (2026b) continue to hold: missing the ten strongest trading days of long periods nearly halves terminal wealth (Estrada, 2008) — and the best days cluster in the middle of the worst phases.

[59] Constantinides (1979) showed the theoretical inferiority of the staggered entry, Statman (1995) established its behavioural value: it lowers regret and keeps investors on plan.

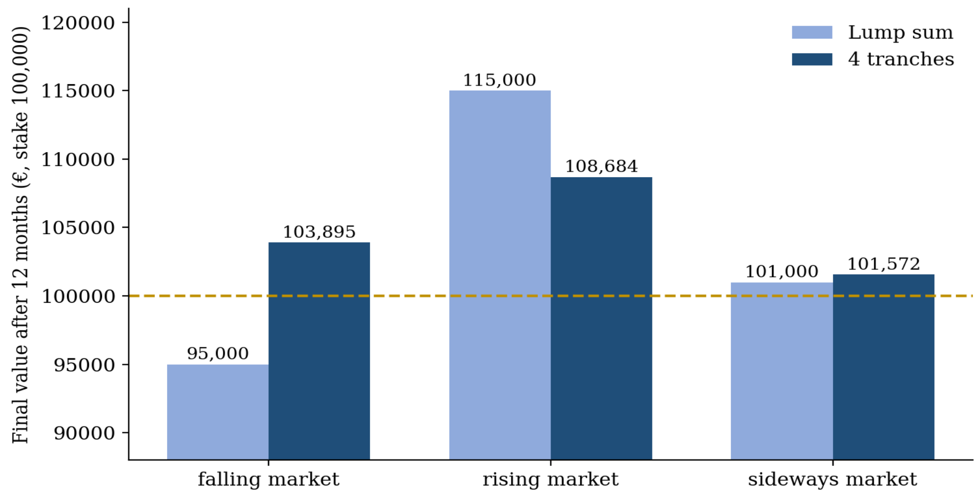

Figure 5: Lump sum versus staggered entry in four tranches in three market scenarios (stake 100,000 euros, terminal value after twelve months; dashed line: stake).
Source: Own calculation.

Table 6: Lump sum versus entry in four tranches: 100,000 euros, three market scenarios over twelve months

Scenario	Terminal value, lump sum	Terminal value, 4 tranches	Avg. entry price (tranches)
falling market (100→85→90)	€95,000	€103,895	€91.44
rising market (100→112→115)	€115,000	€108,684	€105.81
sideways market (100→96→103→99)	€101,000	€101,572	€99.44

Source: Own calculation; four equal tranches at the starts of the quarters, final valuation after twelve months.

Table 6 and Figure 5 show the effect of stepwise investing quite openly: in the falling market the staggering saves almost nine percentage points, in the rising one it costs a good six, sideways it is neutral to slightly advantageous. Averaged over many scenarios the lump sum wins — the market rises more often than it falls — but the staggering buys something else: the certainty of never having fully caught the worst single moment. In behavioural terms, that is the difference between a plan and a stress reaction (Statman, 1995).

11.3 Practical Rules for Entry and Adding

From evidence and example follow application rules. First: the staggering must be defined in advance — number of tranches, dates, amounts — and executed mechanically; a staggering that waits for "better prices" is timing in disguise. Three to six tranches over six to twelve months balance regret protection and opportunity costs for most purposes. Second: the lower-risk the target portfolio, the shorter the staggering may be — for a bond-dominated portfolio the entry risk is small. Third: funds parked in the interim belong in the money market of

Section 3, not in the current account. Fourth: with ongoing savings instalments the question is moot — the savings plan is the born tranche buyer, as Rupprechter (2026b) sets out. And fifth: additions to existing holdings follow the rebalancing bands — money flows to where the portfolio lies below the target weight; thus countercyclical buying arises from discipline instead of forecast.[60]

11.4 Valuation as Timing Substitute: What the Shiller P/E Can Do

If timing fails — does valuation at least help? The honest answer: over long horizons yes, as an entry signal no. The cyclically smoothed price-earnings ratio (Shiller P/E, introduced in Rupprechter, 2026e) explains a substantial part of equity returns over the respectively following ten to fifteen years: expensive starting levels mean lean subsequent decades on average, and vice versa (Campbell and Shiller, 1998). But the measure can stay expensive for years and become more expensive, so that exiting on its signal regularly forgoes years of the bull market.[61]

The useful deployment is therefore not switching from risk-on to risk-off and back, but calibration: valuation levels belong in the return expectations of the strategic allocation (high valuation → dampened expectation → more moderate equity quota within the ranges) and in the investor's expectation management — not in an on-off signal. Valuation thus enters as a sizing instrument, not a timing instrument.

11.5 Buying the Dip: Rules instead of Reflexes

The most valuable timing opportunity is at the same time the psychologically hardest: buying in correction phases. Precisely for that reason it must be cast into rules in advance — say: at declines of the equity sleeve of 15, 25, and 35 percent below the last rebalancing level, one defined tranche each is invested from the cash reserve. Such staggered plans are the mirror image of entering in tranches: they replace the unanswerable question "Is this the bottom?" with the answerable "Is the rule met?".[62]

The same is accomplished — more mildly — by rebalancing itself: a mechanical buy-back to the target quota after an equity slump is countercyclical by construction. The combination of bands (Section 13) and drawdown tranches from the cash reserve gives the portfolio a built-

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[60] For additions to existing holdings, the rebalancing principle applies: steer inflows into the underweighted classes — thus the plan buys countercyclically automatically, without forecasting.

[61] Campbell and Shiller (1998) showed the long-term relationship between valuation level and subsequent returns; as a short-term signal the measure has no accuracy.

[62] The precondition of every dip-buying plan is the liquidity reserve of Section 3: buying in a crisis presupposes not being forced to sell in it.

in crisis buyer — the only one that functions reliably under stress, because it requires no market view.

11.6 The Forgotten Side: Selling and Withdrawing

Timing is almost always discussed as a buying question — yet the exit is the harder half. For the planned exit (drawdown phase, target event), the mirrored tranche logic applies: staggered reduction over months to years, beginning well before the target date, plus a withdrawal buffer in the money market covering one to three years of withdrawals — thus no single bad year ever decides the standard of living. For the rule-bound exit, rebalancing again provides: after strong equity years it automatically sells into strength.[63]

What this paper advises against is the opinion-driven complete exit — the "sell everything until the situation clears". It combines both timing problems (exit and re-entry), and the evidence of Section 11.1 hits it twice: the situation clears in prices first, and the strongest days occur during the period of uncertainty. Where risk can no longer be carried permanently, the profile and with it the strategic weights are changed — a decision with rules, not a reflex with an intention to return.

11.7 The Savings Plan: Tranches as a Permanent State

For ongoing wealth accumulation, the timing question resolves itself: the savings plan is institutionalised tranche buying — each instalment automatically buys more units at low prices according to Equation (11), and the entry moment loses almost all significance over the years. More important than any fine-tuning are three quantities here: the savings rate (it dominates terminal wealth in the first decades), the cost ratio of the instrument being saved into, and persevering through the slumps — the savings plan that is suspended in a market correction loses exactly the instalments with the best entry prices.[64]

The link to the allocation: the savings plan, too, follows the target structure — components saved into in proportion to the strategic weights, an annual check of whether inflows shift the bands. Thus, out of monthly instalments grows the same disciplined portfolio that this paper develops for the lump sum.

[63] For drawdown portfolios the buffer approach has proved itself: one to three years of withdrawals in the money market, so that in weak phases no sales from the risk block are necessary.

[64] The wealth accumulation calculations — terminal values of monthly instalments over decades, the advantage of the early start — are found in Rupprechter (2026b).

12 Sustainability: Integration without Sacrificing Return

12.1 The Approaches: from Exclusion to Impact

Sustainability can be built into a portfolio in five ways, with increasing depth of intervention. Exclusions avoid defined business fields (weapons, coal, tobacco); best-in-class selects the most sustainable providers per industry and thus retains sector diversification; ESG integration takes environmental, social, and governance criteria into the analysis as additional risk factors (the governance dimension was always part of the quality check in Rupprechter, 2026e); engagement uses voting rights and dialogue to change companies instead of selling them; and impact investing seeks measurable impact alongside return — the microfinance of Section 7.3 is the oldest example. Table 7 orders the approaches with their return implications.[65]

Table 7: Sustainability approaches and their portfolio effect

Approach	Principle	Effect on diversification	Return finding (evidence)
Exclusions	avoid defined fields	small with narrow lists, palpable with broad ones	slight premium of excluded sin stocks (Hong and Kacperczyk, 2009)
Best-in-class	select the best per industry	preserved (all industries remain)	neutral
ESG integration	ESG as a risk factor of the analysis	preserved	neutral to slightly positive (Friede, Busch, and Bassen, 2015)
Engagement	change instead of sell	preserved	positively documented individual findings
Impact	measurable impact as the goal	depends on the narrowness of the universe	project-dependent; impact before return

Source: Own compilation based on the data of Friede, Busch, and Bassen (2015), Edmans (2011), and Pástor, Stambaugh, and Taylor (2021).

12.2 What the Evidence Says on Returns

The research base is broader than any sales brochure and more differentiated than any polemic. The meta-study by Friede, Busch, and Bassen (2015) across more than 2,000 investigations finds, at the company level, predominantly positive relationships between ESG quality and operating performance; at the portfolio level, neutral findings dominate — sustainable funds deliver market-standard returns on average (Figure 6, left). Individual findings stand out: Edmans (2011) shows excess returns of companies with high employee satisfaction, Hong and Kacperczyk (2009) the premium of the shunned sin stocks — exclusions

[65] The EU disclosure framework (SFDR) distinguishes products without a sustainability claim (Article 6), with advertised characteristics (Article 8), and with a sustainability objective (Article 9) — a disclosure system, not a quality seal system.

thus have a (small) price. The equilibrium logic is supplied by Pástor, Stambaugh, and Taylor (2021): green preferences depress the cost of capital of green firms — good for the environment, but in equilibrium tantamount to somewhat lower expected returns; the strong ESG years of the past were essentially revaluation (Pástor, Stambaugh, and Taylor, 2022). Bolton and Kacperczyk (2021) show, conversely, a carbon premium: emission-intensive names trade more cheaply, so that avoiding them forgoes this premium while holding them entails the transition risk.[66]

For practice, this condenses into a clear line: ESG integration and best-in-class cost no return and improve the risk analysis; narrow exclusion lists cost little; very narrow green universes concentrate industries and styles and trade return for preference. From exactly this follows the conclusion of this paper: a portfolio need not be one hundred percent green — but sustainability should be taken into account wherever return does not suffer; and where it does cost something, the investor should know the price and pay it deliberately.

12.3 Greenwashing: the Labels and the Fines

Where demand rewards labels, label fraud arises. Greenwashing — sustainability promises that the actual investment practice does not cover — has meanwhile become a supervisory topic of its own, and the fines imposed read as the industry's warning list (Table 8; Figure 6 sets them against the research findings). The largest case concerns the Deutsche Bank subsidiary DWS: after 19 million US dollars to the US Securities and Exchange Commission (2023) for exaggerated statements on ESG integration, the Frankfurt public prosecutor's office imposed a further 25 million euros in 2025 — advertising claims such as "ESG is part of our DNA" did not match practice. The SEC additionally sanctioned Invesco (17.5 million US dollars, 2024) for misleading statements on the share of ESG-integrated assets, Goldman Sachs Asset Management (4 million, 2022) and WisdomTree (4 million, 2024) for ESG processes not followed as described — and opened the series in 2022 with BNY Mellon (1.5 million).[67]

[66] Pástor, Stambaugh, and Taylor (2022) explain apparently superior ESG returns of the 2010s predominantly as a one-off effect of rising demand — expected future returns of green names lie, in equilibrium, rather lower, not higher.
[67] Berg, Kölbel, and Rigobon (2022) additionally show that the ESG ratings of the large providers correlate only weakly; an examination of sustainability must therefore not rely on a single label.

Figure 6: Left: distribution of study findings on the relationship between ESG and performance at the company and portfolio level (after Friede, Busch, and Bassen, 2015, stylised). Right: the largest greenwashing sanctions.
Source: Own calculation.

Table 8: The largest greenwashing sanctions against fund companies

House	Authority / year	Fine	Core allegation
DWS	Frankfurt public prosecutor / 2025	€25 m	advertising (“ESG DNA”) without cover in investment practice
DWS	SEC / 2023	$19 m	exaggerated statements on ESG integration
Invesco	SEC / 2024	$17.5 m	misleading share of “ESG-integrated” assets
Goldman Sachs AM	SEC / 2022	$4 m	ESG processes not followed as described
WisdomTree	SEC / 2024	$4 m	advertised ESG exclusions not implemented
BNY Mellon IM	SEC / 2022	$1.5 m	first case: false statements on ESG reviews

Source: Own compilation with announcements of the SEC (2022–2024) and press reports on the discontinuation order of the Frankfurt public prosecutor’s office (2025); amounts rounded.

For investors, three test rules follow. First, substance before label: decisive is the actual investment process (exclusion lists, integration steps, engagement record), not the fund name or the SFDR article number. Second, read ratings multi-dimensionally: the providers’ judgements diverge strongly (Berg, Kölbel, and Rigobon, 2022) — a single seal is no examination. Third, separate impact and return: where impact is sought, impact is measured (as in microfinance); where return is sought, it is checked whether the sustainable instrument matches the diversification and costs of the conventional one. Sustainability thus becomes a criterion of quality analysis — and no longer remains a mere sales argument.

12.4 Climate Risk as Investment Risk

Beyond preferences, sustainability is simply risk analysis. Climate risks hit portfolios via two channels: physical — extreme weather, water scarcity, location risks — and transitional, when regulation, carbon prices, and technological change devalue business models; the carbon premium of Bolton and Kacperczyk (2021) is the market price of this transition risk. For the allocation this means: emission intensity and transition resilience belong in the quality check like leverage and market position — not as a worldview, but as a question of value durability on the horizon of long-term investors.[68]

In practice, investors check three quantities: the carbon intensity of the portfolio against the benchmark, the concentration in particularly transition-exposed sectors, and — for real assets — physical location risks. Where this analysis leads to reallocations, it is risk management; where it does not, the portfolio has passed the stress test. Both are compatible with the conclusion of Section 12.2 — sustainability as analysis costs no return, it protects it.

12.5 Engagement: the Quiet Effect of Voting Rights

The most underrated sustainability lever is the quietest: engagement. Instead of selling unwanted names — which merely changes the owner — funds and asset managers use voting rights, shareholder motions, and direct dialogue to move strategy, emission paths, and governance. For the private investor, engagement takes place indirectly: through the selection of fund providers with a documented voting and dialogue record. The test question for every provider: how was voting done, with what goals, with what results — published and traceable?[69]

Engagement moreover resolves the dilemma of exclusions: avoiding problematic industries entirely removes all influence over them and leaves the securities to investors without any sustainability interest. Holding and changing can be more effective than selling and looking away — provided the changing demonstrably takes place and does not remain a brochure promise; which closes the circle to the greenwashing chapter.

12.6 The Preference Query: Sustainability in the Advisory Process

In investment advice, sustainability is now a mandatory element: the European advisory process requires querying sustainability preferences — with categories from taxonomy quotas through SFDR features to the consideration of adverse impacts. The answer shapes the product universe of the recommendation; ill-considered maximum statements can narrow it drastically. The wise preparation corresponds to the conclusion of Section 12.2: formulate

[68] Transition risks hit business models via regulation, technology, and demand; physical risks via locations and supply chains — both belong in the scenario calculation according to Rupprechter (2026g).

[69] Hartzmark and Sussman (2019) additionally show that sustainability ranks steer massive fund flows — the capital market prices the preference, which gives engagement additional leverage.

preferences so that integration and quality are demanded, but diversification and costs are not sacrificed.[70]

For investors who decide for themselves, the same applies in the form of a self-inquiry: which exclusions are non-negotiable, where does best-in-class suffice, what is pure preference with a return price? Separating these three levels translates values into investment policy rather than label purchases — the sustainability question thus becomes part of the same investment policy that Section 10.7 defines for all other dimensions.

13 The Overall Process: from Investor Profile to Portfolio

13.1 The Step Sequence of Portfolio Construction

Parts A to D combine into a process in six steps. First, the investor profile: horizon, liquidity needs, risk capacity and appetite, sustainability goals — they define the target return and the loss limits. Second, the strategic allocation: the division across the asset classes of Sections 3 to 9, found with the methods of Section 10 — robustly optimised, with ranges instead of point weights. Third, the choice of instruments per asset class: low-cost core, deliberately measured satellites, sustainability approach according to Section 12. Fourth, the entry according to the rules of Section 11. Fifth, rebalancing: fixed bands around the target weights, whose breach is corrected in a rule-based way — the only form of countercyclical action that needs no forecast. Sixth, monitoring with the metrics from Rupprechter (2026g) and the annual question: does the profile still fit?[71]

Across all steps apply the cost rule — every fee point saved is certain return (French, 2008) — and the humility rule: the risk-return diagram of Figure 2 shows expectations, not promises. A process that gets diversification, costs, and discipline right beats any brilliant single forecast over time — that is perhaps the best-documented statement of all capital market research.

13.2 Case Study: from Cash to Target Portfolio

A connected example ties the threads together. Starting position: two million euros from a company sale, horizon beyond fifteen years, desired annual withdrawal two percent, loss limit “no more than 20 percent from the peak”, sustainability desired as long as it costs nothing.

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[70] Since August 2022, the European financial markets directive (MiFID II) obliges advisers to query clients’ sustainability preferences and to take them into account in product selection.

[71] The monitoring closes the circle to Rupprechter (2026g, 2026h): risk metrics and performance attribution provide the control, derivatives the fine-tuning.

From the rules of this paper follows a strategic allocation of, say, 40 percent global equities (a dual core of ESG-integrated ETFs and actively managed globally investing equity funds, band 35–45), 35 percent bonds (a ladder strategy of government and corporate bonds of medium duration plus a linker component, band 30–40), 10 percent alternatives (a semi-liquid vehicle plus microfinance), 5 percent commodities/gold, and 10 percent money market as reserve and withdrawal buffer.[72]

The implementation: entry in five monthly tranches (Section 11.2), parked funds in the money market fund; rebalancing bands of ±5 points per class, review semi-annually and upon band breach; drawdown rule according to Section 11.5 from the money market buffer; quarterly reporting with the metrics from Rupprechter, 2026g (volatility, value at risk, downside deviation against the withdrawal target return) and an annual profile review. The example is deliberately unspectacular — precisely therein lies its strength: every asset class and every instrument has a named purpose, every number a provenance, every future action a rule.

13.3 The Most Frequent Errors — and Their Counter-Rules

To close, the error list against which the process is meant to immunise. Return chasing: inflows into what has just done well — capital-weighted, the investing public's most expensive habit (Dichev, 2007); counter-rule: inflows follow the bands, not the charts. Concentration lumps: home market, employer shares, a fashionable sector; counter-rule: the return-risk map of Section 9 and caps per name, sector, region. Cost blindness: fees act like negative compound interest (Rupprechter, 2026b, works it out); counter-rule: a total cost view before every purchase. Overactivity: trading without a return contribution (Barber and Odean, 2000); counter-rule: defined occasions — rebalancing, profile change, scheduled dates — and nothing more. And label credulity, whether with thematic funds or sustainability seals; counter-rule: the decomposition test of Sections 2.2 and 12.3.[73]

None of these errors arises from a lack of intelligence — all arise from a lack of rules at the right moment. That is the final and most important function of portfolio optimisation: it is the rulebook that protects the investor from their worst adviser — themselves in extreme mood.

[72] The weights serve to illustrate the process, not as a recommendation; they follow the logic, not the person.

[73] All the errors named are empirically documented; the evidence is found in Sections 6, 10, and 11 as well as in Rupprechter (2026b).

13.4 The Bracketed Factor: Taxes and Structure

This chapter calculates before taxes — in the knowledge that taxes can shift the ranking of instruments and implementations. Three principles stand above any rule change: first, every avoidable tax realisation disturbs compounding — accumulating vehicles, lower turnover, and rebalancing via inflows instead of sales preserve the tax deferral effect that Rupprechter (2026b) quantifies. Second, tax-like costs belong in the same calculation as fees: what drains away annually acts like a negative return point. Third, the structure of the instruments follows the overall picture — for larger fortunes, the structuring question from Rupprechter, 2026g (special funds, foundation, family office) also arises from a tax and organisational perspective.[74]

The proven advice here is: investment logic first, tax optics second. Portfolios built primarily around tax advantages regularly carry concentration, cost, and complexity risks that exceed the advantage — taxes are optimised within a good allocation, not in its place.

13.5 Rebalancing in Detail: Bands, Calendar, Costs

Since rebalancing functions as the central, if inconspicuous, mechanism of the process, the precision of its design is of particular importance. Calendar-based rules (say, at an annual rhythm) and band-based rules (an adjustment only upon crossing defined tolerance limits, say ±5 percentage points or, in relative terms, ±20 percent of the target weight) can be combined: the review takes place at regular intervals, but a transaction occurs exclusively upon a band breach. In this way, transaction costs and tax burdens are minimised while the portfolio structure is kept close to the target allocation. Inflows and withdrawals are the free rebalancing of first choice: they flow into the underweights or out of the overweights before any adjustment is made at all.[75]

Two subtleties decide the quality: illiquid instruments are rebalanced via the sizing of inflows and commitments, not via sales; and in trend phases tight rebalancing costs momentum return — wide bands are therefore no loss of discipline but a deliberate compromise between structural fidelity, costs, and trend capture. What remains decisive is that the rule is fixed before the crisis sets in; amid the turbulence, the rulebook can no longer be designed impartially.

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[74] Tax rules change and act individually; the principles nonetheless hold across jurisdictions — the concrete structuring belongs in tax advice.

[75] Rebalancing is no return machine but risk steering: it keeps the portfolio at its profile and harvests, in passing, a small countercyclical bonus in sideways markets.

14 Conclusion and Outlook

Portfolio optimisation across all asset classes is, in the end, the answering of four questions in the right order. What is there to choose from? — The spectrum ranges from the money market through the widely branched bond family, equities with their vehicles and style strategies, hedge funds, private equity and microfinance, to real estate, commodities, cryptoassets, and derivatives as instruments of allocation control; every asset class is a premium for a specific risk, and duration, credit, and currency decide more with fixed income than the names of the securities. How does one combine? — Via correlations: the efficient frontier shows what is attainable, the tangency portfolio what is efficient, and the robust methods from Black-Litterman to risk parity how to get there without foundering on estimation errors. When is the right moment to enter? — When in doubt, immediately and in tranches: timing fails systematically, staggering buys composure. And how green? — As green as return permits: integration and best-in-class are return-neutral, radical narrowing has its price, and labels replace no examination.[76]

For practice, three guiding principles remain. First: diversification is the only reliable free lunch of the capital markets — the third, lowly correlated return source improves a portfolio more than any refinement within the first two. Second: optimisation is discipline, not precision — ranges, constraints, and robust estimators beat the sham accuracy of the decimal place; absent a defensible return view, the market portfolio is held and deviations are sized along Black-Litterman logic. Third: the process beats the forecast — investor profile, strategic weights, rule-based rebalancing, and low costs together accomplish what no forecasting skill promises.

The limits of this paper are at the same time its outlook. The inputs of the examples are stylised long-term figures; real allocations demand continuously updated estimates and the regime vigilance according to Rupprechter (2026g). Taxes and individual restrictions remained bracketed out, but shift weights and vehicle choice in the individual case. And the investment world itself remains in motion: private markets grow, cryptoassets mature under new regulation, and sustainability data are becoming better and more strictly supervised. The answer to the new, however, remains old: place it on the map of return, risk, and correlation — and admit only what brings the portfolio something it does not yet have.

[76] This paper serves exclusively informational and educational purposes; it constitutes no investment recommendation.

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