# Using CAPM to regulate infrastructure: A critique

Thematic Paper, July 2025

## 1. Cost of capital for regulated infrastructure

The UK Government's June 2025 10 Year Infrastructure Strategy sums it up: "And now, a further step-change in infrastructure investment is needed – at a scale and pace not previously seen – to boost growth, tackle climate change, improve resilience, and deliver better environmental outcomes".[1]

Much of this growth in infrastructure investment will come in regulated sectors—electricity and gas, water, airports, rail and telecoms—that are central to the delivery of core services to current and future populations. The combined regulated asset base (RAB) across these sectors amounts to well over £200 billion today. Cash flows on this asset base are driven by the allowed return, in the form of the regulated cost of capital. This, in turn, drives the investability of regulated sectors. Even a small shift of 25 basis points in the cost of capital can affect billions in investor returns and customer bills.

Over the last two decades, UK regulatory policy has relied on the Capital Asset Pricing Model (CAPM) to estimate the cost of equity for infrastructure sectors. Each sector regulator implements its own customized version of CAPM, and the Competition & Markets Authority (CMA) and UK Regulators' Network (UKRN) have, so far, supported CAPM as the preferred modelling tool. The challenging state of the UK infrastructure landscape, notably in water and wastewater—as identified in the Cunliffe Review [2], raises the question of whether existing policy will be sufficient to underwrite an economy-wide shift to growth.

Infrastructure investors allocate capital globally so the UK competes with other countries. Australia, Brazil and Germany, amongst others, currently also rely heavily on CAPM. More flexible, market-based approaches do exist; in the US, for example, the energy and railroad regulators use bottom-up discounted cash flow (DCF) modelling alongside CAPM. Other major jurisdictions are confronting similar infrastructure challenges and, like the UK, need to attract capital from a global market.

This paper aims to support discussion among key stakeholders by evaluating the CAPM-based status quo and giving a new perspective on the cost of capital. It begins by setting out the financial and economic assumptions underlying CAPM and puts them in the context of infrastructure regulation. It then synthesizes the evidence on CAPM's empirical performance, for listed equities in general and for infrastructure assets in particular. The paper concludes by suggesting another complementary path forward that seeks to retain simplicity and transparency.

[1] UK Infrastructure: A 10 Year Strategy, HM Treasury and National Infrastructure and Service Transformation Authority, 19 June 2025, quote from page 38.

[2] Independent Water Commission: Final Report, 21 July 2025

## 2. Financial assumptions underlying CAPM

CAPM originated in the 1960s as a theory of asset pricing: how rational, diversified investors *should* price risk assets in a frictionless market.[3] Its appeal lies in the result that an asset's expected return can be pinned down by a single statistic: its "beta". This captures systematic risk, namely how closely the asset's fortunes co-vary in a linear fashion with those of the wider market. Assets with greater undiversifiable systematic risk must have a higher required return. Conversely, investors can eliminate all idiosyncratic risks specific to individual assets by widely diversifying portfolios; such risks do not warrant extra return.

CAPM's striking result is based on a set of financial assumptions that reflect the state of neoclassical economics in the mid-to-late 20th Century:

1. **The stock market is fully efficient**, reflecting the fundamental value associated with the future cash flows of each asset. There is no mispricing of assets or "investor sentiment";

2. **Stock returns follow a normal statistical distribution**, implying that good and bad outcomes are equally likely and that extreme outcomes are extremely rare. There are no "black swans" or "fat tails" for individual assets or the overall market;

3. **Markets are complete in that all assets globally are investable**; all company shares are traded in the stock market and available for all investors to trade. There are no unlisted assets held by private equity or under state ownership;

4. **Investors are rational, utility-maximizing actors** with mean-variance preferences who optimize their portfolios to balance return (mean) and risk (variance). There is no behavioural economics related to loss aversion, or a failure to optimize;

5. **Investors are fully diversified across assets** and hold the global market portfolio of all traded bonds and shares—plus cash. There are no institutional constraints that tie an investor to a particular asset class or "home bias" in investor holdings;

6. **Investors can borrow or lend as much as they wish** at the risk-free rate. There are no issues of credit quality or borrowing covenants due to asymmetric information or incentive conflicts between borrowers and lenders;

7. **Transaction costs, and distortions from the tax system, are negligible** so that each investor can rapidly reoptimize their portfolio as and when needed. There are no stockbrokers or bid-ask spreads.

Under a closely related set of assumptions to those of CAPM, capital structure is also irrelevant.[4] That is, companies cannot

[3] Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19(3), 425–442.

[4] Modigliani, F., & Miller, M. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review*, 48(3), 261–297.

create any value by optimizing the mix of debt and equity financing on their balance sheets. There are no investment bankers.

While every model has its assumptions, much of CAPM is at odds with reality. Due to their institutional mandate, most infrastructure investors cannot be fully diversified to the global market portfolio. Conversely, most retail investors cannot access private equity assets. A large share of UK infrastructure assets, notably in energy and water, are no longer listed on the stock market. Investors cannot borrow at the risk-free rate, certainly not when it matters most. CAPM's behavioural and statistical premises can also be questioned.

The finance literature has moved on from CAPM. Relaxing its assumptions quickly leads to risk factors other than the market portfolio becoming relevant. If investors cannot fully diversify or disagree about an asset's return distribution, then idiosyncratic risk often *does* matter—and needs to be rewarded accordingly.[5] CAPM is now seen as a special case of a broader approach to asset pricing based on "stochastic discount factors" that better reflects market realities.[6]

## 3. Economic assumptions underlying CAPM

While CAPM's *financial* assumptions are much-discussed, it also comes with implicit *economic* assumptions that do not appear to be widely understood—but are critical to its application in infrastructure regulation, which sits in the wider context of economic policy. This shift in perspective is needed when the model is transplanted from desk research on capital markets to the practice of delivering infrastructure regulation and investment.

The set of economic assumptions underlying CAPM includes:

1. The economy is comprised of small companies operating at an efficient scale, without any significant barriers to entry or exit of competitors. There are no natural monopolies in, say, electricity grids or water networks;

2. All decision-making is efficiently guided by relying solely on market prices. There is no need for system coordination, strategic planning or real options during the transition towards net zero energy or otherwise;

3. Climate change and other environmental externalities such as air pollution or poor water quality either do not exist or are already correctly priced by the market. There is no under provision of corrective action by government or the market;

4. The future resembles the past: investors already know the statistical distribution of asset returns. There is no radical uncertainty about the future or structural change in the economy—as may be associated with technological change on climate or AI;

5. Regulatory and political uncertainty are not priced by investors above and

[5] Merton, R. C. (1987). A Simple Model of Capital Market Equilibrium with Incomplete Information. *Journal of Finance*, 42(3), 483–510.

[6] Cochrane, J. H. (2005). *Asset Pricing*. Princeton University Press.

beyond what is implied by an asset's "beta". There are no unexpected political "U-turns", windfall taxes or other *ex post* clawbacks on sunk investments.

For infrastructure regulation, CAPM is coherent only under two polar scenarios. The first is that markets already work perfectly so no regulation is needed. The second is that regulation perfectly corrects any market failures, with no remaining information and incentive problems. Reality resides in between: markets and regulatory policy are both necessarily imperfect. The application of CAPM to regulated industries is therefore tenuous from the outset. In the CAPM world, perhaps paradoxically, regulation is not needed in the first place!

The assumptions of efficient market pricing, negligible externalities, and "future-is-like-the-past" may have been palatable in the benign context of the 1990s and 2000s; they have become more suspect in a world today in which large-scale, often irreversible, infrastructure investment needs to take place against a climate-constrained future that is unknown and, to some degree, unknowable.

## 4. CAPM's empirical track record

While CAPM was initially proposed as a normative theory of investor behaviour, a large finance literature has since put its predictions to the empirical test. The case has been summed up as: "... despite its seductive simplicity, the CAPM's empirical problems probably invalidate its use in applications".[7]

From the perspective of infrastructure regulation, two empirical shortcomings of CAPM are especially salient. The first problem is that CAPM *systematically* mis-predicts asset returns. Stocks with a "low" beta in CAPM tend to have returns higher than what CAPM predicts. The converse holds for high-beta stocks—roughly, above ~1 (so riskier than the market). Most, though not all, infrastructure assets have a "low" beta.; for such assets, CAPM typically underpredicts returns so they produce "alpha". Put differently, the return required by investors is typically higher than what CAPM predicts. The discrepancy can run into several 100 basis points. CAPM's errors are far from random.

The second problem concerns CAPM's central prediction that a single factor—the market risk factor—pins down expected returns. A long list of *company-level* factors has been found to have significant explanatory power, starting already in the 1980s with the price-earnings ratio and the size of the underlying company. The Fama-French multifactor model has been a workhorse of the finance literature since the late 1990s; its latest version comes with six factors: a size risk premium, a value premium, a profitability effect, an investment effect and a momentum factor—alongside the CAPM market risk factor.[8]

Another multifactor approach, known as Arbitrage Pricing Theory (APT), finds that additional *macroeconomic* risk factors have explanatory power above and beyond CAPM, including inflation, industrial production, GDP growth, commodity prices and the

[7] Fama, E.F. & French, K. R. (2004). The Capital Asset Pricing Model: Theory and Evidence. *Journal of Economic Perspectives*, 18(3), 25–46, quote from p. 44.

[8] Fama, E. F., & French, K. R. (2018). Choosing Factors. *Journal of Financial Economics*, 128(2), 234-252.

shape of the yield curve on government bonds.[9] Like market risk, these factors are systematic and difficult for investors to diversify away from. (The presence of additional risk factors does not necessarily imply a higher expected return relative to the single-factor CAPM, as the beta coefficient on the market usually adjusts downwards.)

A few papers have examined CAPM's performance specifically for regulated infrastructure. For 129 US electricity, gas and telecoms utilities in the 1980s, CAPM produced a median alpha of 110 basis points on returns.[10] In other words, CAPM usually understated the utilities' cost of capital by a significant margin—consistent with the wider evidence on its empirical performance for "low beta" stocks. An alternative APT specification yielded a median alpha of -17 basis points, indicating a less biased fit.

In a similar vein, for a sample of 28 listed Latin American electricity network utilities over 2010-2022, a multi-factor model outperforms CAPM. The multi-factor model augments CAPM's market risk factor with a size risk premium, country risk premium (the yield spread between Latin American and US government bonds), and a political and regulatory stability risk premium.[11] While CAPM explains between 22-72% of return variation, the multi-factor approach explains 68-79%.

## 5. What is CAPM's future in infrastructure regulation?

CAPM's track record is mixed, at best, both in theory and in practice. Its financial assumptions have long been questioned, and it has been superseded in asset pricing by richer multifactor models. Its economic assumptions are tighter than is often appreciated, and more acutely so in times of large-scale infrastructure build-out. Its empirical track record is weaker, especially for "low beta" assets like infrastructure, again pointing to the pricing of additional risk factors.

Where does this leave infrastructure regulation? CAPM is unlikely to disappear overnight given its relative ease of implementation and decades-long institutionalization that brings a common language across regulators, utilities and investors. Nonetheless, it is important to recognize that financial theory and practice have moved on since the 2000s in a way that regulatory policy has not. And the UK Government's recent 10 Year Infrastructure Strategy reaffirms the need for a "step change" to be able to deliver future-proof investment.

There are promising opportunities ahead. UK regulators—including Ofgem, Ofwat and the CMA—have over the past decade made use of "cross-checks" as a complement to sense-check CAPM estimates of the cost of equity. This has included infrastructure market-to-asset ratios (akin to price-to-book ratios in equity research) and estimates from simpler dividend growth models. This set of cross-checks could be

[9] Ross, S. A. (1976). The Arbitrage Theory of Capital Asset Pricing. *Journal of Economic Theory*, 13(3), 341-360; Chen, N.-F., Roll, R. & Ross, S. A. (1986). Economic Forces and the Stock Market. *The Journal of Business*, 59(3): 383–403.

[10] Roll, R., & Ross, S. A. (1983). Regulation, the Capital Asset Pricing Model, and the Arbitrage Pricing Theory. *Public Utilities Fortnightly*, 111(11), 22-28.

[11] Bedoya-Cadavid, J. A., Lanzas-Duque, A. M., Salazar, H. (2025). Common Risk Factors for Latin American Electric Utilities. *Utilities Policy*, 93, 101812.

expanded to feature an augmented asset pricing model that nests CAPM as a special case. It will be important that the approach remains simple and transparent, with a strong economic intuition.

Multifactor and other more granular approaches could be tailored to the realities of UK infrastructure assets. This sharpens and simplifies the challenge, relative to modelling the entire listed equity universe. Candidate factors span macroeconomic risks like inflation and interest rates—central to the infrastructure investment thesis—and granular risks specific to asset cash flows and the regulatory and policy environment. The modelling process is important: credibly whittling down from 100s of potential forward-looking factors to a shortlist with a clear economic interpretation.

A head-to-head alternative to CAPM can help UK regulators balance the demands of investability and affordability, and make a tangible contribution to the UK infrastructure revival. It is also an opportunity to evolve with—and set the bar for—global best practice on infrastructure regulation and investment.

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