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## **Total risk**

The importance of diversification and risk management was recognized by a few visionaries in the early days of investing. Only in the 1950's, however, did these concepts become central. Since then, increasingly sophisticated mathematical and statistical tools have been brought to bear on the problem of estimating the aggregate risk of a portfolio.

This risk depends crucially on the covariances of the returns of the individual components of the portfolio. Unfortunately, in practical situations, so many covariances come into play that it is impossible to obtain estimates directly from historical data. This difficulty has been addressed successfully through factor models, which substantially reduce the number of covariances that are needed.

We shall review the recent history of quantitative risk management and explain how factor risk models work. We then discuss a mathematical issue that arises in connection with building a 'total risk' factor model: one that spans many different markets and asset classes.