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EDHEC-Risk Institute Research Insights

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Research Insights

Introduction
Noël Amenc

It is my pleasure to introduce the Summer 2013 issue of the Research Insights supplement to IPE presented by EDHEC-Risk Institute. In this issue, we introduce a wide range of results from the ongoing research programmes at the institute that we consider to be of particular interest to institutional investors, with articles on topics ranging from equity and fixed-income allocation to infrastructure and hedge funds.

We begin with an analysis of the impact of the Solvency II Directive on the management of bonds, which is drawn from the Russell Investments Solvency II research chair at EDHEC-Risk Institute. The article responds to four questions that will be of particular interest to institutional investors: what are the defining bond characteristics of the solvency capital requirement? How adequate is the solvency capital requirement as a risk measure? How could Solvency II change the traditional approach to bond management? Will Solvency II give rise to a risk-return hierarchy and arbitrage opportunities between different types of fixed-rate bonds?

In research supported by Newedge within the Advanced Modelling for Alternative Investments research chair, we provide an academic analysis of the main techniques that are currently used by hedge fund managers and that could be transported to the mutual fund and alternative UCITS space in a straightforward manner, so as to provide better forms of risk management in a regulated environment. We also examine the convergence between the mainstream and the alternative asset management industry by studying UCITS and non-UCITS hedge funds.

Our research in the area of infrastructure investment, produced within separate research chairs at EDHEC-Risk Institute supported by NATIXIS on the one hand (debt infrastructure investment), and Meridiam Infrastructure and Campbell Lutyens on the other (equity infrastructure investment), has led to an article in this supplement on the definition of infrastructure investment within Solvency II that will be of particular relevance to institutional investors. Our researchers argue that project financing structures, as defined under Basel II, are much more relevant to the revision of the standard formula in Solvency II than the notion of 'infrastructure'. Project finance is a specific form of corporate governance designed to create the kind of long-term financial instruments that insurers actually want, but that are not currently represented in the Solvency II framework.

Looking at the future of pensions in East Asia, our researchers encourage the region's regulators to implement reforms to ensure that sufficient funds are channelled into retirement schemes and that these funds be exclusively managed towards post-retirement consumption objectives. In this research supported by AXA Investment Managers as part of the research chair on Regulation and Institutional Investment at EDHEC-Risk Institute, they also encourage financial service providers to bring adapted yet standardised and cost-effective investment solutions to the market.

We then draw on research that was conducted by EDHEC Risk Institute–Asia in Singapore to explore whether there is a single volatility factor that can explain a dominant fraction of changes in volatility levels across different regions and segments of the worldwide equity markets, or whether distinct regional volatility indices/products are needed for distinct regions in the world.

The EDHEC European ETF Survey 2012, produced with the support of Amundi ETF as part of the Core-Satellite and ETF Investment research chair at EDHEC-Risk Institute, reveals some interesting trends with regard to investor behaviour, investor perceptions and the general outlook for the ETF industry. Our results suggest that the ETF market is still growing and that it has potential for further growth. We observe increased levels of usage, satisfaction and demand for product development across a variety of asset classes

In the final article in this supplement, we compare the performance of mean-variance optimisation-based portfolios to that of the equal-weighted portfolio. We then investigate the performance of the equal-weighted portfolio relative to value- and price-weighted portfolios, and identify the reasons for the differences in performance. Finally, we study how an investor can achieve out-of-sample performance that is superior to that of the equal-weighted portfolio, even after adjusting for transaction costs.

We hope that the rich variety of articles in the supplement will give you much food for thought. We wish you an enjoyable and informative read and extend our thanks as ever to our friends at IPE for their collaboration on the supplement.

Noël Amenc, Professor of Finance, EDHEC Business School, and Director, EDHEC-Risk Institute

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The impact of Solvency II on bond management

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The insurance industry's new prudential regulation should come into effect in 2016 or 2017. By considering the majority of the risks faced by insurance companies, Solvency II seeks to encourage insurers to better manage and control all the risks they might face (underwriting risk, market risk, counterparty risk, operational risk). One of the major changes with Solvency II is the treatment of market risks. In exchange for complete liberty when choosing and allocating their assets, an intrinsic cost of capital is allocated to each asset (referred to as the solvency capital requirement – SCR). This is likely to structurally change the way in which insurers' assets are managed.

In recent research supported by Russell Investments as part of the Solvency II research chair at EDHEC-Risk Institute, we analysed the impact of Solvency II on insurers' bond management practices by attempting to answer four questions: (i) What are the defining bond characteristics of the SCR?; (ii) How adequate is SCR as a risk measure?; (iii) How could Solvency II change the traditional approach to bond management, using the three dimensions of return, volatility and value at risk?; (iv) Will Solvency II give rise to a risk-return hierarchy and arbitrage opportunities between different types of fixed-rate bonds?

Our study was based on a sample of 4,279 fixed-rate bonds, all sufficiently liquid, with fixed maturities and listed between 1999 and 2011 in 14 different countries (Europe, US, BRICS, PIIGS).

Which bond variables are regulatory capital requirements most sensitive to?

Solvency II uses a delta-normal method to calculate the prudential capital requirement (SCR), which often leads to an underestimation of the real value at risk. This drawback pushed us to conduct an SCR sensitivity study on different bond characteristics (coupon frequency, coupon rate, spread, duration, residual maturity, rating, and the ratios of redemption value/face value, clean price/redemption value and dirty price/redemption value)

Our findings show that it is possible for bond managers to assess bond SCR using only two variables (rating and residual maturity), rather than the nine initially identified above. These two variables alone account for 89% of SCR. Furthermore, our intertemporal study shed light on the fact that, for 68.8% of the bonds in our sample, the time variable explains more than 85% of bond SCR variations. This confirms that bond maturity is the main causal variable when it comes to variation in bond capital requirements.

Moreover, the real credit spread is not strongly correlated to the SCR level (32% using Spearman's rank correlation). This is due to the flat-rate treatment of spread risk in the standard Solvency II formula, which assigns a single risk factor to each rating and does not account for internal variances within a rating. Finally, we show that, due to the construction of the standard Solvency II formula, bonds rated BBB or lower could be neglected by investors that are subject to the new solvency standards, as a result of the additional marginal cost that could be considered excessive in proportion to the return generated. This would likely result in financing problems for companies issuing such bonds.

Is the regulator's chosen risk measure appropriate?

Based on the rolling annual returns of the bonds in our sample, we calculated the frequency with which historical bond losses exceeded regulatory capital requirements over the period studied (1999–2011). When looking at the sample in its entirety, we observe that SCR underestimates historical bond losses. The overall capital overrun rate for the period was 1.23%, while the regulator's target stood at 0.5%.

However, as we were still interested in capital overruns by geographic area, we observed that bond SCR for the Europe 1 zone (UK, France, Germany) was satisfactory, as the rate was only 0.51% between 1999 and 2011. It was during the 2007–09 period that substantial losses became apparent for this area (1.1%) and particularly for the UK (1.7%). The PIIGS zone suffered significant losses with an average capital overrun rate of 1% over the period. However, the majority of these losses are attributable to the 2009–11 period, which indicates that SCR overestimates risk for B and BBB ratings in the absence of a severe crisis. The BRICS zone exhibits similar behaviour. The capital overrun rate is six times higher than that of the regulator's target, but the threshold was only breached during the 2009–11 period (10.619%). During other periods, the rate was close to 0%, suggesting that capital requirements were overestimated for BBB-rated bonds. The US capital overrun rate is five times higher than that of the regulator's target, with notable high concentration during the periods 2001–03 and 2007–09.

"We observed that, in severe crisis periods, SCR underestimates losses for high-risk bonds while in non-crisis periods they are overestimated. For low-risk bonds, losses are in general more accurately estimated"

Analysing capital requirement overruns and the comparison of historical VaR to bond SCR by rating shows that, on average, bond losses increasingly exceeded the limits, the lower the credit quality (0.510% for a AAA rating and 6.185% for a rating of CCC of below). Once again, the general trend is confirmed – SCR underestimates bond losses.

Furthermore, a comparison between historical VaR and the regulatory measure (bond SCR) was conducted for the entire period. This comparison showed a tendency to underestimate SCR. This is particularly true for bonds with average and high risk profiles, while for those with low risk profiles (SCR below 10%), losses are slightly overstated. Given that significant disparities do exist depending on the period in question, we were keen to see the effects of the crisis on bond losses. So, we observed that, in severe crisis periods, SCR underestimates losses for high-risk bonds while in non-crisis periods they are overestimated. For low-risk bonds, losses are in general more accurately estimated.

An analysis by geographical area confirmed these trends. For the three zones – Europe 1, the US and PIIGS – we noted that during a crisis, high-risk bond losses were underestimated and low-risk bond losses were overestimated. The degree of over- and underestimation is certainly dependent on the zone in question.

Elsewhere, an analysis of the relationship between historical volatility and bond SCR shows that these two risk measures are strongly correlated, as are bond SCR and historical VaR. This means that there is no need for Solvency II to add a fourth dimension to bond management, which would be based on the triple return-volatility-VaR factor. On the contrary, it would be possible to manage fixed-rate debt instruments using the bond SCR-return pair alone. On the whole, we therefore conclude that bond SCR is an appropriate risk measure for fixed-rate bonds, which is highly correlated to the two traditional asset management measures – VaR and volatility.

Are there any preferred fixed-rate bond instruments or opportunities for arbitrage within the new Solvency II environment?

In order to determine whether Solvency II led to changes in bond preferences and provided arbitrage opportunities, we studied the behaviour of the return-risk pairs of fixed-income instruments – in other words, the bond return-SCR pair.

Using return-SCR pairs, it was possible to establish general trends of investment choices within the constraints of Solvency II. Risk-taking through an increase in duration was rewarded for SCR levels below a certain threshold, depending on the maturity and the inversion of the interest rate term structure. Beyond this threshold, only a ratings downgrade provided any reward for risk. Lastly, beyond a certain very high risk threshold (20%

for our sample), no risk-taking is rewarded under bond SCR. The calibration of the Solvency II standard formula for high-risk bonds produces an SCR risk measure. This is the case for long maturity investment grade and high-yield bonds. The regulator has defined a common method for the treatment of bonds regardless of the specific characteristics of each, including the ALM objective underlying investment grade bonds and the relatively high probability of default for high-yield bonds. Bond SCR cannot fully reflect the real risk (historical VaR) of these instruments, nor can it serve as an explanatory variable of returns for high levels of risk.

Solvency II regulation thus penalises holding bonds with low ratings and particularly long duration bonds, because capital requirements are high and returns do not compensate for additional risk taking. On this last point, ALM could thus be penalised in terms of cost of capital.

We also observed the return distribution functions for each SCR level. It appears that the deformation of the density function is consistent with the increased level of risk (bond SCR) – increasing the level of risk produces higher return at the cost of a more dispersed distribution. However, beyond a certain threshold, any additional risk-taking does not generate additional returns. For a bond SCR between 5% and 10%, the average maximum return is 7.18%. Beyond a 10% SCR, the average return decreases. When we compare the 99.5% VaR of historical returns to the SCR bond level, we find that from an average risk level of 5%, bond SCR underestimates the VaR.

We are also interested in the relationship between the Sharpe ratio and bond SCR so that we can identify the links between asset management with or without the Solvency II constraint. This link will enable asset managers to use their bond SCRs to determine the magnitude of their Sharpe ratios. We observe that the general trend of the Sharpe ratio is to decrease with an increasing bond SCR until it reaches a point of stagnation (third order polynomial function). This means that the increase in volatility is not offset by higher returns.

To further analyse investment choice trends, we looked at the efficiency of risk-taking instruments using the bond return/SCR ratio. The objective is to analyse whether risk taking is systematically rewarded. The analysis shows that efficiency decreases with increasing bond duration. So, regardless of credit rating, maximum efficiency is achieved for short durations (less than or equal to three over the 1999–2011 period), and thus for low levels of risk (SCRs between 0% and 15%). When we classify all bonds in our sample according to their risk-taking efficiency, it appears that the standard Solvency II formula tends to favour short-duration and particularly high-yield bonds, regardless of the shape of the interest rate term structure (except in cases of extreme steepening of the curve).

What are the improvements suggested for the prudential bond risk measure?

EIOPA should consider implementing an adjustment of bond SCR, which would incorporate the effects of macroeconomic cycles, as the equity dampener approach does. Moreover, a geographical analysis of the relationship between VaR and bond SCR produces highly heterogeneous results between the areas studied (Europe 1, PIIGS, US and BRICS). It could therefore also be useful for Solvency II to integrate these differences in geographical risk via an adjustment to SCR.

Additionally, high-risk bonds – such as long maturity investment grade bonds and high-yield bonds – generally meet insurers' specific needs (with the hope that they will deliver additional performance and with their contribution to the ALM objective, respectively). Their valuation is highly sensitive to the estimation of loss given default and relatively unresponsive to movements of the term structure of interest rates. In order to address this problem, long-maturity investment grade bonds subject to ALM should be treated based on EIOPA's chosen approach for equities backing ring-fenced pension liabilities. As for high-yield bonds, they should be assessed using a model in which default risk is paramount.

The research from which this article was drawn was supported by Russell Investments as part of the research chair on Solvency II at EDHEC-Risk Institute.

The aim of this research chair is to provide the investment industry with the latest academic analyses of the Solvency II Directive and to enable European insurance companies that do not have a full internal risk mitigation model to be able to avail of an objective academic reference in order to manage the risk of their equity investments.

The full version of the research is available on the EDHEC-Risk Institute website at the following address: www.edhec-risk.com/ALM/Russell_Research_Chair

An analysis of the convergence between mainstream and alternative asset management

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Recent research[1] conducted as part of the Advanced Modelling for Alternative Investments research chair at EDHEC-Risk Institute, supported by the Prime Brokerage Group at Newedge, had two objectives. The first was to provide an academic analysis of the main techniques that are currently used by hedge fund managers and that could be transported to the mutual fund and alternative UCITS space in a straightforward manner, so as to provide better forms of risk management in a regulated environment.

We categorise techniques according to three groups: risk management, alpha generation and leverage (see figure 1 on page 4). Within the group of risk management techniques, we review techniques based on derivatives, techniques based on dynamic trading strategies, volatility scaling of positions, risk measurement techniques, currency overlay and performance-enhancing compensation and incentive structures. In the context of alpha creation techniques, we discuss advanced econometric techniques for asset allocation, asset-specific betas and stock-picking, shareholder activism, order execution alpha and currency alpha. Finally, we show how leverage can act as a performance driver and distinguish financial leverage, construction leverage, instrument leverage, risk-parity techniques and value at risk techniques and leverage.

Alternative investment fund managers are increasingly deciding to implement alternative strategies through traditional investment vehicles such as mutual funds in order to access assets from retail and institutional investors that, for various reasons (such as investment mandates, for example), cannot invest through less regulated structures. Packaging hedge fund strategies in a traditional format is not straightforward and it raises a lot of challenges for the managers as well as for the UCITS brand. An important question is to know whether structuring hedge fund strategies through mutual funds will compromise these strategies and provide the same level of returns, considering the constraints under mutual fund regulations such as investment restrictions, liquidity requirements, opera- ►

1 Joenväärä, J. and R. Kosowski (February 2013). *An Analysis of the Convergence between Mainstream and Alternative Asset Management*. EDHEC-Risk Publication produced as part of the Newedge research chair on Advanced Modelling for Alternative Investments.

tional requirements and risk management. We therefore carefully examine how dynamic trading and derivatives strategies can be transported to the mutual fund space.

Our second objective was to examine the convergence between the mainstream and the alternative asset management industry by studying UCITS and non-UCITS hedge funds[2]. The latest amendment of the UCITS framework, referred to as UCITS III and IV, allows mainstream fund managers to supply regulated forms of hedge fund-type products to their traditional customer base, while also permitting hedge funds to reach out to the same customers[3]. We refer to the latter as UCITS hedge funds (UHFs) to distinguish them from traditional non-UCITS hedge funds (HFs)[4]. A recent Pertrac study found that alternative UCITS assets under management (AUM) peaked at €178.82bn in May 2011[5]. Alternative UCITS or UCITS hedge funds are funds that follow a hedge fund-type strategy aiming to generate absolute return or absolute performance. They are, in other words, simply UCITS that take advantage of certain investment techniques allowed by the UCITS regulations which enable them to pursue strategies that were previously more common in the alternative investment sector – in particular, the hedge fund sector.

Based on regulatory requirements that apply to UCITS, we economically motivate a range of hypotheses regarding differences in AUM growth, performance and risk between UHFs and HFs and empirically test them using one of the most comprehensive hedge fund databases constructed to date. We examine differences between UHFs and HFs based on a range of cross-sectional fund features such as investment objectives and other fund characteristics including compensation and redemption structures. Regulatory requirements that apply to UCITS imply that UHFs impose less binding share restrictions than HFs. Hence, UHF investors can exploit performance persistence, if any, more easily than HF investors. Our research sheds light on the convergence of mainstream and alternative investment management as well as drivers of performance and risk for different types of UCITS funds. This research is timely since UCITS funds, and in particular the so-called retailisation of complex products and the use of total return swaps, recently attracted the attention of regulators in 2012[6].

UCITS funds differ from hedge funds in several ways, which leads to testable hypotheses about differences in their performance and risk. First, the requirement of (i) a separate risk management function in UCITS funds as well as (ii) leverage limits and (iii) VaR limits leads to our first hypothesis that the risk of UHFs is lower than that of HFs. Measuring risk is a complex issue and therefore we apply a range of different risk metrics to capture tail-risk in addition to volatility (Patton [2009]). Second, UCITS funds face restrictions regarding the use of derivatives. This leads to two further hypotheses. Our second hypothesis is that restrictions in the use of derivatives reduce option-like payoff profiles and non-normal returns in UHF return distributions. Our third hypothesis is that reduced flexibility in the use of derivatives makes UHF returns less counter-cyclical than those of HFs. A fourth hypothesis is that the investment objective is crucial and that the extent to which UCITS restrictions affect risk and performance depends on the investment objective of the fund. We therefore carry out our hypotheses tests for all funds as well as by investment objective to distinguish, for example, long/short equity funds and global macro funds as well as event-driven funds. Previous studies of UHFs have typically focused on a smaller set of investment objectives (Darolles [2011]). Our fifth hypothesis is related to the fact that different countries have implemented the UCITS Directive in different ways, which implies that geography and in particular domicile matters for UHFs.

One of the main strengths of our research is that we examine the relationship between performance and risk of HFs and UHFs and a range of economically important fund characteristics related to fund manager incentives and fund liquidity which have not been previously examined in the context of UHFs. Liquidity is linked to fund performance in at least two important ways. First, liquidity, in terms of less binding redemption restrictions for UHFs investors, may allow them exploit performance persistence. On the one hand, Joenväärä, Kosowski and Tolonen (hereafter JKT [2012]) show that HF performance may hypothetically persist but investors' ability to exploit it is limited by strict share restrictions. Hence, the UHF universe provides an interesting setting to test whether performance persists and whether it can be exploited in practice. On the other hand, Teo (2011) provides evidence that capital outflows can be costly if HFs are exposed to liquidity risk. This suggests that liquidity may be harmful in certain circumstances. Thus, it is interesting to study the role of share restrictions and liquidity risk for UHFs.

Moreover, in terms of the time-series and number of funds in our data, our research is to our knowledge one of the most comprehensive analyses of the performance and risks of HFs and UHFs. Previous studies have typically analysed UHFs in isolation without comparing them to the HF universe or they have examined at most 460 UHFs and less than 2,800 HFs. First, we carry out a comprehensive aggregation process to construct an aggregate HF dataset that consists of more than 24,000 unique hedge funds that report at least 12 return observations. This database consists of active and inactive or defunct funds. This group of funds represents our HF control group. The number of hedge funds in our database is close to that reported by UBS's proprietary AIS database consisting of about 20,000 hedge funds and 45,000 share classes[7], while the PerTrac 2010 hedge fund database study finds that the hedge fund industry contains about 23,600 funds. Therefore, we believe that our aggregate database containing the union of five major databases is close to the true unobservable population of hedge funds.

Second, by merging data on UCITS funds from the EurekaHedge, BarclayHedge and HFR databases on UCITS hedge funds we also construct an aggregate database on UHFs. In our study we thus carry out a comprehensive analysis and comparison of both UHFs and HFs. Hedge fund databases are also non-overlapping – we find that almost 70%

1. Techniques that hedge funds use, with an assessment of whether this particular technique is transferable to UCITS funds

Technique	Sub-group	Transferable to UCITS
Risk management techniques (reduction of risk exposures and change in return distribution)	Techniques to change the fund return distribution by means of derivatives (futures, forwards, options, swaps and other derivatives)	Partly
	Techniques to change the fund return distribution by means of dynamic (option-like) trading strategies (portfolio insurance)	Partly
	Volatility scaling of positions	Yes
	Risk measurement techniques (VaR, EVT, advanced risk measures)	Yes
	Currency overlay	Yes
	Performance-enhancing compensation and incentive structures (high water marks, performance fees, clawback)	Partly
Alpha creation techniques	Advanced econometric and forecasting techniques for global tactical asset allocation	Yes
	Asset-specific bets and stock-picking	Yes
	Shareholder activism	Yes
	Order execution alpha	Partly
	Currency alpha	Yes
Leverage as performance driver	Financial leverage (borrowing leverage and/or notional leverage; prime broker funding)	Partly
	Construction leverage (shorting as a source of leverage)	Partly
	Instrument leverage	Partly
	Risk-parity techniques	Yes
	VaR techniques and leverage	Yes

"One of the main strengths of our research is that we examine the relationship between performance and risk of HFs and UHFs and a range of economically important fund characteristics related to fund manager incentives and fund liquidity which have not been previously examined in the context of UHFs"

2 The Undertakings for Collective Investment in Transferable Securities, Directives 2001/107/EC and 2001/108/EC (or UCITS) are a set of European Union directives that are designed to allow collective investment schemes to operate freely throughout the EU on the basis of a single authorisation from one member state.

3 See, for example, http://www.hedgefundintelligence.com/UCITS.

4 UCITS III-compliant hedge fund strategies are sometimes referred to as or Newcits or 'absolute' UCITS.

5 *The Coming of Age of Alternative UCITS Funds January 2012*, January 2012, Pertrac Research Study.

6 See, for example, ESMA's guidelines on ETFs and other UCITS issues, available at http://www.esma.europa.eu/system/files/2012-44_0.pdf.

7 See Güner, Rachev, Edelman and Fabozzi (2010). The AIS database includes funds that UBS allocated capital to, but that do not report to commercial databases.

of funds in our consolidated database report only to one of the major databases used. JKT (2012) recently documented that data biases are different between hedge fund databases, thus affecting stylised facts about performance and risk of HFs. This suggests that merging several databases will provide us with a more accurate view of the aggregate size of the UCITS hedge fund universe.

We document stylised facts about hedge fund performance, data biases and fund-specific characteristics explaining cross-sectional differences in UHF and HF performance. To understand why the performance results differ between UHFs and HFs, we start by highlighting how the total return and AUM time-series differ on a value and equal-weight basis between UHFs and HFs. We then move to differences in fees and risk-adjusted performance and study how Sharpe ratios (see figure 2), the Fung and Hsieh (2004) seven-factor model alphas and risk exposures differ between HFs and UHFs (see table 3).

Finally, we examine the cross-sectional relationship between fund characteristics and hedge fund performance. The existing literature on HFs has documented that managerial incentives, share restrictions and capacity constraints are associated with cross-sectional differences in hedge fund performance. Using portfolio sorts and the Fama and MacBeth (1973) regressions, JKT (2012) demonstrate that smaller and younger funds, and funds with greater capital flows deliver better future returns than their peers. This conclusion is in line with the previous literature (eg, Teo [2010] and Aggarwal and Jorion [2010]). In contrast to the existing literature, JKT (2012) find, however, that fund characteristics related to managerial discretion or illiquidity do not consistently explain hedge fund cross-sectional returns. In fact, they find very little evidence that share restrictions in the form of lockup, notice and redemption periods are related to higher risk-adjusted returns when they control for the role of other characteristics in multivariate regression. Given regulatory requirements on the liquidity of UHFs it is therefore of particular interest to study the relationship between UHF performance and fund liquidity.

In our empirical results, we find that UHFs underperform HFs on a total and risk-adjusted basis. However, UHFs have more favourable liquidity terms and when we compare liquidity matched groups of UHFs and HFs, we find that UHFs generate similar performance. Thus we uncovered an important liquidity-performance trade-off in the sample of UHFs. Our results also show that HFs have generally lower volatility and tail risk than UHFs, which is consistent with hurdles to the transportation of risk management techniques discussed. Finally we find important domicile effects related to firm and fund performance.

The research from which this article was drawn was supported by Newedge as part of the research chair on Advanced Modelling for Alternative Investments at EDHEC-Risk Institute.

The purpose of the chair is to expand the frontiers in alternative investment modelling techniques by enhancing the understanding of the dynamic and non-linear relationship between alternative investment returns and the returns on underlying fundamental systematic factors, and analysing the implications for managing portfolios that include alternative investments.

The full version of the research is available on the EDHEC-Risk Institute website at the following address: www.edhec-risk.com/multistyle_multiclass/Newedge_Research_Chair

2. Performance of alternative UCITS III and hedge funds

Panel A: Equal-weighted portfolio from January 2003 to June 2012

	Number of funds in portfolio			Performance measures				
UCITS	Mean	Min	Max	Mean	Std	Sharpe	CVaR	M Sharpe
No	6,979	4,530	8,200	7.23	7.65	0.94	5.34	1.35
Yes	266	46	589	7.81	13.63	0.57	10.00	0.78

Panel B: Value-weighted portfolio from January 2003 to June 2012

	Number of funds in portfolio			Performance measures				
UCITS	Mean	Min	Max	Mean	Std	Sharpe	CVaR	M Sharpe
No	5,607	3,000	6,655	6.19	6.62	0.94	4.15	1.49
Yes	164	21	492	7.99	13.46	0.59	9.77	0.82

Panel C: Benchmark portfolio from January 2003 to June 2012

	Mean	Std	Sharpe	CVaR	M Sharpe
Global equities	9.72	20.67	0.47	14.38	0.68
European equities	8.44	16.78	0.50	12.08	0.70
North American equities	7.94	15.84	0.50	10.89	0.73

Table 2 presents standard performance measures for alternative UCITS III and hedge funds. 'Number of funds in portfolio' refers to the number of funds in a given portfolio (mean, minimum and maximum). Mean represents the annualised average return of a specific portfolio. Std denotes the annualised standard deviation of a specific portfolio. Sharpe is defined as the annualised mean return of a portfolio divided by the standard deviation of portfolio. CVaR refers to empirical expected shortfall at 5% level. M Sharpe refers to modified Sharpe ratio defined as the annualised mean divided by expected shortfall.

3. Average risk-adjusted returns of alternative UCITS III and hedge funds

Panel A: Equal-weighted portfolio from January 2003 to June 2012

UCITS	Alpha	t-value	SP	SCLC	CGS10	Credspr	PTFSBD	PTSFX	PTFSCOM	RSQ
No	3.917	2.494	0.335	0.001	0.032	0.263	−0.004	0.016	0.007	0.689
Yes	0.943	0.327	0.642	−0.052	0.272	0.410	−0.011	0.026	0.014	0.669

Panel B: Value-weighted portfolio from January 2003 to June 2012

UCITS	Alpha	t-value	SP	SCLC	CGS10	Credspr	PTFSBD	PTSFX	PTFSCOM	RSQ
No	3.586	2.146	0.259	−0.054	0.051	0.229	−0.003	0.016	0.010	0.528
Yes	1.502	0.515	0.615	−0.104	0.201	0.419	−0.016	0.018	0.013	0.653

Table 3 presents average risk-adjusted returns and risk loadings. The risk is adjusted using the Fung and Hsieh (2004) seven-factor model. Alpha refers to the annualised intercept of the Fung and Hsieh (2004) model. T-value is the t-statistic of the Fung and Hsieh (2004) model's intercept. Risk loadings of the Fung and Hsieh (2004) model are obtained as the excess return of the S&P 500 index (SP), the return of the Russell 2000 index minus the return of the S&P 500 index (SCLC), the excess return

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Defining infrastructure investment under Solvency II

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European institutions have recently led several initiatives to delineate the future of long-term investment in the EU. In June 2013, the European Commission received the final responses to its Green Paper on long-term financing, which focuses on the role of financial intermediation to support economic growth in the EU. In May 2013, the European Insurance and Occupational Pensions Authority (EIOPA) concluded its consultation about the role of long-term investment in the Solvency II framework. Initiated at the request of the Commission, this consultation aimed to evaluate the need to revise the standard formula used to calculate solvency capital ratios, in order to better accommodate the investment of insurers' assets into long-term endeavours.

Both the Commission and EIOPA's work highlighted the absence of well-established definitions of long-term investment. For example, the EIOPA discussion paper earmarked a number of sectors of the economy representing a specific demand for long-term capital, including small and medium enterprises (SMEs), socially responsible investment (SRI) and infrastructure. In other words, sectors of the economy that are characterised by value creation, innovation, knowledge spill-overs and positive externalities.

The EU has plenty of capital and a highly-trained workforce but demographic trends also suggest that this workforce will soon start to shrink. Thus, focusing the debate on these investments that can further improve the productivity of factors is very relevant from the point of view of the European Commission. But is it relevant from the point of view of institutional investors?

Insurers' motives to provide long-term finance

Providing long-term finance to the real economy is not part of the mandate or mission statement of institutional investors, including insurance companies. In effect, such investors cannot be expected to have much interest in financing infrastructure or SMEs per se or in channelling funds into SRI for the sole purpose of being good corporate citizens.

Institutional investors are nevertheless increasingly attracted to such investments because of the risk factors to which they may provide exposure, and the extent to which increasing their exposure to these risk factors helps them achieve their own objectives.

In the case of infrastructure, as highlighted in EIOPA's discussion paper, these investments are unlisted at the underlying level. They are also characterised by a focus on cash flows rather than capital value or indeed collateral value, since, as we argued in a recent paper (Blanc-Brude [2013]) infrastructure investments are relationship-specific and have little or no value outside of the contractual framework that allows such long-term investments to take place.

The characteristics of these cash flows spring from a number of commitment mechanisms created by writing long-term contracts between the relevant parties to an infrastructure project, be they public or private.

Thus, infrastructure cash flows are expected to be stable because they have been defined long in advance. As a consequence they are also expected to be less correlated with the business cycle, or even to be indexed to inflation, if such indexation has been included in their contractual or regulatory set-up.

There are two main reasons why insurers and other institutional investors may wish to increase their exposure to instruments yielding such cash flows: the construction of liability-hedging or liability-matching portfolios, and the management of short-term regulatory constraints such as solvency or funding ratios.

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Instruments with a significant and well-defined duration, and yielding predictable cash flows, are instrumental in building liability-management portfolios, and long-term investments like infrastructure are one of the few alternatives to the bond market for such purposes.

Institutional investors are also typically required to maintain a solvency or funding ratio above a certain threshold, while applying market valuation principles to their assets. By investing a larger share of their long-term assets in unlisted instruments such as infrastructure debt or equity, they can reduce the impact of sharp market downturns affecting public markets.

Meeting long-term objectives while respecting short-term solvency constraints are the fundamental motives for insurers to acquire long-term, unlisted assets like infrastructure debt or equity.

Asset allocation and revising the standard formula

The Solvency II framework approaches the calculation of solvency capital requirements using building blocks representing a set of risk modules and submodules, the linear combination of which is known as the standard formula.

By focusing on broad categories of risk factors, the standard formula implicitly addresses the strategic asset allocation of a typical insurer. It follows that justifying a revision of the standard formula to accommodate long-term investment in general, and infrastructure investment in particular, first requires the demonstration that such investments are relevant as a matter of strategic asset allocation for a typical insurer.

Measuring the risk inherent in investing in long-term unlisted assets such as infrastructure debt or equity should be made with reference to a representative or 'well-diversified' basket of infrastructure assets. We may refer to an infrastructure beta for shorthand, even though we really mean gaining exposure to a series of risk factors, as argued above.

Three questions underpin the notion of an infrastructure beta:

- Does it exist? In other words, can the demonstration be made of the distinctive behaviour of baskets of such assets? Answering this question implies identifying what a well-diversified basket of infrastructure debt or equity might be.
- Is it accessible? How large is this basket and how can one become exposed to it?
- Is it relevant? Is there enough investable infrastructure in the world to be relevant at the strategic asset allocation level – ie, to invest at least a few percentage points of institutional investors' assets under management, estimated at $85trn in 2012.

These questions are gradually being answered by researchers but the focus is complicated by a degree of confusion as to what is relevant from the point of view of institutional investors and therefore from that of their regulator.

Defining long-term investment in infrastructure

Answering these questions first requires a definition of what we mean by 'investing in infrastructure'. Most publications on the subject highlight the fact that there is no widely accepted definition of infrastructure, which may or may not include such sectors as telecommunications, energy, oil and gas installations, as well as roads, schools and airports or even crematoria (see Kjorstad [2013], on this last point).

But as argued above, investing in infrastructure per se is not the primary motive of institutional investors. If instead, their focus is on investing in instruments yielding cash flows that have certain duration, return and risk characteristics, then the objective of the regulator should be to identify the relevant instruments and to decide how they should be treated within the Solvency II framework.

In its discussion paper, EIOPA correctly identifies that long-term investment in infrastructure may take the form of direct project

financing, or investing in such projects via equity or debt funds, or through debt securitisation vehicles. EIOPA also highlights the role of the 'look-through' principle under the Solvency II framework, according to which risk charges apply as if insurers had invested directly in the underlying assets used by funds or securitisation vehicles.

These three types of instruments are not found in equal measure today. Genuinely long-term, pass-through infrastructure equity funds seldom exist, since most 'infrastructure funds' have relatively short investment periods and typically use fund-level leverage (Blanc-Brude [2013]), while infrastructure debt funds and securitisation vehicles are still very new market developments that are yet to become widely available.

Thus, the limited relevance of indirect investment vehicles, combined with a focus on the nature of the underlying, mean that defining long-term investment in infrastructure boils down to defining direct project financing. Thankfully this has already been done in the context of the Basel II capital accord: "Project finance (PF) is a method of funding in which investors look primarily to the revenues generated by a single project, both as the source of repayment and as security for the exposure. In such transactions, investors are usually paid solely or almost exclusively out of the money generated by the contracts for the facility's output" (BIS [2005]).

We argue in a forthcoming paper (Blanc-Brude and Ismail [2013]) that project financing leads to the creation of several inter-related types of financial claims, splitting the total net operating cash flow of any given project between a senior, fixed-rate claim, and subordinated, fixed-rate and variable-rate claims.

If project finance senior debt is akin to a self-amortising bond paying a fixed rate of interest, project finance 'equity' has a known duration and is effectively the equivalent of a floating rate note issued by the special purpose entity, with a bullet repayment of the principal when the latter is dissolved at the end of a project's life.

Modifying the standard formula: towards a project finance submodule?

A focus on infrastructure or SMEs from the point of view of the Solvency II framework is less important than the question of the instruments used to finance these sectors and their role at the strategic asset allocation level for insurers.

Focusing on the financing of industrial sectors by insurers may not allow the development of a robust regulatory framework since real world infrastructure and other sectors may well be financed using new instruments with different characteristics in the future, making past calibrations irrelevant. A definition of long-term investment is not so much what is needed to revise the standard formula. Instead, the type of financial instruments which have recently drawn insurance companies to the infrastructure sector is what need to be identified and, if relevant, regulated.

In this perspective, we argue that the well-understood and documented project financing structures, as defined under Basel II, are much more relevant to the revision of the standard formula than the ill-defined and changing notion of 'infrastructure'. Indeed, project finance is a specific form of corporate governance designed to create the kind of long-term financial instruments that insurers actually want, but that are not currently represented in the Solvency II framework.

To conclude, project finance allows investors to gain specific exposure to risk factors and durations that are highly relevant to meet their own objectives. In so far as this exposure is distinct from the one embodied in other risk modules and sub-modules, we may refer to a project finance beta.

The existence of this distinctive effect, in turn, justifies revising the standard formula to integrate what the academic literature already recognises to be a specific type of financial instruments that is expected to behave neither like corporate debt nor corporate equity (see Blanc-Brude [2013]; Blanc-Brude and Ismail [2013], for a review).

Finally, from the perspective of public policy and the question of providing long-term financing to the real economy, project financing, as it is defined above, has provided the bulk of the financing to new investable infrastructure projects over the past three decades globally (Blanc-Brude [2013]). It is therefore the most relevant investment route from this perspective as well.

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The full versions of the research publications drawn from these chairs are available on the EDHEC-Risk Institute website at the following addresses: www.edhec-risk.com/multistyle_multiclass/Meridiam_Infrastructure_and_Campbell_Lutyens_Research_Chair; www.edhec-risk.com/multistyle_multiclass/Natixis_Research_Chair

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The future of pensions in East Asia: Is demography destiny or can asset management make a difference?

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Demographic trends, in particular the rapid ageing of East Asia, defined as Japan, South Korea, Taiwan, Hong Kong and mainland China, suggest a future of old age poverty and fiscal ruin with the seeming mathematical certainty of demographics. However, public pension reserves and vast household savings have the potential to become powerful tools to help avert these scourges, provided they are properly invested to achieve this end.

We make this argument in a new paper highlighting the need to develop investment solutions for East Asia's pension savings (Blanc-Brude et al [2013]) and produced as part of the Regulation and Institutional Investment research chair at EDHEC-Risk Institute, established in partnership with AXA Investment Managers. This paper reviews the state of funded pension systems in the region and documents the investment practices, governance and regulation of public pension reserve funds and of private defined-benefit and defined-contribution plans. Drawing from recognised industry and academic best practice, it also discusses potential improvements of these schemes.

Combining macro and micro-perspectives, we discuss among other issues the relevance of asset management (the micro-perspective) to minimise the impact of population ageing on the announced decline of living standards and concomitant fiscal collapse (the macro-perspective), and how a scientific approach to long-term investing may help deliver adequate ►

◄ post-retirement income for the region's fast ageing population.

Funded pension systems in East Asia: different levels of development

The paper's focus on North-East Asia and Greater China is warranted because the five jurisdictions reviewed exhibit relatively similar demographic and economic fundamentals but are at different stages in their development. Japan in particular, prefigures the demographic evolution of the rest of the region, but also provides a benchmark case for pension regulatory reform in a fast ageing economy that relied on exports and high investment to generate wealth.

Reviewing the different pension systems in existence in the region reveals that the largest pool of pension-related assets is made up of the reserves accumulated by public, pay-as-you-go pension systems when the aggregate contributions of a rapidly increasing workforce exceed the public pension benefits paid to a relatively small number of retirees.

The pace of demographic change (creating a larger workforce) and of economic development (higher labour productivity leading to higher wages) has resulted in the rapid growth of these surpluses in East Asia. But as demographic trends are reversed and marginal wage growth tails off, these reserves must eventually peak, as they did in Japan in 2004. Other countries in the region are still accumulating public pension reserves but, like Japan, which currently plans to have exhausted its reserves by the end of this century, they are expecting to eventually spend them down entirely.

Figure 1 illustrates the size of public pension reserves relative to GDP in comparison with private pension assets, defined as both defined-benefit (DB) and defined-contribution (DC) corporate, occupational and individual plans. Clearly, East Asia's public pension reserves are only 'large' because private pension assets are small by international standards (the OECD average is above 70%).

And while this may be expected in countries that did not have any funded pension plans until very recently (eg, mainland China), it is striking to observe that in Japan, which has had private pension plans since the 1960s, low levels of accumulation remain the norm.

Indeed, East Asia's private pension plans have historically been voluntary. Thus, asset growth in private plans, DB or DC, has typically tended to level off after an initial period of development[1]. Private accumulation has only been made mandatory very recently in Hong Kong (2000), Taiwan (2004) and South Korea (2011). Mainland China and Japan, the two largest economies in the region, still do not have mandatory private pensions.

Where are East Asia's pension assets?

Economies undergoing the initial stages of their demographic transition during which the number of producers (the workforce) increases faster than the number of consumers (the population) should experience an increase in their savings rate, as empirical research confirms to be the case in East Asia (Horioka and Terada-Hagiwara [2011]; Cole and Wright [1997]).

However, while we should also expect fast ageing populations to invest their increasingly large savings in dedicated post-retirement investment vehicles, such as voluntary pension schemes or individual retirement products, no such trend is visible in the region. The net financial assets of the household sector represent a relatively high proportion of GDP, but private pension assets have remained typically small in size, as figure 2 illustrates. Furthermore, an examination of the financial balance sheet of the household sector reveals that a very large proportion (between 50% and 70%) of savings are held in deposits and cash.

Even in Japan, by far the most advanced and financially sophisticated economy in the group studied, households make limited use of private retirement plans and have been holding more than half of their financial assets in cash since the 1970s.[2]

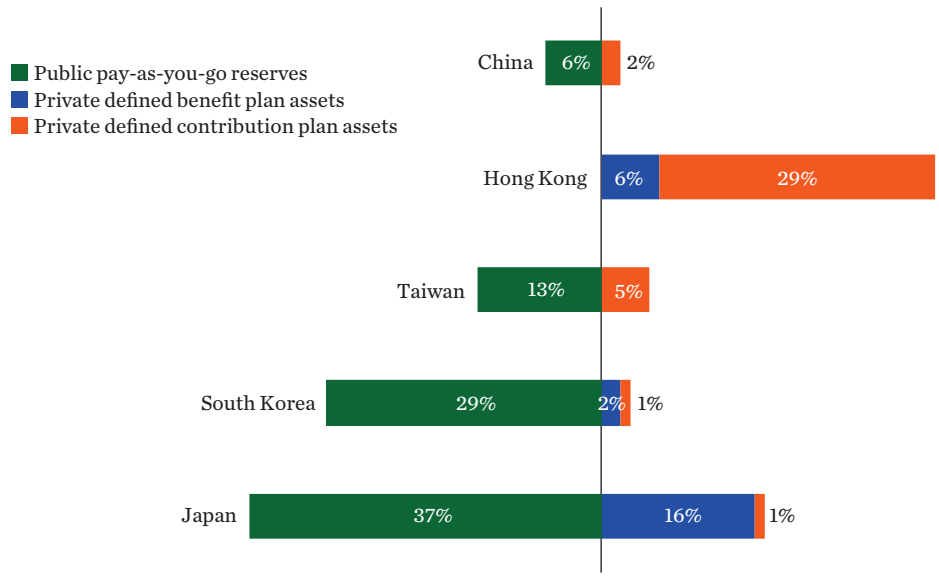
We suggest that one of the reasons for the under-development of retirement products in the context of a fast demographic transition, is that the demand for such products has remained muted because the size of intergenerational transfers currently masks the true cost of population ageing.

The cost of population ageing: why pension asset management matters for long-term fiscal sustainability

The life-cycle hypothesis, according to which individuals alternate periods of borrowing, saving and dis-saving to smooth their lifetime consumption profile, underpins most pension thinking and modelling. However, recent empirical research suggests a significant divergence from the behaviour implied by the life-cycle model.

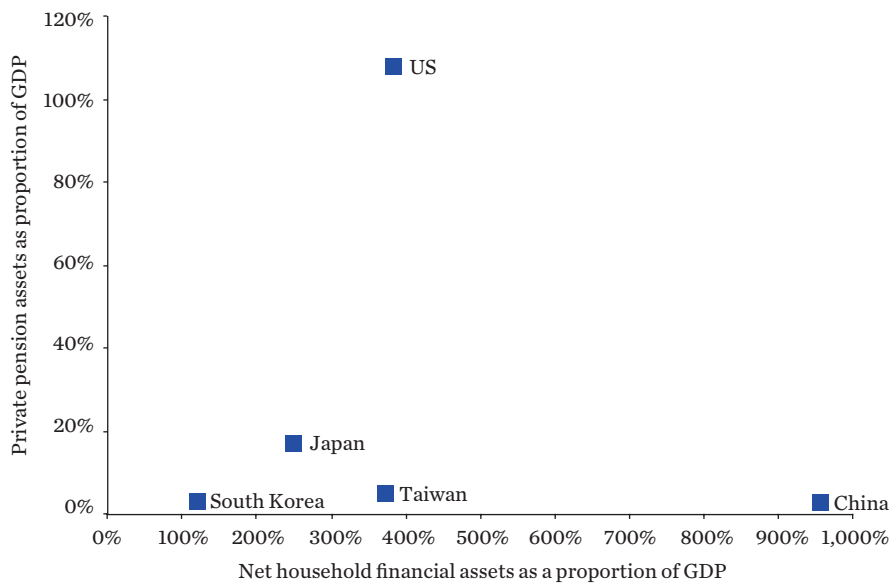
First, it is shown that, in East Asia, unlike the US for example, the oldest segment of society can afford to continue to accumulate (ie, have positive net savings) long after its retirement date and thus does not have to dis-save (see figure 3). Second, with population ageing, the cumulative (public and private) lifetime consumption profile of individuals is found to shift from a relatively smooth or flat profile, to one that is upward sloping as a function of age – ie, in ageing societies, retirees consume increasingly more than the workforce on a per capita basis if both public

1. Public and private pension assets in East Asia (% of GDP)



Source: Blanc-Brude et al (2013).

2. Private pension assets and net household assets (% of GDP)



Source: Flow of funds data, Blanc-Brude et al (2013); Gan (2012).

1 Low asset growth typically results from the combined effect of limited coverage, modest contributions and very conservative allocations.
2 The equivalent figure for US households is 16% in 2012 (source: US flow of funds data).

and private transfers are accounted for (see Lee and Mason [2011]; Ogawa et al [2011], for a detailed analysis).

In other words, the aggregate long-term liability of retirees and the workforce tends to grow dramatically with population ageing. However, the current generation of retirees has not been involved in financing the majority of what is effectively its long-term consumption objective. Thus, it has not had to invest its savings to meet such objectives, hence the absence of effective demand for retirement products designed to finance individuals' life-cycle.

Using data from the National Transfer Accounts (NTA) project covering 23 countries with a range of inter-generational transfer systems and per-capita wealth (see Lee and Mason [2011]), we show that the 'life-cycle deficit' (the difference between consumption and labour income) of the young and elderly grows three times as fast as the 'life-cycle surplus' of the workforce, when expressed as a function of GDP per capita, as illustrated on figure 4.

At the aggregate level and in any given year, the life-cycle deficit of a population must, as a matter of accounting identity, equal its life-cycle surplus, plus any income from financial assets (public or private), minus any new savings, plus any new (public or private) debt.

If life-cycle deficits are set to increase three times as fast as life-cycle surpluses and domestic savings already are at historic highs (eg, 50% of GDP in China), then for the NTA flow identity to hold, either the income from financial assets must play a significant role in meeting this liability or (public) debt must increase significantly.

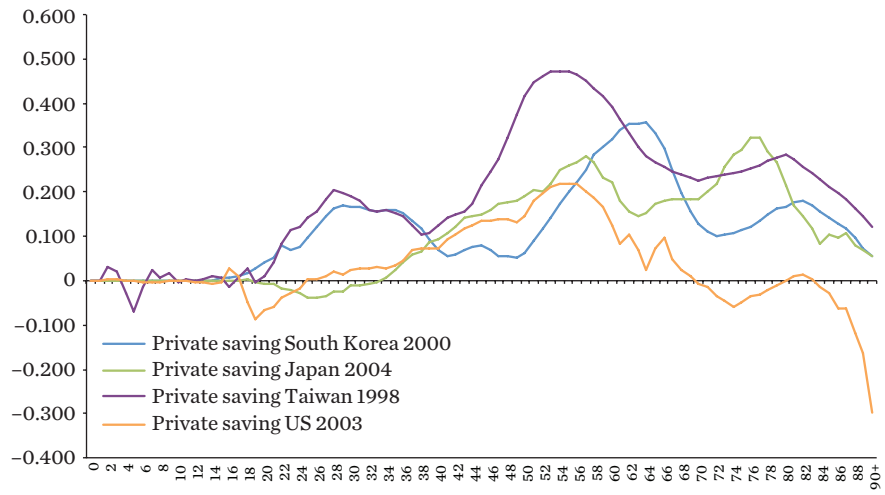
This last point highlights the relevance of implementing micro-approaches, which offer to design investment solutions maximising the likelihood of meeting a given objective function while respecting a set of constraints, for financial and fiscal stability at the macro-economic level.

One may argue that the current state of public indebtedness of the Japanese economy, a significant part of which is the result of the cost of population ageing on public pension and healthcare programmes, is also the result of the absence of proper management of the country's gigantic pension reserves. In other words, rather than solely being the outcome of it demographic destiny, Japan's current fiscal state also results from the failure to manage its pension reserves to meet a complex and dynamic long-term liability.

NTA data highlights the fact that funded pension systems provide a way to formalise an intergenerational debt which exists anyway and grows seemingly continuously as societies develop and undergo their demographic transition. Whether this debt is public or private and is met through funded pension schemes, other financial and real assets, public transfers financed by taxing the workforce, private (familial) transfers or new (public) debt issuance, does not fundamentally change the nature or dynamics of this liability.

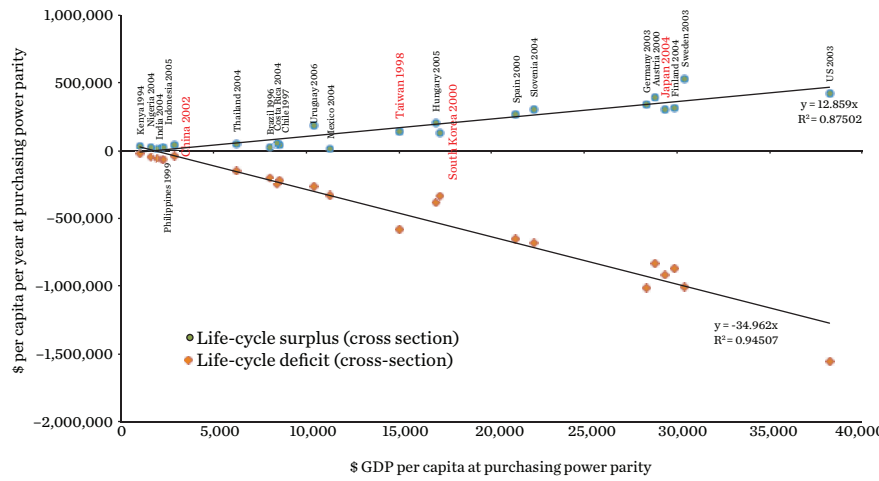
However, we know that public and private savings can be invested to maximise the likelihood of meeting long-term liabilities at the horizons of choice, while managing risks and respecting short-term constraints with respect to risk aversion for example. Pension funds and retirement products, when they are properly designed, essentially exist to play this role of intermediating short-term savings towards meeting long-term consumption objectives.

3. Per capita private savings flows, normalised by the average of labour income for individuals between 30 and 49 years of age, relevant years



Source: Lee and Mason (2011).

4. Per capita life-cycle deficits and surpluses of 23 countries as a function of GDP per capita, $ at purchasing power parity in relevant years



Source: Blanc-Brude et al (2013).

Supply-side pension economics: East-Asia's pension plans should offer post-retirement investment solutions

If the demand for life-cycle investment products has remained muted because the current generation of retirees has had no direct need for them, the limited supply of adequate retirement products in East Asia may also explain why the region's household savings are not being invested to generate post-retirement income streams.

Thus, even when corporate or occupational plans have been made mandatory, incentives for employers or employees to contribute more than the required minimum are often lacking or insufficient.

Crucially, the immense majority of such plans are avatars of the age-old retirement allowance system, which is still in existence in the region – ie, they only pay a lump sum when employees leave their position or retire but fail to provide any post-retirement income.

East Asia's private DB schemes for example are crude forms of 'hybrid' plans, sharing risk between plan sponsors and members, since the former are not exposed to longevity or indexation risk post-retirement of the latter.

DC plans are also deficient: instead of coming with default options that would channel member funds into adequate retirement solutions, they typically offer a dazzling variety of investment products. Thus, where DC plan members can choose investment options, as is the case in Hong Kong or Korea, they may keep assets in cash or equivalent (eg, Korea) or, on the contrary, pursue short-term speculative objectives by investing in substantial equity positions (eg, Hong Kong). Whether this behaviour results from domestic savings cultures or reflect the biases in offerings and their presentation, they are not adapted to meeting long-term consumption objectives.

Target-date funds, when they are available, are only one of many options for DC plan members and, above all, are not designed properly: they are blind to members' differences in risk tolerance other than those related to the investment horizon and their deterministic glide paths fail to take into account the dynamic nature of long-term liabilities or the role of market conditions in the evolution of the plan's asset allocation. ►

◄ The current situation needs to change urgently. A substantial share of East Asia's savings needs to be used to maximise the likelihood of meeting long-term public and private consumption objectives.

Pension reserves provide a unique opportunity to support the public pension systems and minimise the impact of population ageing. Private pension schemes must be developed and optimised and voluntary contributions into these schemes and adequate individual retirement solutions must be incentivised.

EDHEC-Risk Institute has devoted significant attention to advancing techniques for the management of pension schemes and the design of retirement solutions (see for example Amenc et al [2010], Martellini and Milhau [2011]; Martellini et al [2012]; Deguest et al [2013]). Some of these ideas are already at work in retirement schemes around the world.

For funded pension systems to deliver levels of wealth in real terms that are commensurate with post-retirement consumption objectives, this literature highlights three fundamental dimensions of pension solutions:

➔ Pensions are long-term liabilities, which are in fact dynamic and depend on several time-varying factors. Pension solutions should therefore be designed in order to maximise the likelihood of meeting those liabilities at the horizon.

➔ As they approach retirement, plan members should be exposed to less risk. The strategy, notably the amount of risk taking, should be dynamic depending on the current wealth and future expected performance, and should explicitly consider the investment horizon.

➔ Such a strategy also needs to be implemented while managing risk levels: along with long-term risk tolerance, there need to be short-term constraints too, which take into account the existence of a sponsor when there is one. These constraints can either be self-imposed (eg, maximum drawdown) or defined by the regulator (eg, funding ratio).

This approach can be applied to public and private, centralised and decentralised systems – importantly, EDHEC-Risk Institute research has demonstrated that it can be mass-customised in a parsimonious manner to adequately serve the diverse needs of a wide range of retail investors or scheme members without giving up the benefits of pooling (see Martellini and Milhau [2010]).

In the case of public savings, the need to turn reserve funds into policy instruments dedicated to solving the pension crisis requires implementing all three dimensions highlighted above. Regulators should also ensure that mandatory and incentivised voluntary private schemes adopt state-of-the-art techniques for pension management and retirement provision.

In the case of individual DC accounts in particular, the regulator has a responsibility to highlight the type of products that can help individuals meet their post-retirement objectives, thus creating incentives for financial providers to offer such solutions instead of run-of-the-mill investment products, which can only be regarded as relevant in the context of retirement if individual investors are assumed to have the resources to treat them as building blocks to be assembled and dynamically rebalanced over time in reaction to changes in liability and asset risks and variations in their long-term and short-term risk tolerance. This is highly unrealistic, as the behavioural finance literature documents extensively (see Blake [2006], for a review).

Today, the onus is on East Asia's regulators to implement the reforms to ensure that sufficient funds are channelled into retirement schemes and that these funds be exclusively managed to post-retirement consumption objectives, and on financial service providers to bring adapted but standardised and cost-effective investment solutions to the market.

The research from which this article was drawn was supported by AXA Investment Managers as part of the research chair on Regulation and Institutional Investment at EDHEC-Risk Institute.

The chair investigates the interaction between regulation and institutional investment management and highlights the challenges of regulatory developments for institutional investment managers.

The full version of the research is available on the EDHEC-Risk Institute website at the following address: www.edhec-risk.com/ALM/AXAIM_Research_Chair

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Implications of regional volatility factors for asset management

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Stock market volatility is an important input to asset allocation and risk management. With the increase in stock market uncertainty and the recent financial crises, there has been a growing interest in volatility both as a sentiment indicator and also as an asset class. Both applications implicitly or explicitly rely on the empirical relationship between volatility and equity returns, which is that of negative correlation.

There are two widely accepted theoretical explanations for the negative correlation between equity volatility and equity returns which indicates that the empirical relationship is persistent – the leverage effect (see Black [1976]) and the volatility feedback effect (see Poterba and Summers [1986]). The leverage effect hypothesises that a market downturn increases the leverage of the firm and thus the risk of the stock. While the volatility feedback effect assumes that the volatility is incorporated in the stock prices, a positive volatility shock would increase the future required return on stock and stock prices are expected to fall simultaneously.

From an investor perspective, the negative correlation presents hedging and diversification opportunities if volatility is regarded as an asset class. In addition, negative correlation and high volatility are particularly pronounced in stock market downturns, offering protection against stock market losses when it is most needed and when other forms of diversification do not provide very effective exposure (see, for example, Szado [2009]).

Given the need for investors in different regions to obtain downside protection, one question of practical importance is whether there is a single volatility factor that can explain a dominant fraction of changes in volatility levels across different regions and segments of the worldwide equity markets, or whether distinct regional volatility indices/products are needed for distinct regions in the world. Empiri-

cal research based on parametric volatility models supports the case of country-specific or regional-specific volatility factors unless changes in volatility are caused by a global crisis with a significant volatility spill-over from developed to emerging markets. The existence of local volatility factors is also supported by model-free volatility indicators including cross-sectional, realised, option-implied volatility indicators (see Loh, Martellini, and Stoyanov [2013] and the references therein).

In this article, we summarise the practical implications of the presence of local volatility factors for asset management by focusing both on volatility as an asset class and also on a more subtle possible application of volatility indicators in the construction of target volatility strategies, which does not necessarily require investability of volatility. While the first point explicitly relies on the empirical properties of volatility, the second is deeply rooted in dynamic portfolio theory.

Regional volatility indicators and target volatility strategies

Target volatility strategies are by definition dynamic portfolios with constant volatility equal to a given target level. A simple example is a portfolio with a risky asset (eg, a market index) and a riskless asset (eg, cash or a treasury bond); the investment in the risky asset is inversely proportional to the forecasted volatility of the asset. Empirically, it has been demonstrated that target volatility strategies generate better risk-adjusted returns (see Giese [2012] and Hallenbach [2012]). This can be explained intuitively through the properties of high and low volatility markets – the former are declining and structurally unstable while the latter are usually bullish and accompanied by positive views on the economy. Finally, from the standpoint of long-term investors, the academic literature demonstrates that target volatility strategies can be used as a building block in optimal long-term portfolios, which provides conceptual justification irrespective of the empirics (see Merton [1969, 1971]).

A question of practical importance is what measure of volatility to use in the construction of the target volatility fund. It has been shown (Hallenbach [2012]) that the quality of the improvement in the Sharpe ratio of the target volatility fund depends on the quality of the volatility forecast which can be based on backward- or forward-looking volatility measures. The presence of local equity volatility factors detectable basically through all common methods of volatility estimation implies that a volatility proxy can be selected conditional on the equity exposure. From an empirical perspective, apart from an improved Sharpe ratio and the explicit control of volatility, the benefits of target volatility portfolios also include reduced extreme risk and better upside potential due to the reduced leptokurtosis and improved skewness originally present exactly because of the stochastic nature of volatility (see Stoyanov [2011]). Using an inappropriate volatility proxy would reduce these benefits.

Regional volatility as an asset class

Rather than using a volatility indicator as a determinant of the exposure to the assets providing risk premia in a target volatility fund, investors can gain direct exposure to volatility or variance in order to hedge or diversify an existing equity exposure.

A common way to gain pure exposure to implied volatility is through the volatility futures market and the most popular index is the 30-day implied volatility of the S&P 500 pioneered by CBOE, the VIX index, which is often referred to as the default volatility indicator on a global basis. Since versions of the CBOE methodology have been adopted for other markets in Europe and Asia, we can assess the hedging efficiency of a given volatility exposure conditional on the type of the existing equity exposure and verify if the US implied volatility can indeed be regarded as a global volatility factor.

To check whether an exposure to VIX is a better hedge than an exposure to a local implied volatility indicator, Loh, Martellini, and Stoyanov (2013) regress the market returns on the changes in VIX and the local volatility index on a stand-alone basis and also together for all markets that have their own volatility indicator. A summary of the empirical results for the full sample is provided in figure 1. The explanatory power of the local implied volatility is higher than that of VIX on a stand-alone basis and also the VIX betas are smaller in absolute value, which implies higher hedging efficiency on a stand-alone basis. The bivariate regressions show lower VIX betas than the betas of the local volatilities, implying a smaller incremental hedging benefit of an exposure to US volatility added to an existing exposure to the corresponding local volatility.

These conclusions are stronger for Asian equity exposures than European ones and are less pronounced, although still valid, during US recessions, and also during the financial crisis of 2008. The same conclusion holds for realised and cross-sectional volatility, although the statistical relationship is weaker (see Loh, Martellini, and Stoyanov [2013]).

From a practical perspective, the exposure to option-implied volatility can be implemented through the volatility derivatives market – through volatility futures or volatility options. Volatility futures and options have been available for VIX since 2004 and 2006 respectively, and for VSTOXX, the implied volatility of the EURO STOXX 50 index, since 2009 and 2010 respectively. Volatility futures were launched in Asia in February 2012 on VHSI and VNIKKEI, the implied volatilities of the Hang Seng and Nikkei 225. The liquidity of the Asian volatility futures is, however, very limited compared to the VIX and VSTOXX futures.

The better hedging benefits of a local implied volatility exposure imply that there is room for further development of local volatility products. In cases where the equity markets are significantly integrated, developing a regional volatility derivative market rather than many local ones could be a way to improve liquidity and bring down the cost of implementing the exposure while preserving most of the hedging benefits. While this certainly holds for the eurozone and is a case more difficult to make for Asia, it is nevertheless possible to consider one implied volatility index as a proxy for hedging an equity exposure to a market that has no local implied volatility indicator.

"In cases where the equity markets are significantly integrated, developing a regional volatility derivative market rather than many local ones could be a way to improve liquidity and bring down the cost of implementing the exposure while preserving most of the hedging benefits"

1. Fitted betas and adjusted R^2 statistics for a linear model in which the market return is regressed on to the change of the corresponding volatility indicator

	Change in local volatility	Change in US volatility	Adjusted R^2	Change in local volatility	Change in US volatility	Adjusted R^2	
France	−0.4985*	–	0.3571	−0.8756*	–	0.6034	Germany
	–	−0.4329*	0.2398	–	−0.4624*	0.2542	
	−0.3973*	−0.2597*	0.4290	−0.8258*	−0.0732*	0.6078	
Netherlands	−0.6746*	–	0.5222	−0.5289*	–	0.2680	Switzerland
	–	−0.4259*	0.2310	–	−0.2916*	0.1520	
	−0.5989*	−0.1443*	0.5417	−0.4342*	−0.1657*	0.310	
Hong Kong	−0.5964*	–	0.3926	−0.5842*	–	0.5654	UK
	–	−0.3218*	0.1260	–	−0.3515*	0.2300	
	−0.5478*	0.0989*	0.3896	−0.5293*	−0.1070*	0.5815	
South Korea	−0.5557*	–	0.4351	−0.4604*	–	0.4074	Japan
	–	−0.2885*	0.0891	–	−0.3269*	0.1710	
	−0.5542*	−0.0394*	0.4425	−0.4123*	−0.1405*	0.4222	

The models are estimated using daily data from 1 January 2000 to 1 July 2012, with the exception of South Korea for which the starting date is 1 January 2003. The symbol * denotes statistical significance at the 5% level (see Loh, Martellini, and Stoyanov [2013] for further details). In the regressions for the countries in Asia, the change in US volatility is lagged to reflect the difference in trading hours.

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The principal conclusions of the European ETF Survey 2012

Noël Amenc, Professor of Finance, EDHEC Business School, Director, EDHEC-Risk Institute;
Felix Goltz, Head of Applied Research, EDHEC-Risk Institute

EDHEC-Risk Institute has conducted a regular survey of exchange-trade fund (ETF) investors since 2006, thus allowing us to compare the results of our 2012 survey, supported by Amundi ETF as part of the Core-Satellite and ETF Investment research chair at EDHEC-Risk Institute, to previous results. This analysis shows that many long-term trends from previous results are confirmed, but there are also important changes in investor perceptions of specific issues. In this article, we first look at the main findings that are in line with long-term trends, before turning to an analysis of recent changes.

Continuing growth in the ETF market

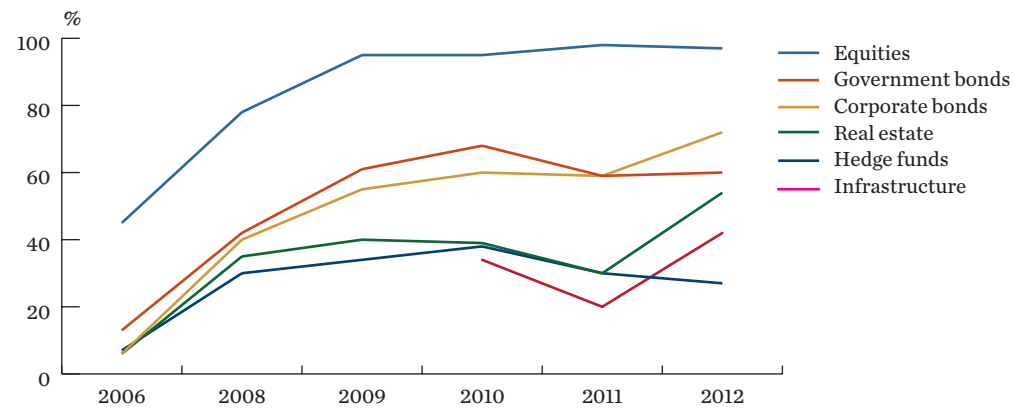
In 2011, we reported that the ETF market was maturing as ETF usage was no longer growing at previously seen rates and had begun to stabilise across most asset classes. This year we can see that, whilst this trend has persisted for certain asset classes, product development within other asset classes has driven significant increases in ETF usage. Figure 1 illustrates significant increases in rates of ETF usage in 2012 within corporate bonds, real estate and infrastructure.

The increased usage of infrastructure ETFs seems likely due to an increase in the range of ETF products available to infrastructure investors. This may be due to the recent emergence of more 'specialised' infrastructure ETF products. For instance, investors are now able to gain infrastructure exposure to individual geographic regions through ETFs, whereas previously ETFs could only provide 'global' infrastructure exposure.

"Investors are now able to gain infrastructure exposure to individual geographic regions through ETFs, whereas previously ETFs could only provide 'global' infrastructure exposure"

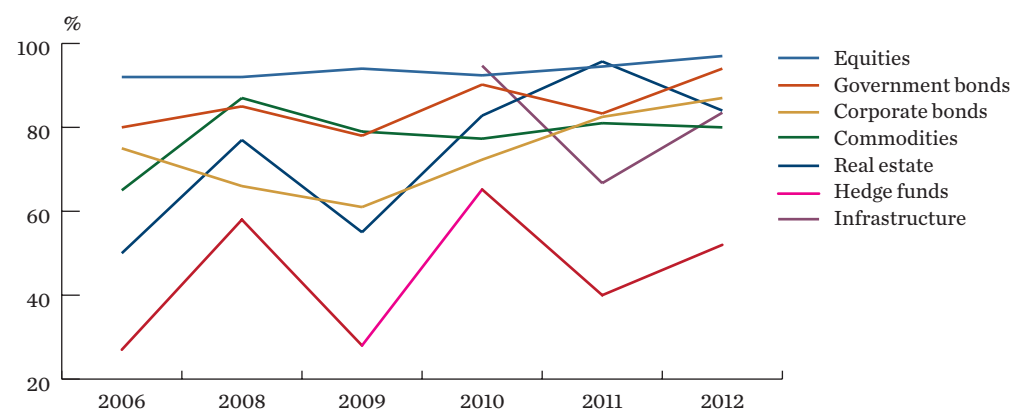
The increase in the use of corporate bond ETFs may be linked to the increasing interest of investors in passive products for their bond investments. This increasing interest in bond indexing has been paralleled by an increase in the availability of alternative bond index weighting schemes (to traditional market value of debt weighting) and an increase in the variety of ETFs. The broader availability of bond ETFs may allow investors to choose an ETF more closely suited to their risk preferences (see also Rachidy and Goltz [2012]). Hence it would seem that continuing innovation of the offering within the industry is a facilitator of increased usage of ETFs within certain asset classes.

1. Use of ETFs or ETF-like products over time



This figure indicates the use of ETFs or ETF-like products for different asset classes over time. The percentages are based on the results of EDHEC ETF survey 2006, 2008 to 2011.

2. Satisfaction with ETFs or ETF-like products over time



This figure indicates the percentages of respondents that are satisfied with ETFs or ETF-like products for different asset classes over time. The percentages are based on the results of EDHEC ETF survey 2006, 2008 to 2011.

High satisfaction with ETFs

Satisfaction with ETFs has remained at high levels across most asset classes as shown in figure 2.

There have been increases in satisfaction for government bond, corporate bond and infrastructure ETFs. This may also be linked to the fact that there has been an increase in product variety over recent years for these asset classes resulting in a product offering that is more likely to satisfy investor requirements.

Of all asset classes, satisfaction with equity ETFs has been the highest and the most consistent over the last six surveys. Aside from the fact that product variety is greatest for equity ETFs, another reason for the consistently high satisfaction rates within equities may be the fact that they have the longest history, hence investors are most familiar with their advantages and their drawbacks. This could also be related to the highly liquid nature of the underlying equity asset class compared to other types of ETFs. Indeed, we can see from figure 2 that satisfaction rates for ETFs based on the most liquid ETF asset classes are far more consistent than those based on illiquid asset classes. For instance, hedge fund ETFs (respectively, real estate ETFs) have exhibited variations ►

in satisfaction rates between 30% and 65% (respectively, between 50% and 95%) over the last six surveys. In contrast, we can see that equity and government bond ETF satisfaction rates have been consistently in the region of 90% and 80%, respectively. This may be due to the fact that two of the key attractions of ETFs are their liquidity and efficient pricing, both of which are determined by the liquidity of the underlying assets.

Continued demand for new product development

Figure 3 ranks the different ETF product types in order of descending demand for future product development from investors in our 2012 survey.

There are three main areas of ETF products where investors see a need for further product development. First, we can see that the area of most interest to respondents is the emerging market equities segment with 49% of respondents wanting to see further product development in this asset class. It is interesting to note that investors still require more product development in this area despite the fact that existing products in this segment have seen important inflows with approximately a five-fold increase of inflows in 2012 over 2011.

Second, there is strong interest from investors for further product development in the area of high yielding fixed income assets, such as emerging market bonds, corporate bonds and high yield bonds. Our findings are paralleled by reports showing that, whilst all segments of the fixed-income ETP sector have grown in terms of assets in 2012, particularly pronounced increases have been within high yield fixed income subsectors such as high yield corporate bonds ($11bn increase) and emerging market debt ($5bn increase).

Third, we can see that there is strong interest amongst investors for development of ETFs based on new forms of indices, with 37% of investors interested in further product development in this area despite the fact that there have recently been a significant number of ETF launches, which track new forms of indices (also known as smart beta).

Overall, the answers of survey participants on their wishes for future product development suggest that despite the broad range of available ETF products, investors still show demand for more product development to better address their specific needs.

Increased number of ETF trading counterparties

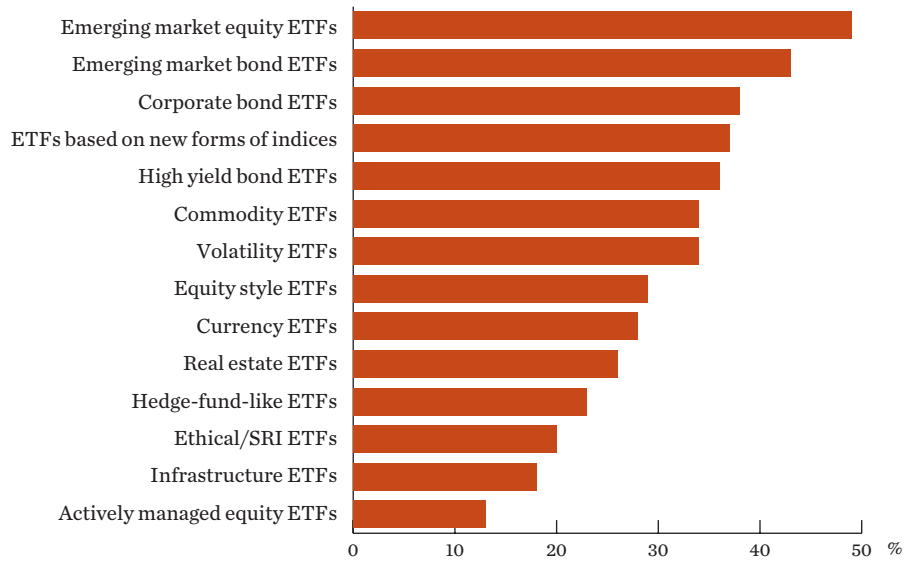
The results of our survey reveal that investors are taking action to mitigate the risk associated with trading their ETFs. Figure 4 illustrates the average number of ETF counterparties that our respondents trade with. We can see that there is a clear upward trend over the past four years and that the average number of ETF trading counterparties per respondent has steadily increased from 2.9 to 4.1 between 2009 and 2012.

After having outlined the main results concerning the use and satisfaction with ETFs, we now turn to a summary of the results that highlight recent changes in investor perceptions.

Blurring of the line between active and passive fund management

An interesting and consistent trend in this year's survey was increased interest in actively managed ETFs, where we saw an increase in levels of interest across all relevant questions that we asked. For example, figure 5 shows us that in 2012, 17% of respondents were of

3. What type of ETF products would you like to see developed further in the future?



This figure indicates how many respondents would like to see further development in the future for different ETF products. Respondents are able to choose more than one product.

4. Number of ETF trading counterparties used by respondents

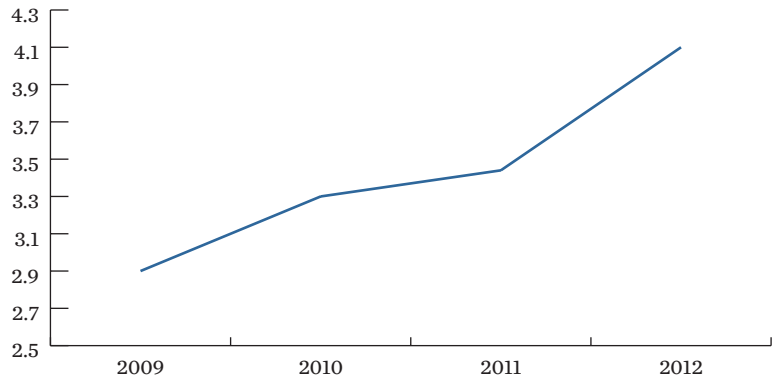
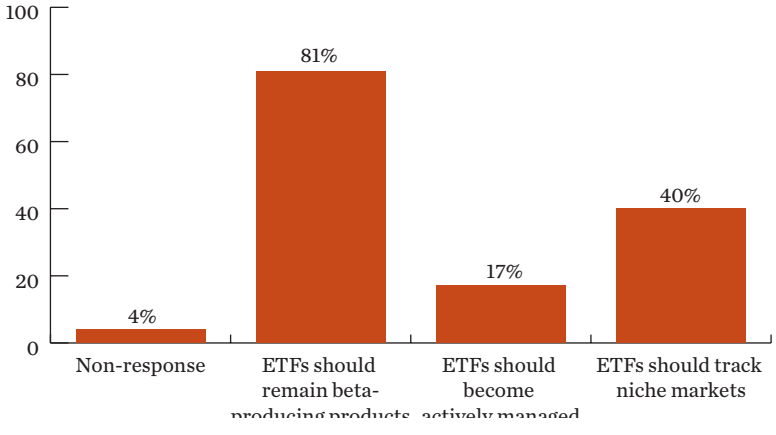


Figure 4 shows the average number of ETF trading counterparties per respondent as indicated by the respondents of our survey.

5. Respondent preferences for investment philosophy of ETFs



This figure indicates the distribution of different areas which are the possible directions for development of ETFs. Non-responses are reported as 'no answer' so that the percentages for all categories add up to 100%.

the opinion that ETFs should become actively managed, which is an increase from just 11% in 2011. Similarly, other results show an increase in the percentage of respondents who prefer either 'active' or 'active and passive' ETFs.

The increased interest in actively managed ETFs may be related to the increased levels of disclosure and transparency which are being imposed on actively managed ETFs by the new 2012 European Securities and Markets Authority (ESMA) Guidelines aimed at increasing investor protection. Specifically, the guidelines require actively managed ETFs to clearly inform investors that they are actively managed and to disclose how they will meet their stated investment policies including, where applicable, the intention to outperform an index.

However, we think that there is also a possible blurring of the distinction between what is considered an active or passive product, which is at least partially responsible for this increased interest. In particular, this may be due to the emergence of strategy indices and

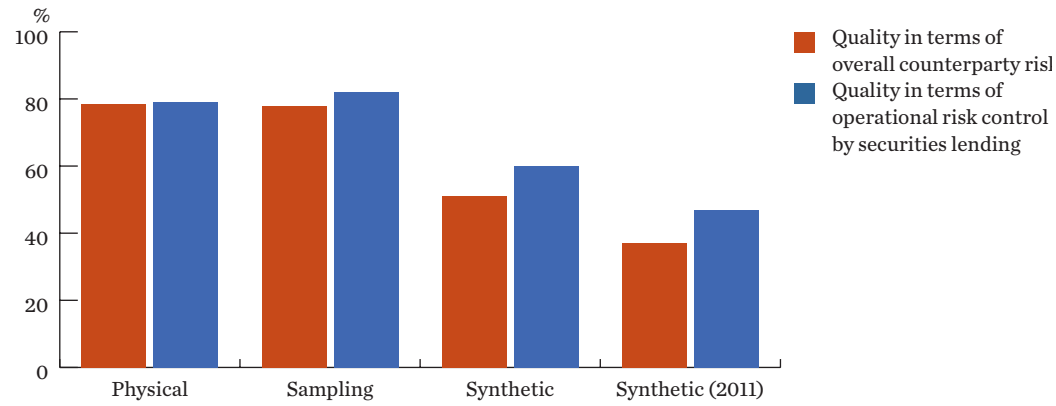
"The answers of survey participants on their wishes for future product development suggest that despite the broad range of available ETF products, investors still show demand for more product development to better address their specific needs"

smart beta ETFs based on alternative and increasingly sophisticated index construction methods (with regard to both stock weighting and selection), compared to traditional cap-weighted indices. This results in indices with different compositions and risk profiles to cap-weighted indices, hence investing in them may not be considered passive in the sense of buying and holding market representation. However, they are still passive in the sense that they follow a set of systematic and transparent rules as opposed to a discretion-based and opaque active management process.

Hence, ETFs that track strategy indices can be seen as passive in the sense of absence of discretion or as active in the sense of moving away from a buy-and-hold strategy (cap-weighting). That many respondents were referring to ETFs on strategy indices when they indicated interest in actively managed ETFs was confirmed when we contacted those respondents who expressed an interest in actively managed ETFs to investigate what the cause of the increased interest in actively managed ETFs was. The respondents were asked if, in their interpretation, an actively managed ETF was one that involved discretion within the investment process. We found that in the majority of cases respondents were not interested in ETFs involving discretionary decision making by a manager, but instead stated that they were expressing an interest in ETFs based on alternatively weighted indices that should follow a systematic approach to their construction.

Hence it seems that there are differing interpretations amongst our respondents as to

6. Comparison of replication methods in terms of perception of counterparty and operational risks



Respondents were asked to score each replication mechanism with regard to quality in terms of counterparty risk and operational risk by assigning 3 to very good, 2 to fairly good, 1 to poor. The percentages plotted on the graph show the respondents who answered very good and fairly good excluding non-responses.

what constitutes an active versus passive ETF, and what appears to be an increased interest in actively managed ETFs is an interest in alternative indexation methods which are arguably more active than cap-weighting. After accounting for this, the key results from our previous years' surveys that ETF users predominantly wish to stay with ETFs which track some form of index as opposed to involving discretionary decisions of an active manager are actually confirmed in the most recent results.

Some improvement in misperceptions regarding synthetic replication

In our 2011 survey we reported that there were misperceptions about the risk exposures and construction mechanism of synthetically replicated ETFs amongst our survey respondents. This was because synthetically replicated ETFs scored the least strongly out of the three replication mechanisms (notably full physical replication, sampling-based physical replication and synthetic replication) with regard to both counterparty risk and operational risk caused by securities lending.

These results were rather surprising, because as reported by Amenc et al (2012), ETFs based on all three replication methods are exposed to similar levels of counterparty risk although this arises from different sources. Full physical and sampling based replication are exposed to counterparty risk arising from securities lending whilst synthetically replicated ETFs are exposed to counterparty risk from swap transactions.

Moreover, one can argue that the regulation applicable to synthetically replicated ETFs is more stringent than that which applies to physically replicated ETFs (Amenc et al [2012]). Even more surprising was the result that synthetically replicated ETFs scored least favourably with regard to operational risk from securities lending because as shown in Johnson et al (2011), synthetic ETFs in general do not engage in any securities lending activities. This finding in our 2011 survey shows that respondent perceptions were counterfactual, which indicates that there were severe misperceptions of the risks and benefits of different replication mechanisms.

Figure 6 illustrates respondent perceptions with regard to the exposure of each of these replication mechanisms to these two risks in 2012. We have included the 2011 results for synthetic replication to serve as a comparison. We can see that the situation has improved and synthetically replicated ETFs have scored more strongly with regard to both overall counterparty risk and securities lending risk compared to 2011. However, our results suggest that there are still misperceptions with regard to how synthetically replicated ETFs are constructed and the risks they are exposed to as there is still an unjustifiable lag behind the other two replication mechanisms. Clearly, that respondents still state that synthetic ETFs have lower quality in terms of operational risk from securities lending whereas no securities lending is conducted by synthetic replication ETFs in Europe, shows that misperceptions prevail. These misperceptions are likely due to a debate about the risks of ETFs, which has subsequently created some confusion among ETF users.

Conclusion

Overall, our survey has revealed some interesting trends with regard to investor behaviour, investor perceptions and the general outlook for the ETF industry. Our results suggest that the ETF market is still growing and that it has potential for further growth. We observe increased levels of usage, satisfaction and demand for product development across a variety of asset classes, especially so for ETFs on emerging market equities, ETFs on fixed income indices, as well as ETFs on new forms of indices. We also find that recent launches of ETFs tracking strategy indices or smart beta indices seem to be blurring the traditional boundaries between active and passive investment. The key requirement for most investors is that an ETF tracks a systematically constructed index rather than implementing discretionary investment decisions. However, the increasing breadth of systematic indices now includes strategies which move quite far away from traditional broad cap-weighted market indices.

This year saw the publication of ETF guidelines from the European Securities and Markets Authority, which aim to increase levels of investor protection through increased levels of disclosure and transparency. Hence in this year's survey we posed new questions with regard to some key issues covered by the ESMA guidelines and also investor perceptions with

regard to the overall effectiveness of the guidelines. Overall, we found that investors were supportive of the guidelines and felt that they had improved investor protection. In particular, the vast majority of respondents support regulatory requirements for the disclosure of securities lending revenues and costs by ETF providers.

We also find that respondents have a positive outlook for their future usage of ETFs. ETFs and futures are the favoured indexation vehicles compared to total return swaps and index funds when respondents are asked to evaluate them according to objective quality criteria. This perception of high quality is translated into high expectations of future use, resulting in a positive outlook for the industry, as 67% of respondents intend to increase their use of ETFs going forward.

The research from which this article was drawn was supported by Amundi ETF as part of the research chair on Core-Satellite and ETF Investing at EDHEC-Risk Institute.

The chair analyses the developments in the use of exchange-traded funds as part of the asset allocation process and looks at advanced forms of risk budgeting within the framework of a core-satellite approach.

The full version of the research is available on the EDHEC-Risk Institute website at the following address: www.edhec-risk.com/indexes/Amundi_Research_Chair

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Understanding and outperforming equal-weighted portfolios

Raman Uppal, Professor of Finance, EDHEC Business School

In this article, we compare the performance of mean-variance optimisation-based portfolios to that of the equal-weighted portfolio. We then investigate the performance of the equal-weighted portfolio relative to value-and price-weighted portfolios, and identify the reasons for the differences in performance. Finally, we study how an investor can achieve out-of-sample performance that is superior to that of the equal-weighted portfolio, even after adjusting for transaction costs.

Markowitz (1952) showed that an investor who cares only about the mean and variance of static portfolio returns should hold a portfolio on the efficient frontier. To implement these portfolios in practice, one needs to estimate the means and covariances of asset returns. Traditionally, the sample means and covariances have been used for this purpose. But, due to estimation error, the portfolios that rely on the sample estimates typically perform poorly out of sample (see, for example, Michaud [1989] and Litterman [2003]).

The work described in this article is based on joint research with Victor DeMiguel (London Business School), Lorenzo Garlappi (Sauder School of Business at University of British Columbia), Yuliya Plyakha (Goethe University Frankfurt), Javier Nogales (Universidad Carlos III de Madrid) and Grigory Vilkov (Goethe University Frankfurt).

Several approaches have been proposed for improving the performance of portfolios based on historical data. These approaches include: imposing a factor structure on returns (Chan, Karceski and Lakonishok [1999]), using data for daily rather than monthly returns (Jagannathan and Ma [2003]), using Bayesian methods (Jobson, Korkie and Ratti [1979]; Jorion [1986]; Pástor [2000]; Ledoit and Wolf [2004b]), constraining short sales (Jagannathan and Ma [2003]), and using stock-return characteristics such as size, book-to-market ratio and momentum to choose parametric portfolios (Brandt, Santa-Clara and Valkanov [2009]).

1. List of asset allocation models considered

Number	Model	Abbreviation
Naive		
0	Equal-weighted with rebalancing (benchmark strategy)	ew or 1/N
Classical approach that ignores estimation error		
1	Sample-based mean-variance	mv
Bayesian approach to estimation error		
2	Bayesian diffuse-prior	not reported
3	Bayes-Stein	bs
4	Bayesian data and model	dm
Moment restrictions		
5	Minimum-variance	min
6	Value-weighted market portfolio	vw
7	MacKinlay and Pástor (2000) missing-factor model	mp
Portfolio constraints		
8	Sample-based mean-variance with short sale constraints	mv-c
9	Bayes-Stein with short sale constraints	bs-c
10	Minimum-variance with short sale constraints	min-c
11	Minimum-variance with generalised constraints	g-min-c
Optimal combinations of portfolios		
12	Kan and Zhou (2005) 'three-fund' model	mv-min
13	Mixture of minimum-variance and 1/N	ew-min
14	Garlappi, Uppal and Wang (2007) multi-prior model	not reported

Optimisation-based portfolios compared to equal-weighted portfolio

In DeMiguel, Garlappi and Uppal (2009), we compare the out-of-sample performance of the sample-based mean-variance portfolio rule — and its various extensions designed to reduce the effect of estimation error — relative to the performance of the equal-weighted portfolio, across eight datasets of monthly returns, using the following three performance criteria: (i) the out-of-sample Sharpe ratio; (ii) the certainty-equivalent (CEQ) return for the expected utility of a mean-variance investor; and (iii) the turnover (trading volume) for each portfolio strategy[1].

The models we evaluate are listed in figure 1.

Our main finding is that, of the models evaluated, none is consistently better than the equal-weighted benchmark in terms of Sharpe ratio, certainty-equivalent return or turnover. In general, the unconstrained policies that try to incorporate estimation error perform much worse than any of the strategies that constrain short sales, and also perform much worse than the equal-weighted portfolio. Imposing constraints on the sample-based mean-variance and Bayesian portfolio strategies leads to only a modest improvement in Sharpe ratios, ►

1 Results based on the Sharpe ratio are very similar to those based on the certainty-equivalent return, so in the rest of this article we discuss only the Sharpe ratio of various portfolio strategies.

◄ though showing a substantial reduction in turnover. Of all the optimising models we study, the minimum-variance portfolio with constraints studied in Jagannathan and Ma (2003) performs best in terms of Sharpe ratio. But even this model delivers a Sharpe ratio that is statistically superior to that of the equal-weighted strategy in only one of the empirical datasets, and a turnover that is always higher than that of the equal-weighted policy. We then show that the optimisation-based models need very long estimation windows before they can be expected to outperform the equal-weighted portfolio.

The intuition for our findings is that to implement the mean-variance model, both the vector of expected excess returns over the risk-free rate and the variance-covariance matrix of returns have to be estimated. It is well known (see Merton [1980]) that a very long time series of data is required in order to estimate expected returns precisely; similarly, the estimate of the variance-covariance matrix is poorly behaved (Green and Hollifield [1992] and Jagannathan and Ma [2003]). The portfolio weights based on the sample estimates of these moments result in extreme positive and negative weights that are far from optimal. Consequently, 'allocation mistakes' caused by using the equal-weighted portfolio can turn out to be smaller than the error caused by using the weights from an optimising model with inputs that have been estimated with error.

Value- and price-weighted benchmarks compared to equal-weighted portfolio

In Plyakha, Uppal and Vilkov (2013) we try to understand the source of the performance of the equal-weighted portfolio. We investigate whether equal-, value- and price-weighted portfolios are similar in terms of their performance. Are the differences in the total returns of the equal-weighted portfolio and the value- and price-weighted portfolios because of differences in exposure to risk factors or because of differences in alphas? Is the good performance of the equal-weighted portfolio driven mostly by the obvious over-weighting of small stocks, or are there other forces at play? If yes, what are these other forces, do they depend on equal weights or would they apply to any portfolio with constant weights, and do they operate at a particular rebalancing frequency?

To answer the above questions, we use portfolios composed of the constituents of large-, medium- or small-cap stock indices, to show that there are significant differences in the performance of equal-, value- and price-weighted portfolios. We find that the equal-weighted portfolio with monthly rebalancing outperforms the value-and price-weighted portfolios in terms of total mean return and four-factor alpha from the Fama and French (1993) and Carhart (1997) models. The total return of the equal-weighted portfolio is higher than that of the value- and price-weighted portfolios by 271 and 112 basis points per year. The four-factor alpha of the equal-weighted portfolio is 175 basis points per year, which is more than 2.5 times the 60 and 67 basis points per year for the value-and price-weighted portfolios, respectively. The differences in total mean return and alpha are significant even after allowing for transaction costs of 50 basis points.

We find that only a part of the higher total return of the equal-weighted portfolio arises from differences in exposure to systematic risk factors, including the overweighting of smaller stocks, which one might expect. However, a substantial proportion of the total return of the equal-weighted portfolio comes from alpha. We show that the source of this alpha is the rebalancing required to maintain constant weights for the equal-weight portfolio, which is a contrarian strategy that exploits reversal in stock returns at the monthly frequency. Therefore, if one were to form a passive portfolio simply overweighting small stocks, one would fail to achieve the return of the active equal-weighted portfolio, which is rebalanced each month to maintain the equal weights.

We demonstrate through two experiments that the higher alpha and less negative skewness of the equal-weighted portfolio are a consequence of the monthly rebalancing to maintain equal weights, which is implicitly a contrarian strategy that exploits the reversal in stock prices at the monthly frequency[2]. In the first experiment, we reduce the rebalancing frequency of the equal-weighted portfolio. We find that as the rebalancing frequency decreases from one month to six months, the excess alpha earned by the equal-weighted portfolio decreases and the skewness of the portfolio return becomes more negative; when the rebalancing frequency is further reduced to 12 months, the alpha of the equal-weighted strategy is statistically indistinguishable from that of the value- and price-weighted strategies. In the second experiment, we artificially keep the weights of the value- and price-weighted portfolios fixed so that they have the contrarian flavour of the equal-weighted portfolio, and we find that this increases their alpha and makes skewness less negative. If we keep the weights of the value- and price-weighted strategies fixed for 12 months, the alpha of these portfolios increases and is statistically indistinguishable from that of the equal-weighted portfolio. A key insight from the two experiments described above is that it is not the initial weights of the equal-weighted portfolio but the monthly rebalancing that is responsible for the alpha it earns, relative to the alphas for the value- and price-weighted portfolios.

"It is not the initial weights of the equal-weighted portfolio but the monthly rebalancing that is responsible for the alpha it earns, relative to the alphas for the value- and price-weighted portfolios"

In the next two sections, we investigate how an investor can design optimisation-based portfolios that perform better than the equal-weighted portfolio out of sample.

Improving performance by generalising the short sale constraint

In DeMiguel, Garlappi and Uppal (2009), we provide a general framework for determining portfolios with superior out-of-sample performance in the presence of estimation error. This general framework relies on solving the traditional minimum-variance problem (based on the sample covariance matrix) but subject to the additional constraint that the norm of the portfolio-weight vector be smaller than a given threshold, where the 1-norm of the portfolios weights is the sum of the absolute portfolio weights, and the 2-norm is the sum of the squares of the portfolio weights. We show that these norm-constraints are a more general version of short sale constraints, and allow portfolios to achieve superior out-of-sample performance.

It is well known that it is more difficult to estimate means than covariances of asset returns (see Merton [1980]), and also that errors in estimates of means have a larger impact on portfolio weights than errors in estimates of covariances. For this reason, recent academic research, for instance Jagannathan and Ma (2003), has focused on minimum-variance portfolios, which rely solely on estimates of covariances, and thus are less vulnerable to estimation error than mean-variance portfolios. Just like Jagannathan and Ma (2003), we too focus on minimum-variance portfolios, even though the general framework we develop applies also to mean-variance portfolios. But even the performance of the minimum-variance portfolio depends crucially on the quality of the estimated covariances, and although the estimation error associated with the sample covariances is smaller than that for sample mean returns, it can still be substantial. Following Brandt (1999) and Britten-Jones (1999), we treat the weights rather than the moments of asset returns as the objects of interest to be estimated. So, rather than shrinking the moments of asset returns, we introduce the constraint that the norm of the portfolio-weight vector be smaller than a given threshold.

We show that our framework nests as special cases the shrinkage approaches of Jagannathan and Ma (2003) and Ledoit and Wolf (2003, 2004b), and also the equal-weighted portfolio. We then provide a Bayesian interpretation for the norm-constrained portfolios that is in terms of a certain prior belief on portfolio weights rather than on moments of asset returns. Finally, we demonstrate how our framework allows one to calibrate the model using historical data in order to improve its out-of-sample performance. We compare empirically the out-of-sample performance of the norm-constrained portfolios to several portfolio strategies in the literature. In terms of out-of-sample variance (risk), the norm-constrained portfolios often have a lower variance than the shortsale-constrained minimum-variance portfolio studied in Jagannathan and Ma (2003), the equal-weighted portfolio, and also other strategies proposed in the literature, including factor portfolios and the parametric portfolios in Brandt, Santa-Clara and Valkanov (2009); however, the variance of the norm-constrained portfolios is similar to that of the portfolios in Ledoit and Wolf (2003, 2004b). In terms of out-of-sample Sharpe ratio, the portfolios we propose attain a Sharpe ratio that is higher than the shortsale constrained minimum-variance portfolio, the equal-weighted portfolio, and the portfolios in Ledoit and Wolf (2003, 2004b), although the higher Sharpe ratio is accompanied by higher turnover. Finally, the Sharpe ratio and turnover of the proposed portfolios is similar to that of Brandt, Santa-Clara and Valkanov (2009), but without relying on firm-specific characteristics.

Improving performance by using information in option prices

In DeMiguel, Plyakha, Uppal and Vilkov (2013), we use forward-looking moments of stock-return distributions that are implied ►

2 For the literature on momentum and contrarian strategies, see Jegadeesh (1990), Conrad and Kaul (1998), Jegadeesh and Titman (1993, 2002), Lo and MacKinlay (1990), DeMiguel, Nogales and Uppal (2010), and Asness, Moskowitz and Pedersen (2009).

◄ by option prices to improve the estimate of the first and second moments of returns. The main contribution of our work is to evaluate empirically which aspects of option-implied information are particularly useful for improving the out-of-sample performance of portfolios with a large number of stocks. Specifically, we consider option-implied volatility, correlation, skewness and the risk premium for stochastic volatility, and we obtain these not just from the Black-Scholes model, but also using the model-free approach, which has the benefit that the measurement error resulting from model misspecification is reduced.

In selecting portfolios, we use a variety of moments implied by prices of options. First, we consider the use of option-implied volatilities and correlations to improve out-of-sample performance of mean-variance portfolios invested in only risky stocks. When evaluating the benefits of using option-implied volatilities and correlations, we set expected returns to be the same across all assets so that the results are not confounded by the large errors in estimating expected returns. Consequently, the mean-variance portfolio reduces to the minimum-variance portfolio. In addition to considering the minimum-variance portfolio based on the sample covariance matrix, we consider also the shortsale-constrained minimum-variance portfolio, the minimum-variance portfolio with shrinkage of the covariance matrix (as in Ledoit and Wolf [2004a] and Ledoit and Wolf [2004b]), and the minimum-variance portfolio obtained by assuming all correlations are equal to zero or with correlations set equal to the mean correlation across all asset pairs (as suggested by Elton, Gruber and Spitzer [2006]). We find that using risk-premium-corrected option-implied volatilities in minimum-variance portfolios improves the out-of-sample volatility by more than 10% compared to the traditional portfolios based on only historical stock-return data, while the changes in the Sharpe ratio are insignificant. Thus, using option-implied volatility allows one to reduce the out-of-sample portfolio volatility significantly.

"Our empirical results indicate that the gains from using implied correlations are not substantial enough to offset the higher turnover resulting from the increased instability over time of the covariance matrix when it is estimated using option-implied correlations"

Next, we examine the use of risk-premium corrected option-implied correlations to improve the performance of minimum-variance portfolios. We find that in most cases option-implied correlations do not lead to any improvement in performance. Our empirical results indicate that the gains from using implied correlations are not substantial enough to offset the higher turnover resulting from the increased instability over time of the covariance matrix when it is estimated using option-implied correlations.

Finally, to improve the out-of-sample performance of mean-variance portfolios we consider the use of option-implied volatility, risk premium for stochastic volatility and option-implied skewness. These characteristics have been shown in the literature to help explain the cross section of expected returns[3]. Therefore, it makes sense to explore their effect in the framework of mean-variance portfolios. Using these characteristics to rank stocks and adjusting by a scaling factor the expected returns of the stocks, or using these characteristics with the parametric-portfolio methodology of Brandt, Santa-Clara and Valkanov (2009), leads to a substantial improvement in the Sharpe ratio, even after prohibiting shortsales and accounting for transaction costs.

3 For instance, Bollerslev, Tauchen and Zhou (2009) have documented a positive relation between the variance risk premium and future returns. Bali and Hovakimian (2009) and Goyal and Saretto (2009) show that stocks with a large spread between Black-Scholes implied volatility and realised volatility tend to outperform those with low spreads. Bali and Hovakimian (2009), Xing, Zhang and Zhao (2009) and Cremers and Weinbaum (2010) find a positive relation between various measures of option-implied skewness and future stock returns.

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