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#04

4th issue 2017

The rise of digital lending

Is it a factor and – if so – how many?

Benford's law and financial analysis

Securitized assets: what you didn't know you've been missing

"Generation Income" – looking beyond traditional real estate

Risk & Reward

Research and investment strategies

#04

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One of the most interesting and potentially impactful developments accompanying the advent of financial technology – "fintech" – has been the appearance and rapid growth of digital lending and other alternative finance platforms.

While many of these platforms are still in their infancy, we are convinced that fundamental changes are on the way, and investors should be prepared. As always, the details are important: business models are not all created equal, the regulatory environment is shifting and client demands are constantly evolving.

This edition of Risk & Reward explores these developments and their implications for markets and investors. Our equity and private capital teams have partnered with outside experts, practitioners and academics to gain insight into the opportunities and challenges in the digital lending space, as well as what may lie ahead. Have a look at our interview section to share in their perspectives.

In addition to our qualitative research on alternative finance, this issue also features Invesco's quantitative expertise with the latest report on our factor investing research. This time, we analyze whether less may be more when it comes to the number of factors used for portfolio analysis – deploying Invesco Quantitative Strategies' extensive database to explore the trade-offs between more detail and less cost.

And speaking of quantitative analysis: in the world of numbers, Benford's law describes a surprising empirical phenomenon that may help improve investment management. Our article on the topic explores how this finding can be used for investment analysis.

I hope you enjoy the latest issue of Risk & Reward.

Best regards,

Mark L. Flanagan

Marty Flanagan
President and CEO of Invesco Ltd.

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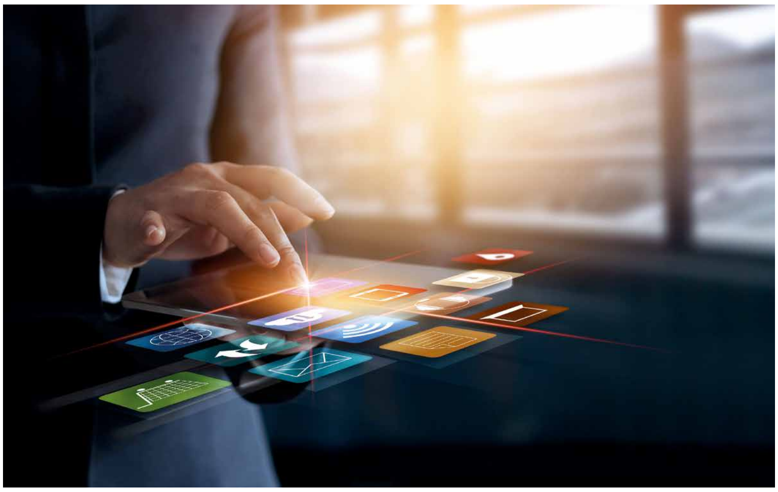

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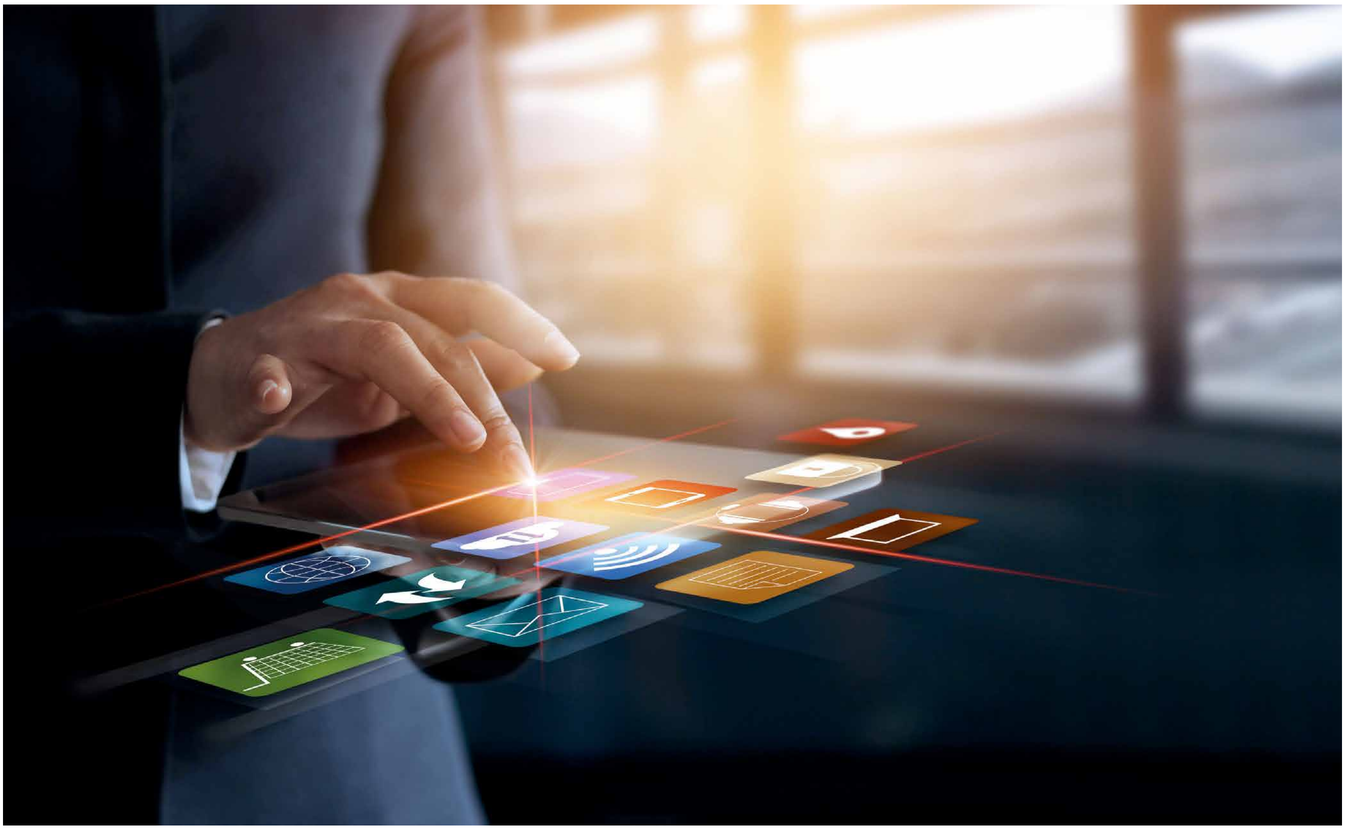
The rise of digital lending

By Mark Barnett, Theresa Boyd, Matthew Heimermann and Evan Jaysane-Darr



In brief
Digital lending platforms have grown enormously in recent years, with far-reaching consequences for traditional banks. We give a detailed description of various aspects of the digital lending phenomenon and discuss different business models, such as: balance sheet lending, marketplace lending and a hybrid of the two. We also review how digital lenders can distinguish themselves from competitors, give an overview of regulatory issues and speculate about how the sector may transform and evolve in the years to come.

The rapid growth of digital lending platforms is forcing traditional banks to reassess the sustainability of their business models. Using technology and tech-enabled business models to disintermediate incumbents, digital lenders are disrupting the traditional banking industry – and may be poised to extend their influence more widely. As companies such as SoFi, Lending Club, Funding Circle, OnDeck Capital and Zopa move ever further into the mainstream, we assess the threat they pose to traditional lenders and the broader implications for investors at a time when the line between finance and technology is becoming increasingly blurred.

Fintech – financial technology – is rapidly transforming the global financial services landscape.

Fintech – financial technology – is rapidly transforming the global financial services landscape, redefining payment processing, lending, money transfers, fundraising and even asset management. According to a recent research report, funding of fintech startups increased at a compound annual growth rate of 41% from 2013-2017, with over USD 40 billion in cumulative investment.[1] Few would doubt that this figure will continue to escalate.

In this article, we focus on one of the most significant fintech innovations: digital lending. Specifically, we evaluate the threat that digital lending platforms pose to traditional banks at a time when the latter's historical monopoly on credit has already been weakened by the global financial crisis and its aftermath. We examine which business models are most likely to prove genuinely sustainable – both in the near future and over the longer term – as well as the impact these new platforms are having on the traditional financial services industry.

New platforms emerging

Traditional bank lenders have managed to evolve and thrive over time despite having to contend with developments, such as the growth of capital markets and the advent of consumer credit. The near-collapse of the banking system during the global financial crisis, however, led to a significant reduction of lending capacity in certain areas of the market, such as home mortgages.[2] It also prompted a raft of regulations around the world designed to reduce systemic risk and restore confidence. These new regulations have forced banks to shed various assets and lines of business in order to meet tighter restrictions and more stringent stress-testing requirements.

At the same time, over the last decade, many tech-enabled startups have gained attention and interest from investors as a result of their ability to "unbundle" banks, picking off individual banking functions that are ripe for a digital solution. Nowhere has this been more prevalent than in banks' core function of lending. Digital (or non-bank) lending has emerged as an alternative means for providing credit solutions to borrowers who desire a faster solution, are deemed "unbankable" by traditional banks[3] or simply prefer a non-bank experience. Alternative lenders have also created entirely new lending markets.

The development of these new platforms has been enabled in large part by continued advances in computing power. Data ubiquity and the ever-expanding nexus of smart devices have fuelled process re-engineering on a massive scale, both across and within industries. The ability to gather, store and access digital information is increasing exponentially, and as artificial intelligence becomes more of a day-to-day reality, "machine learning" is increasingly giving way to "deep learning". Digital lending is leveraging these advances, challenging traditional banks to adopt their own digital strategies or risk losing their relevance and pre-eminence.

The global reach of digital lending phenomenon is illustrated by a recent University of Cambridge study, "Law, Trust and the Development of Crowdfunding."[4] Examining more than 1,350 platforms in 152 countries, the research highlights how factors such as regulation and financial market development are determining the spread of alternative financing platforms around the world (see our interview with Professor Raghavendra Rau).

Evolving business models

While ostensibly technology companies, in reality digital lenders are specialty finance businesses, facing many of the same considerations as traditional lenders. Most alternative lenders are either focused on consumers or small and medium-sized enterprises (SMEs), though real estate and more niche strategies are proliferating. Today, there are two primary non-bank lending models within the industry – marketplace and balance sheet lending, although there is a growing trend toward utilizing a hybrid model between the two.

Balance sheet lending

Balance sheet lenders fund from their own capital base, often retaining a substantial portion of the loans (unless securitized) on their books. These companies function as banks by assuming all the risk, but also retaining the return from the net interest margin. Their loans tend to be shorter term, which results in quick failures that supply additional data for underwriting models, and ultimately reduce default rates. However, balance sheet lending companies often scale their business at a slower rate due to the cash requirement to fund new loans. Balance sheet lenders currently make up almost 50% of the players in the non-bank space, and include credit funds like Eaglewood Capital and Victory Park, which – while not digital lenders themselves – provide needed access to capital and therefore play a crucial role in the new digital ecosystem. Examples of early tech-enabled players who favoured this approach include OnDeck Capital and Kabbage.

Marketplace lending

Marketplace lending began as a "peer-to-peer" model, matching consumers or small businesses looking to borrow with investors searching for yield in a near-zero interest rate environment. Like many marketplaces, the model sought to disintermediate an incumbent (in this case banks). With marketplace lenders, risk is assumed by the third-party purchaser in exchange for a larger portion of the return, as the purchaser retains the interest rate spread during the repayment period. The platforms took an origination fee (and often a servicing fee) for matching buyers and sellers, but didn't actually hold the loans on their balance sheet. This model spawned quite a few businesses, but it was difficult to scale without institutional investors on the platform. So, platforms began courting institutional lenders – including hedge funds and banks – to the demand side of the marketplace. This model allows the marketplace lender to originate a high volume of loans by avoiding capital constraints and leverage ratios.

Marketplace loans are generally extended to more "bankable" clients, such as near-prime consumers and SMEs or asset-backed financings. With roughly 30% of non-bank participants, this structure was pioneered by companies like Lending Club and Prosper (in consumer lending) and Funding Circle (in SME) – for more, see our interview with Samir Desai. The universe of marketplace lenders has grown dramatically over the past few years, as niche marketplaces have proliferated in more esoteric categories and outside the US. The pure marketplace model faces a number of challenges, including the alignment of interests with its capital providers. Many marketplace lenders do not plan to retain risk on their balance sheets, which can create incentives to grow the volume of loans on their platform at the expense of returns for investors. As marketplace lenders began adding institutional investors to their platforms and realized the advantages of access to more diverse and stable capital sources, new hybrid models began to emerge.

Hybrid Model

Over the past few years, many marketplace lenders have gravitated toward a hybrid model, incorporating both marketplace and balance sheet elements. A lender utilizing this structure retains a portion of the loans on their balance sheet with the remainder financed by third parties (both individuals and institutions) through the marketplace. This composite model has a number of benefits. First, it allows for access to a more diverse set of capital sources. It also allows the alternative lender to diversify their product offering, expanding into new markets using their own capital for the proof of concept loan model and then ultimately offering it to marketplace lenders once the new loan product is proven. It also diversifies marketplace lenders' revenue streams from purely origination fees to one including a net interest margin. Many established players in the alternative lending market that traditionally favoured one model – such as Lending Club, OnDeck and Prosper – have now moved towards some form of hybrid model.

As much as there are strategic benefits, the move to a balance sheet or hybrid model is largely driven by access to capital and the question of the viability of the model through market cycles – specifically what happens in a credit downturn. Alternative lenders experienced an awakening in 2015 and 2016, when credit spreads widened significantly and lending volumes dried up. Like mortgage originators during the global financial crisis, alternative lenders realized the difficulty of the "originate to distribute" model when no one is buying your loans anymore. Many marketplace lenders realized their need to explore other capital sources, including: whole loan sales, capital markets and their own balance sheet. Some, like SoFi, have always had a diverse financing strategy. Others, like Prosper, historically relied on their marketplace, until forced by the market to do otherwise. Prosper was shut off from the market in late 2016, until bringing in private equity firms in to act as the de facto balance sheet for the firm. Having bank relationships or the ability to retain loans on the balance sheet will be critical for any platform attempting to challenge traditional banks and digital competitors, since it both lowers the cost of capital and increases the stability of funding.

The importance of differentiation

The factor that will ultimately determine the size of the threat posed to traditional banks by non-bank lenders will be the latter's ability to combine both financial and technology strategies, namely creative use of the capital markets and customer acquisition. In order to successfully disintermediate banks, digital lenders will need to differentiate themselves across one or more aspects of the financing value chain, encompassing cost of funding, customer acquisition, underwriting and servicing. Cost of funding is clearly a critical consideration, but it is ultimately difficult to compete with banks borrowing at near zero percent. Moreover, servicing tends to be an inherently variable cost model that, for now, is difficult to automate fully. Thus, new entrants have often focused on business models underpinned by more creative customer acquisition and efficient underwriting (which ultimately informs cost of capital).

> Customer acquisition has proved both an opportunity and challenge for the non-bank lending industry.

Customer acquisition

Customer acquisition has proved both an opportunity and challenge for the non-bank lending industry. On the one hand, online customer acquisition is an advantage over banks, which face costs associated with manual origination and significant branch infrastructure. On the other hand, digital lenders often pay high prices for advertising and lead generation compared to traditional banks. To be sure, a high customer acquisition cost is not necessarily bad if a lender receives repeat business, as that customer retention can translate into a high lifetime value for that customer. Diversification of product offerings is one solution to the customer acquisition cost/lifetime value challenge, allowing the lender to effectively become an all-encompassing credit solution for a consumer or SME. Doing so will elongate the customer interaction with a variety of lending solutions, mostly at more reasonable interest rates.

First movers like Lending Club and Prosper built their brands on repaying consumer credit card debt and disintermediating banks after the financial crisis, when banks were unpopular and reluctant to lend. This led to low initial customer acquisition costs before the market matured and competition intensified. Newer entrants have pursued initially underserved, and often unprofitable, segments, like student debt, as a wedge toward a more diversified offering. Alternative lender SoFi has taken this approach.

SoFi, which stands for Social Finance, is a consumer-focused finance company employing a hybrid model encompassing on-balance sheet and marketplace lending. Originally conceived as a marketplace to connect university alumni with students looking to borrow, SoFi originally built a business around student loan financing – targeting a traditionally hard to reach demographic (millennials). Recent graduates, frustrated with the state of banking, welcomed the ability to refinance their student loans with an online provider. This demographic of recent graduates includes a large cohort of near-prime borrowers with low default rates and a long lifespan to utilize credit. SoFi has evolved to become the largest and fastest growing non-bank lender, diversifying their product offerings to include student loans, personal loans, mortgages, and – most recently – wealth management. This cross-selling allows the company to extend their lifetime value, while reducing their customer acquisition costs. Ultimately SoFi's goal is to provide an all-in-one financial solution that would replace a traditional bank.

Affirm, founded by PayPal co-founder Max Levchin, has taken a different approach to acquiring a similar customer group. Affirm is a point-of-sale financial services company, offering installment loans on consumer purchases. Levchin has been quite public in his criticism of banks, arguing that they provide little transparency and often offer financing with hidden terms and fees that catch consumers off guard. Levchin's tech-oriented, anti-bank branding and partnerships with merchants, including popular e-commerce companies like Casper, has helped attract a strong millennial customer base. Similarly, Square has used its point-of-sale payment processing business to better acquire and underwrite SME borrowers. This vertical integration makes sense given their access and insights into the underlying businesses.

Differentiated lead generation is important, and may also result in a different point of integration in the value chain, between point-of-sale and financing. Insikt takes this idea a step further in their belief that brands (rather than banks) will be the lenders of the future, and provides a "lending-as-a-service" solution to enable them to do just that. In China, Ali Baba also offers consumer financing (through Ant Financial), which raises the possibility of other large online marketplace players such as Amazon expanding into this space as well.

Underwriting

Another key component in an alternative lender's ability to challenge its digital and traditional competitors is the strength of its underwriting program. While traditional banks may have come a long way from the pop-culture cliché of a pinstripe-suited manager basing lending decisions on a borrower's choice of cigar or club membership, many banks' underwriting processes remain antiquated by 21st-century standards. Despite the promise of improved underwriting through technology, heretofore the primary advantage digital lenders have shown over incumbents is due to speed and efficiency of process. Going forward however, drawing on the enormous quantities of available consumer information, digital lenders are increasingly exploiting the power of big data and employing algorithms to improve outcomes (see box "From fiction to frictionless").

These tools may permit digital lenders to identify desirable customers who previously would have been deemed too risky. Yet, at least as important as the algorithms themselves is mining the data that feeds

From fiction to frictionless

*Some of the cutting-edge methods now used to inform credit analysis would have been largely unthinkable less than a generation ago. Many rely on factors that might not be intuitively linked to creditworthiness. All are rooted in the credo explored in recent research from the Massachusetts Institute of Technology and Georgetown University: "All data is credit data."**

Proponents argue that these approaches can detect behavioural patterns and signals that would otherwise go unnoticed within a vast sea of information. Most smartphones, for example, provide a constant stream of data that can be "scraped" and analyzed, including:

- *Geolocation*
- *Purchasing habits*
- *Social media use*
- *Bill payments*
- *Punctuation and emoji use in text messages/emails*
- *Duration/frequency of calls*
- *Battery life*

Inevitably, the notion of "big data" is at the heart of this form of analysis. For example, frequent recharging of a smartphone battery would not in itself be sufficient to indicate non-creditworthiness; but it could trigger a "red flag" if correlated with factors such as the age of the handset, how often it is used and how much battery power the user's favourite apps consume – all of which might indicate that the user cannot afford a new phone.

Similarly, smartphone tracking can identify a potential borrower who spends 16 hours a day at an office building versus one who spends all night every night at a club.

At present, these methods are employed principally to help the "unbanked" in developing nations, where regulation is light. However, many analysts believe they will become increasingly commonplace in the developed world. Anyone wishing their creditworthiness to be assessed in this way would have to give permission for the full range of their data to be accessed.

One potential issue in more tightly regulated environments would be the legal requirement to explain how a loan decision is reached. "Black box" technology, which is more likely to emerge as machine learning gives way to deep learning, is liable to be a problem in any jurisdiction where regulators do not allow decisions to be made "blindly".

* Mikella Hurley and Julius Adebay conclude: "While alternative credit scoring may ultimately benefit some consumers... it also poses significant risks." Source, Credit Scoring in the Era of Big Data, Yale Journal of Law and Technology (18), 2016.

them. Finding unique and potentially better sources of data (for example, cell phone data) can be a source of differentiation for digital lenders. This is one of the benefits for companies partnering with merchants – access to point-of-sale data. The jury is still out as to whether the new underwriting techniques employed by digital lenders will prove superior over time to more traditional approaches employed by incumbents focused on more holistic banking relationships. And it is not axiomatic that more sophisticated tools will lead to better underwriting outcomes. But, if digital lenders can demonstrate different performance across sources of data, this can add quality to their inherent advantage of speed and force banks to increasingly digitalize themselves.

Regulation, transformation and consolidation
One potential headwind faced by digital lending platforms is the possibility of more stringent regulation. The UK's Financial Conduct Authority (FCA), for example, has warned that some digital lenders were "testing the boundaries" of their interim operating permissions by introducing "provision funds" – insurance-like pools of cash set aside to compensate lenders for losses – and balance sheet lending. It has also criticised "inadequate rules about risk and loan performance" and a nascent tendency to lend to other lenders. The strict implementation by global regulators of regulations surrounding these and other issues could oblige some digital lenders to revise or abandon their growth aspirations or to modify their business models accordingly. Similarly, some US-based platforms, whose success to date has been built on highly selective targeting of borrowers, could invite allegations of prohibited "redlining" as they edge ever closer to the regulatory territory occupied by their more traditional rivals. In many Asian countries, meanwhile, regulations still mandate personal contact for some transactions.

The current digital lending environment has experienced little new platform formation of scale. Rather, it has been epitomized by the main players hybridizing and re-establishing loan volumes in the face of self-inflicted and market-driven storms. Meanwhile, many new entrants have focused on mortgages or other more esoteric industries (see box "Finding their niche"). Ultimately consolidation may be inevitable as larger players buy up smaller or niche lenders so they can either defend themselves or compete in a new segment. Furthermore, the industry arguably does not need five or six different marketplace lenders – particularly with little differentiation. For example, Lending Club and Prosper appear to be very similar businesses, each serving similar borrowers. In the end, who consolidates the market may be determined by those who have achieved scale through better access to capital, as well as lower capital and customer acquisition costs.

The capital-intensive nature of lending may cause the survivors ultimately to look (and trade) more like tech-enabled banks and less like other two-sided marketplaces. Indeed, in May 2017, Funding Circle and Zopa became the first major digital lenders to be granted full authorization by the FCA. The Peer-to-Peer Finance Association described the move, which both companies had actively sought for years, as "a landmark in the development of fintech in the UK". In some ways, full authorization represents an official "badge of trust". Going forward, authorised platforms should have a much smoother path towards product expansion and attracting cheaper and "stickier" funding.

Likewise, in the US, larger players like SoFi and Square have already filed with federal banking

Finding their niche

Many first-mover digital lenders were focused on consumer lending when there was greater demand for credit card refinancing post-crisis and it was easier to get to scale. It is typically more difficult to underwrite a small business loan, where fraud is a greater concern. Small business lending was initially focused on the riskier "payday" segment, with companies like OnDeck Capital, but soon included all of the SME lending market with the arrival on the scene of companies like Funding Circle in the UK. In recent years we have seen alternative lending evolve to include niche strategies beyond the typical consumer or small business loan. Given the high activity levels and large market opportunities, we expect these areas to be a prominent source of innovation in the alternative lending industry going forward.

Mortgage tech is a new area that many incumbent alternative lenders, as well as new start-ups, are focusing on. SoFi branched from student loan financing to offer mortgage loans to the same customer base of millennial borrowers. Others, like LendingHome, Ethos Lending, and PeerStreet, have developed hybrid lending models for the space, choosing to go after the massive USD 8.4 trillion US mortgage industry as an initial entry point.

Additionally, auto loan debt is a USD 1.1 trillion market in the US, exceeded in size only by the mortgage and student loan markets. Due to the scale of the opportunity, it was only a matter of time before digital lenders began supplementing banks and specialty finance companies in financing auto purchases. For example, AutoFi is an online point-of-sale financing company founded in 2015 that allows consumers to purchase and finance a vehicle entirely online with an automated application and approval process. Recently, more diversified lenders, such as Lending Club and Upgrade, have entered the auto loan market as well.

Growth in the use of factoring, the ability of a company to leverage their outstanding customer accounts receivable (AR) in exchange for instant financing, in the industry has also paved the way for more niche sectors to be addressed. Factoring often provides upfront cash at amounts of 70-90% of total AR value. Although invoice or accounts receivable factoring is not a new practice, the progression of a simple, streamlined online assessment has modernized the practice. Online platforms have opened up factoring to small businesses typically unable to access this type of financing, like bakeries, cafes and florists. BlueVine and FundBox are two exciting startups focused on this area of the market.

A growing number of companies are providing lending alternatives in even more ancillary industries, highlighting the large greenfield opportunity for more niche lenders. For example, Renovate America is partnering with local governments to provide homeowners with long-term Home Energy Renovation Opportunity (HERO) financing, incentivizing consumers to upgrade homes to energy-efficient solar power. Alternative lending has also moved into the agricultural industry with AgTech-focused lending solutions. For example, ProducePay provides a variety of payment and financing solutions to the fresh produce industry, allowing growers, shippers and distributors to smooth their cash flows by financing immediate payment on shipments. ProducePay was conceived after the founder witnessed that growers assume the risk of growing and shipping their product and then rely on cash advances from distributors to acquire funds to plant for the next season. While this use case is fairly unique, these same underlying supply chain characteristics can be found in numerous industries that have yet to be disrupted by alternative lending options.

regulators to become "industrial loan companies". If approved, they will become actual bank entities, enabling them to take deposits and potentially expand margins, as federally chartered banks can export rates across state lines. Such an evolution will allow digital lenders to compete on cost of funding as well, effectively "re-bundling" the bank.

Combined with a potential integration at the point of sale, both with the consumer and small business, we could see a new digital bank emerging with a more direct customer relationship. While it may be a far cry from the initial aspirations of early peer-to-peer lenders, it could ultimately be more effective in allocating capital while improving trust and transparency in our banking system.

> The way ahead is also likely to be characterized by more partnerships between banks, servicers and digital lenders.

The way ahead is also likely to be characterized by more partnerships between banks, servicers and digital lenders, and the incumbents that stand out at present, are those that are already exploring such avenues and exhibiting a readiness to invest heavily yet sensibly in digitalization. This could be through their existing capital markets businesses including securitizing digital loan portfolios. Or it could come through explicit partnerships or acquisitions. Examples of this trend can be seen in the US with Navient's (formerly Sallie Mae) acquisition of Earnest, an online lender focused on refinancing student loans, for USD 155 million this year. Charles Schwab recently held talks to acquire SoFi, which broke down at the proposed USD 8 billion price tag, while in the UK, Santander recently entered into a partnership with Funding Circle.

Conclusion

It is now 20 years since Bill Gates famously declared: "We need banking, but we don't need banks anymore." A confluence of factors, several of them traceable to banks' own shortcomings, has rendered his sentiment more realistic than ever. Traditional banks will need to evolve to fend off the challenges posed by their digital competitors.

Business models, technology and regulation will be among the many factors that determine the victors, the vanquished and those in between – both in terms of digital lenders and digital banks versus traditional banks and in terms of the constituents of each group. As investors, our job is to identify and anticipate those entities that are likely to flourish and those that are likely to flounder.

Investors and customers alike look for strong value propositions. It remains to be seen whether the new capabilities and alternative business models introduced by digital lenders will inevitably lead to stronger value propositions for their customers. What we can say with confidence is that a bank's digital technology strategy has become one of the most important considerations for investors. Those banks that do not muster a meaningful reaction to the unfolding revolution are likely to pay dearly for their failure to evolve rapidly enough, not least when profitability is already at the mercy of low interest rates.

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Notes

1 pwc, Global FinTech Report 2017.

2 A recent paper by researchers at Harvard reported that in 2010 the level of lending to small businesses by the four largest banks in the US – Bank of America, Citigroup, JPMorgan Chase and Wells Fargo – stood at 41% of the level in 2006. See, "The Decline of Big-Bank Lending to Small Business: Dynamic Impact on Local Credit and Labour Markets" (2017).

3 A survey conducted in 2014 reported that 79% of borrowers had attempted to secure funding from banks before turning to the peer-to-peer arena. This finding is reported in, "Understanding Alternative Finance" (2014), published by Nesta and the University of Cambridge.

4 Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2989056

Inside the Circle: Samir Desai on online lending

Interview with Samir Desai, CEO, Funding Circle

Samir Desai
CEO, Funding Circle

Funding Circle recently became the UK's biggest online lending platform, in terms of cumulative volume. Specializing in loans to small businesses, it currently operates in the UK, US, Germany and the Netherlands. Its institutional investors include Invesco and Dutch insurer Aegon, with which it recently signed a deal worth GBP 160 million. We spoke with co-founder and CEO Samir Desai about the changing lending landscape.

Risk & Reward
In the past, you've talked about the need to "revolutionize a broken system." Why was it broken?

Samir Desai
It takes a very long time for small businesses to get a loan from a bank – maybe 15 to 20 weeks. The overall experience is very divorced from what you would expect in a digitalized world, where people increasingly transact online. In 2010, when we launched Funding Circle, we realized that conventional lending just wasn't working.

At the same time, we saw that investors were increasingly looking for different ways to get attractive returns. They were also losing trust and satisfaction with banks. So, we asked ourselves: "How can we bring together these disaffected parties to create a better deal for everyone?"

Risk & Reward
Has the system now been successfully "revolutionized"?

Samir Desai
If you look at the UK, where we've been in the market longest, we estimate we account for about 2% of gross lending, which is the total amount of lending to small businesses. But, if you look at net new lending, which is a measure of gross lending less repayments coming back, from January to July 2017, 30 UK banks contributed GBP 474 million, while Funding Circle alone provided GBP 338 million.

Our business has thus far grown at 60-100% a year, and if we keep going at that rate then it will eventually add up to a very big number. But I wouldn't go so far as to say we've revolutionized the system yet – I think that's our aspiration.

Risk & Reward
You've also spoken about the possibility of digital lenders one day accounting for 10-20% of the loan market. Is that a realistic target?

Samir Desai
Everything I've seen so far suggests that the estimate is pretty conservative. About one-fifth of the borrowers we lend to are businesses that wouldn't have been able to access finance through a bank, so we're expanding the market. Also, a lot of the small businesses we interact with are living their digital lives and interfacing with online brands like Facebook, Airbnb, Uber – brands that don't really have physical locations – so it's very natural for them to come straight to us.

The interesting question for banks is what they should do in this situation. They could create a sub-brand or an online-only brand. They may decide to partner with platforms like ours, as RBS and Santander have done, referring customers they can't help conventionally. They can also partner with platforms like ours by purchasing loans. Whatever they do, they'll need to be savvy.

Risk & Reward
Given that banks are reassessing their own business models, how will digital lenders stay ahead of the curve?

Samir Desai
We've said that we expect there will always be banks, just like there will always be physical retailers. They will continue to serve a large chunk of the market. But, in the end, it comes down to customers – and what we say is that customers want faster, better, cheaper loans.

Can banks become faster in terms of processing? Yes, but it's a problem for them in a way, because the bank model is built on cross-selling, which takes time. Can they get better in terms of service? Maybe. But have retailers been able to replicate the levels of service and customization offered by Amazon and similar platforms? And, perhaps banks can lower borrowing costs eventually, but this really comes down to analytics and the ability to price loans effectively. They may have a lot of data, but they haven't been doing online lending for very long – they're facing a steep learning curve, and we have a seven-year head start.

There will definitely be more competition – we expect that – but platforms like ours are getting to levels of scale and data that will also make us very difficult to dislodge.

Risk & Reward
You're a firm believer that excellence in "fin" is as important as excellence in "tech". Going forward, what areas should digital lenders be focusing on with that in mind?

Samir Desai
We need to be really good at assessing credit risk; we need to look at compliance; and we need expertise in creating different funds and vehicles, working with different agencies and matching investors' requirements. The key is bringing all of these aspects together with market-leading technology, analytics, branding and an optimized experience for users.

Risk & Reward
You mentioned your relationship with regulators. What does full authorization by the Financial Conduct Authority (FCA) mean for you?

Samir Desai
The UK is the only country where regulators have put in place regulation tailored to online lending platforms. That's a big deal, because they're regulating based on the specific activities we're actually performing, rather than trying to cram us into an existing framework designed for more traditional financial institutions that may be very different from us.

The thing we sometimes worry about is that regulation will be implemented for the wrong reasons. The UK process was one we lobbied for over a long time. The needs were understood by the regulators and the regulation was well done. The danger is that increased regulation will come along when something blows up.

Risk & Reward
Is that likely to happen?

Samir Desai
There are going to be things that go wrong. One of the threats to platforms like ours is that we exist only because we provide great value to borrowers and investors. If we stop providing value – if investors don't get the returns they need or if borrowers have a rubbish experience – then the model doesn't work.

But when I take a step back and look at the value we're creating and how much better it is than the existing system... I think it will definitely become a big part of the financial system, even though there will be periods when it's going to feel like that's not the case. The momentum is unstoppable. Raising awareness will be a big first step – then it will just be a question of being ready when more customers show up.

Risk & Reward
Thank you, Mr Desai.

A global perspective: Professor Raghavendra Rau on crowdfunding and digital lending

Interview with Professor Raghavendra Rau, University of Cambridge

Professor Raghavendra Rau,
University of Cambridge, Judge Business School

Raghavendra Rau is the Sir Evelyn de Rothschild Professor of Finance at Cambridge Judge Business School. He is a past president of the European Finance Association and a founder and director of the Cambridge Centre for Alternative Finance. His latest research paper, "Law, Trust and the Development of Crowdfunding", offers the first detailed analysis of the economic determinants of digital lending and similar activities worldwide.

Risk & Reward
Your new paper begins by pointing out that crowdfunding isn't an entirely new phenomenon. What do you mean by that?

Professor Rau
The concept itself isn't entirely new, in the sense that charities have long relied on donor drives that aggregate small donations to fund their causes. For example, Joseph Pulitzer was recently described as "America's crowdfunding pioneer" in light of his campaign to finance the Statue of Liberty's pedestal in 1885.

That said, there are obviously several elements of crowdfunding as we now know it that are new – most obviously the underpinning technology, the global growth of the phenomenon and the sheer volume of financing now provided.

Risk & Reward
Why is it important to understand the economic determinants of crowdfunding?

Professor Rau
Firstly, crowdfunding has been suggested as a form of innovation that could impact economic development as significantly as the spread of mobile communication. Yet there has been no evidence to date that crowdfunding is more likely to penetrate financial systems in countries with little formal credit.

Secondly, crowdfunding constitutes a new form of financial innovation that has emerged and taken hold over a very short period. This being the case, we need to understand how its growth might relate to the evolution of legal systems and regulation.

Risk & Reward
You surveyed a total of 1,362 platforms in 152 countries. What were your principal conclusions?

Professor Rau
Perhaps most importantly, although China accounts for 29% of all platforms globally and has the highest volume of financing of any country, financing volumes are significantly higher in developed markets than in emerging markets. Emerging markets, excluding China, account for 30% of all platforms globally, but only 0.3% of financing. At least for now, then, we can safely say that crowdfunding is largely a developed-market phenomenon.

In addition, our analysis shows that borrowers raise financing mainly through fixed-income instruments used by investors pursuing financial motives. Some 98% of crowdfunding platforms worldwide are debt or equity platforms that investors use to earn financial returns, and the vast majority – 96% – are debt-based.

Risk & Reward
What other determinants were you able to identify?

Professor Rau
As one might expect, the level of internet access in a country is positively related to volumes of financing. So is the financial development of a given market.

There appears to be little evidence that a country's legal regime – that is, civil law or common law – is a factor. However, the rule of law, as proxied by the control of corruption and the quality of regulation, plays a significant role.

Risk & Reward
How are different countries approaching the question of regulation?

Professor Rau
In the UK, which punches way above its weight in terms of the diversity of emerging business models, we've worked with the Financial Conduct Authority to help advise on potential regulation for alternative finance platforms. For instance, we analyzed data to determine whether investors are sufficiently sophisticated to understand the regulatory framework. It's essential to understand who a market's users are when devising regulation, which is why I prefer the approach that the UK has taken.

In the US the regulation currently in place pretty much assumes that these are regular securities, exactly like those issued by banks or larger financial institutions, and that the regulation therefore really doesn't need to be changed very much. That, I think, is a major difference in approach.

China is especially interesting, because tighter regulation has only recently been put in place there. China has an enormous number of platforms, and it will be fascinating to see whether the volume of alternative finance goes up or down in the next year or so in response to the changing regulatory environment. The next wave of data should allow us to test and verify some of our hypotheses.

Risk & Reward
Do you see traditional and digital lenders competing or co-existing in the years ahead?

Professor Rau
Personally, I think there will always be a mixture. But traditional financial intermediaries will certainly have to become more efficient to compete with the new innovators.

One reason for this is simply ease of use. For example, according to our data, 56% of individuals who applied for a bank loan before turning to a digital lender would actually have been given a loan by a bank. In the end, many people's decision to go to a digital lender has nothing to do with the fact that they can't get funding elsewhere – it's simply because the platform process is quicker and less cumbersome.

Another reason why banks currently find themselves under pressure, of course, is the difference in cost structures. Platforms have no branch network to support, and they use algorithms instead of loan officers, which is clearly reflected in their costs.

One of the big questions is whether these algorithms are as good as traditional loan officers in evaluating the quality of a loan. It could be that they are, but we have to remember that the model has never been tested during a really bad downturn. Although everything looks good at the moment, none of these platforms – with the exception of Zopa, which was founded in 2005 – has gone through a complete credit cycle.

So, these digital lenders may or may not survive in their present form over the longer term. All we can say at this stage is that methodologies and cost structures have changed fundamentally and, for now, it's the traditional financial institutions that have to find ways to reduce their costs. Otherwise it will be very difficult for them to keep competing.

Risk & Reward
Thank you, Professor Rau.

Is it a factor and – if so – how many?

By Michael Fraikin, Xavier Gerard, Ph.D., and Joo Hee Lee, Ph.D.

In brief
We analyze whether 19 factors from the Invesco Quantitative Strategies model should, as before, be grouped into the traditional four families (Price Trend, Earnings Expectations, Quality and Value) or whether the parsimony of our model could be improved, with little information loss, by joining Price Trend and Earnings Expectations to a joint "Momentum" family. Joining Price Trend and Earnings Expectations is not only motivated by the fact that they build upon the same theoretical foundations; we also find strong empirical evidence that they are exposed to similar latent properties. Thus, the emerging picture from our analysis is that, in practice, three factor families trumps four.

Are more factors always better? As with many questions, the answer is: it depends. Given the overlaps between many economic signals, and in view of the apparent collective effort by academics and practitioners to find new factors, successful factor investing requires reliable tools to guard against the pitfalls of data mining, as well as meaningful rules to group homogeneous factors and improve parsimony. In this article, we show how the latter can work based on a practical example from the Invesco Quantitative Strategies universe.

Factors have come to the forefront of investment in recent years. Academics and practitioners have been reinforcing that trend, so that factor investing is no longer the exclusive realm of traditional quantitative managers and has moved into the mainstream.

Along with the wider recognition that factors are among the key drivers of a fund's return and risk, investors have become inundated by an almost never-ending flow of articles documenting new factor strategies.[1] But are these findings real – or have methodological flaws skewed the perspective?

Needless to say, ascertaining the robustness of factors against methodological flaws is critical before including them in the investment process. Our paper addresses a second important issue also related to the growing dimensionality of factors. Namely, we investigate how to group factors in a way that facilitates the overall modelling process. Improving parsimony by grouping homogeneous factors is important in order to reduce estimation noise and simplify the allocation decision across heterogeneous

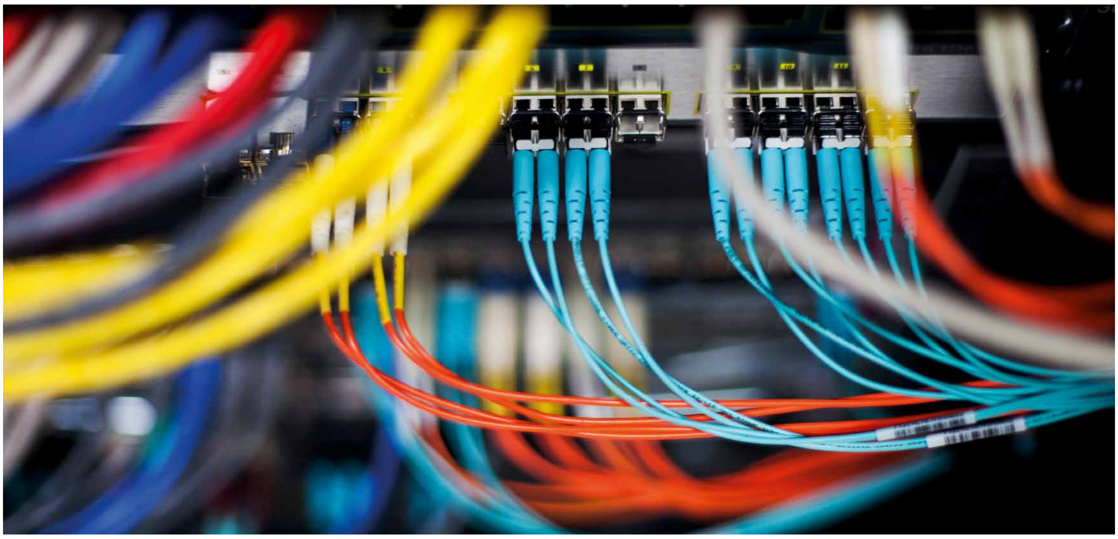


Table 1
Key metrics for the four traditional concepts

	Annualized returns	Standard deviation	Information ratio	t-Stat	Maximum drawdown	Turnover
Price Trend	9.00%	10.30%	0.87	3.92	34%	646%
Earnings Expectations	10.17%	6.75%	1.51	6.75	20%	849%
Management Action & Quality	8.11%	5.46%	1.49	6.66	9%	357%
Value	11.23%	8.49%	1.32	5.93	34%	393%

Source: Invesco.

factor families. However, it is critical to ensure that a more parsimonious model does not come at the expense of a significant loss of information.

For this purpose, we look at 19 factors of the Invesco Quantitative Strategies model,[2] explore their similarities with a principal component analysis and then determine whether it makes sense to group them into four broader families (Price Trend, Earnings Expectations, Quality and Value) or three (by joining Price Trend and Earnings Expectations to a joint "Momentum" family). The analysis is based on a global universe of developed market equities covering the period from December 1996 to December 2016.

Price Trend and Earnings Expectations – or Momentum?

We start by using the four factor families corresponding to the traditional concepts of the Invesco Quantitative Strategies model, i.e. by keeping Price Trend and Earnings Expectations separate, to create market-neutral single-factor portfolios consisting of long positions in the quintile of stocks with the highest positive factor scores and short positions in the quintile with the lowest factor scores. Table 1 shows key metrics for this quintile spread.

> We can clearly see the considerable correlation between Price Trend and Earnings Expectations.

Table 2 shows the correlations of the spread returns. We can clearly see the considerable correlation between Price Trend and Earnings Expectations – as well as a fairly high correlation between Quality and Value. All other correlations are much lower, or negative.

But what is the driving force behind this high correlation? There is a large body of academic research that finds a positive relationship between earnings announcement errors and post-announcement price drift, as well as studies that support price and earnings momentum. Several explanations have been advocated for each of these effects. For price momentum, behavioural biases, such as a disposition effect or loss aversion, have been cited and – perhaps counterintuitively – price momentum can also be seen as a delayed overreaction to initially underappreciated news. However, in all instances, underreaction to news is seen as playing a role, and therefore provides a strong theoretical link between these different types of momentum strategies. In contrast, risk-based explanations are much less common and more difficult to rationalize given the large magnitude and short-term nature of these strategy returns.[3] In short, there are convincing theoretical arguments in favour of a Momentum concept to replace Price Trend and Earnings Expectations.

Further evidence from a principle component analysis of factor returns

When we use a principal component analysis (PCA) to determine the relative importance of common components for the original broader groups of four factor families, we find that the first 2 components already explain 90% of the common variance of factor returns; 53% is accounted for by the first

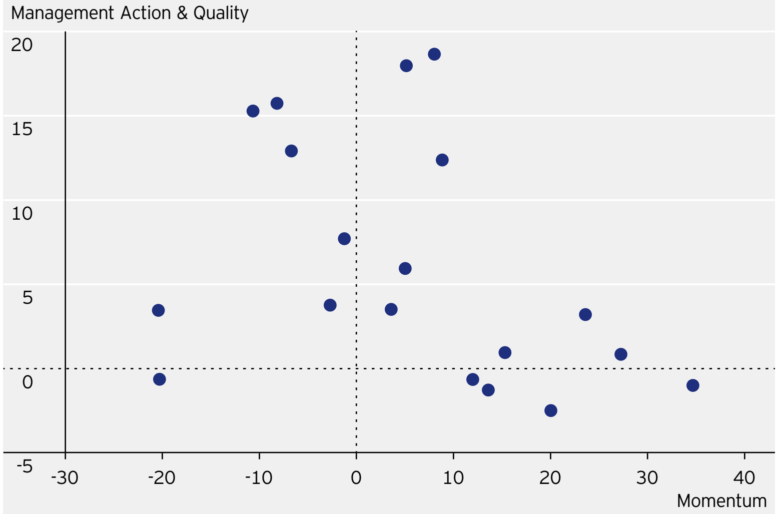
Table 2
Correlations of the four traditional concepts

	Price Trend	Earnings Expectations	Management Action & Quality	Value
Price Trend	100%	83%	38%	-34%
Earnings Expectations	83%	100%	37%	-29%
Management Action & Quality	38%	37%	100%	48%
Value	-34%	-29%	48%	100%

Source: Invesco.

component and 37% by the second. Figure 1 illustrates the significance of the first two components of the PCA for most of the signals used by Invesco Quantitative Strategies in determining factor exposures of developed market equities.

Figure 1
t-Statistics of a principal component analysis of factor returns

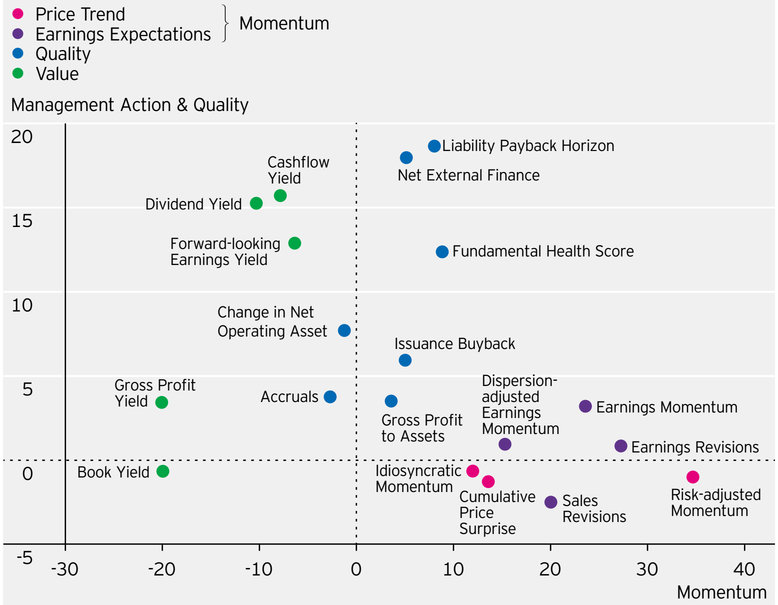


Each of the 19 dots represents a signal used by Invesco Quantitative Strategies for selecting stocks (e.g. Risk-adjusted Momentum, Earnings Revisions, Earnings Momentum, Sales Revisions, Dispersion-adjusted Earnings Momentum, Cumulative Price Surprise, Idiosyncratic Momentum, Fundamental Health Score, Liability Payback Horizon, Net External Finance, Issuance Buyback, Gross Profit to Assets, Change in Net Operating Assets, Accruals, Forward-looking Earnings Yield, Cashflow Yield, Dividend Yield, Book Yield, Gross Profit Yield). High t-values indicate that the first two principal components are of high significance for the respective signals.
Source: Invesco.

Signal clustering
While the PCA itself does not postulate the meaning of the components, we can nonetheless deduce it by looking at signal clustering. In figure 2, we have added not only the factors' names, but also used a colour code to show how we have linked them to the four well-known Invesco Quantitative Strategies concepts: Price Trend, Earnings Expectations, Quality and Value.

We see that the factors associated with Quality score high on the y-axis, and somewhat positively on the x-axis; whereas the Value factors garner mixed scores on the y-axis and somewhat negative scores on the x-axis. Both, however, are in stark contrast to the Price Trend and Earnings Expectations factors, the two of which have high x-scores and y-scores around zero. In short, there are striking similarities between Price Trend and Earnings Momentum, while Value and Quality fall further apart.

Figure 2
t-Statistics of a principal component analysis of factor returns



Source: Invesco. See notes below figure 1.

> It appears to make sense to merge the two families (Price Trend and Earnings Expectations) into just one.

Thus, again it appears to make sense to merge the two families (Price Trend and Earnings Expectations) into just one – the Momentum family – as we have done in figure 3.

In the following part of this study, we explore the effects of this merger.

What difference does it make?
Having established that Price Trend and Earnings Expectations are highly related from theoretical and statistical perspectives, we now examine the consequences of a merger of the two factor families. For this purpose, we look to explore two questions: Would a Momentum strategy combining Price Trend (PT) and Earnings Expectations (EE) be superior to a pure Price Trend strategy? And is a four factor approach including Price Trend, Earnings Expectations, Management Action & Quality and Value superior to a three factor approach with Momentum (PT and EE), Management Action & Quality and Value?

To answer the first of these questions, we use the same market-neutral portfolios created earlier as a conceptual starting point. Typically, single-factor portfolios are used in combination with an existing portfolio to complete the range of factor exposures, or as a stand-alone strategy. In this context, there are practical advantages for our single-factor market-neutral portfolios to be exposed only to the factor that they aim to capture. Doing so allows us to achieve two important objectives: Firstly, by removing unwanted exposures to other factors, we can easily add the new factor bet with minimum impact on the other existing bets. Secondly, factors can sometimes be negatively correlated, as tends to be the case with Value and Momentum, so that removing these negative exposures improves the performance of the stand-alone strategy.

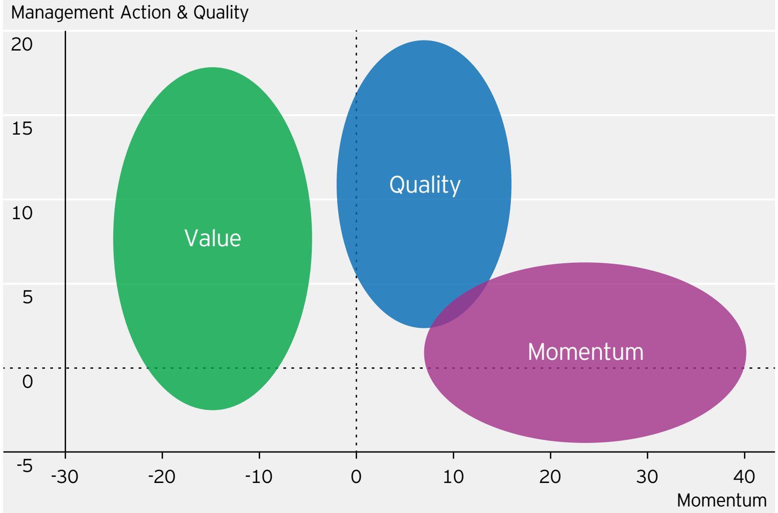
What is less evident, however, is how exposure to the desired factor and neutrality to the others should be achieved. Most commonly, a requirement to have zero score exposure to other factors seems to be the route of choice. Below, we represent the consequences of testing this in the context of a number of alternative combinations of PT, EE and Value. Even though the single strategies have already been explored, we repeat them here for convenience.

Table 3 shows that a traditional price trend strategy benefits from including information about Earnings Expectations, even when using a simple equally weighted combination of the two signals. Adding Earnings Expectations (EE) to Price Trend (PT) materially improves that concept's return-to-risk trade-off at the cost of only a marginal increase in turnover. This is all the more remarkable given how highly correlated the two concepts are.

To move forward, we modify the construction of our market-neutral portfolios by controlling exposures to other factor(s), using Value as an example. To neutralize the exposure to Value, we first regress Momentum scores on Value scores. By construction, the residuals from these regressions are highly correlated with Momentum scores, and have a correlation of 0 with Value scores. In turn, top and bottom quintiles based on these residuals have similar exposures to Value. The resulting "adjusted" Momentum strategy, which goes long the top quintile and short the bottom quintile, has a score exposure of 0 to that factor.

In an alternative approach, we estimate the sensitivity of our original market-neutral Momentum strategy to an identically constructed Value strategy. Our measure of return sensitivity, i.e. beta, is based on the estimate of the covariance matrix of stock returns for our universe of securities, as well as the weights of each individual strategy. By computing beta at the portfolio level, we are able to alleviate some of the issues that relate to the estimation errors of stock-specific beta estimates. Our adjusted Momentum portfolio then combines the original Momentum portfolio with a short position in the Value strategy that is scaled by the estimated beta exposure of Momentum to Value. Finally, the resulting portfolio holdings are standardized, so that each side is fully invested.

Figure 3
Abstracted equity factor landscape



Source: Invesco. See notes below figure 1.

The first of the two modifications makes little difference. It creates a marginal improvement in simulated returns and a small reduction in turnover. However, the second modification, where we force the beta of the Momentum portfolio to be zero with respect to Value, makes a meaningful difference. Return increases, risk decreases and the maximum drawdown is more than halved.

The multi-factor context
Finally, while the evidence so far suggests that combining Price Trend and Earnings Expectations makes sense, our analysis would not be complete without investigating whether this conclusion holds for a multi-factor allocation. To do so, we compare the Information Ratios (IR) of an optimal allocation across Value, Quality and an equally weighted combination of Price Trend and Earnings Expectations (model 1) to a model that keeps Price Trend and Earnings Expectations separate (model 2).

Table 3
Key metrics of the four traditional concepts vs. Momentum

	Annualized returns	Standard deviation	Information ratio	t-Stat	Maximum drawdown	Turnover
Price Trend (PT)	9.00%	10.30%	0.87	3.92	34%	646%
Earnings Expectations (EE)	10.17%	6.75%	1.51	6.75	20%	849%
Management Action & Quality	8.11%	5.46%	1.49	6.66	9%	357%
Value	11.23%	8.49%	1.32	5.93	34%	393%
Momentum (PT & EE)	11.13%	10.02%	1.11	4.98	34%	700%
Momentum (PT & EE)*	11.34%	9.98%	1.14	5.09	34%	674%
Momentum (PT & EE)**	12.09%	7.00%	1.73	7.74	14%	665%

* Value-Score = 0; ** Value-Beta = 0.
Source: Invesco.

Table 4
Optimal weights

	Model 1	Model 2
Price Trend (PT)		-8%
Earnings Expectations (EE)		57%
Momentum (PT & EE)	41%	
Management Action & Quality	-7%	-2%
Value	53%	34%

The absolute values of the weights do not add to 100% due to rounding.
Source: Invesco.

For clarity, these optimal weights are scaled so that the sum of their absolute values equals one.

The weights of both allocations in table 4 suggest that we would have maximised the IR of our multi-factor portfolio by blending Value and Momentum, and that we could have more or less disregarded Quality over the study period. More importantly, we find that model 2, where Price Trend and Earnings Expectations are kept separate, would have shifted all the Momentum weight to Earnings Expectations only.

Table 5 reports statistics for the simulated performance of these two allocations, which go long and short the top and bottom quintiles of factor combinations based on the optimal weights in table 4. Unsurprisingly, we find that being able to distinguish between Price Trend and Earnings Expectations (instead of being constrained to hold an equal mix of these two factors) would have improved the multi-factor portfolio IR. The IR of model 1 is 2.03, whereas that of model 2 is 2.36.

However, what these headline numbers miss is that, by significantly increasing our reliance on Earnings Expectations in model 2, we also substantially inflate turnover. In fact, a transaction cost assumption of only 30bp would suffice to eliminate any economic difference between the IR of these competing allocations.

Conclusion

The Price Trend and Earnings Expectations factor families capture the same basic economic phenomenon. Earnings Expectations dominate Price Trend on a raw return basis over the period of our study, but this also comes with a much higher rate of turnover. On balance, the economic significance of any information loss from combining these factors appears, at worst, to be marginal. Accordingly, the principle of parsimony would call for merging these two families into one Momentum factor.

Table 5
Simulated performance of different multi-factor portfolios

	Annualized returns	Standard Deviation	Information Ratio	Maximum Drawdown	Turnover	Net returns (TC: 30bp)	Net IR (TC: 30bp)
Model 1	15.91%	7.85%	2.03	15%	649%	12.01%	1.53
Model 2	13.93%	5.91%	2.36	13%	804%	9.11%	1.54

Source: Invesco. TC = Transaction cost.

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Notes

[1] E.g. Green, Jeremiah, Hand and Zhang (2013); Hou, Xue and Zhang (2017).

[2] The Invesco Quantitative Strategies model is a factor-based quantitative model used by Invesco Quantitative Strategies for stock selection. The model used an extensive database of around 3,000 global stocks, the so-called Invesco Quantitative Strategies universe. When we mention "our model", "our universe", "the model", "the universe", etc., we always refer to the Invesco Quantitative Strategies model and its database.

[3] Ball and Brown (1968), Bernard and Thomas (1990), Jegadeesh and Titman (1993), Barberis, Shleifer and Vishny (1998), and Hong and Stein (1999) analyze Earnings Expectations and Price Trend separately; Chan, Jegadeesh and Lakonishok (1996), Zhang (2006), Chordia and Shivakumar (2006) and, more recently, Novy-Marx (2015) offer analyses of the two combined.

Benford's law and financial analysis

By Dr. Martin Kolrep and Satoshi Ikeda

> *"Undoubtedly there are, in connection with each of these things, cases of fraud, swindling and other financial crimes; that is to say, the greed and selfishness of men are perpetual."* William Graham Sumner

> *"Corruption, embezzlement, fraud – these are all characteristics which exist everywhere. It is regrettably the way human nature functions, whether we like it or not. What successful economies do is keep it to a minimum. No one has ever eliminated any of that stuff."* Alan Greenspan

In brief
With the growth of computing power, data analysis has become ever more sophisticated. In this paper, we examine how financial analysts can make use of Benford's law, i.e. the empirical observation that the figures from a data set are more likely to start with 1 or 2 than with 9, and that each number has its own probability (which is significantly different from the 11.1% one would normally expect). After a detailed description of the law, we provide a few examples from outside finance, then we show how the law applied to financial statement data can help to improve both stock selection and risk management.

Are all numbers equally likely? Not if you look at the leading digits of figures from numerous empirical data sets. This finding has some rather interesting implications, not least for financial analysis. We look at Benford' law in detail and show how it can be used for investment management.

Since information today is largely digitalized, it can easily be analyzed with computers. In recent decades, technological progress, such as the expansion of computational capacity and high-speed data transmission, have made it possible to process ever larger amounts of data in a shorter time.

These innovations have significantly impacted the financial industry. Traditional financial data, including financial statements and market quotations, has become highly detailed and frequent, and it is available to almost everyone. Additional data, such as managements' statements and information on capital structures, once considered unobtainable, is now readily available to financial analysts.

Although the volume of data is vast, computing power is no longer the limiting factor. Today's critical intersection lies in the capacity for data treatment: gleaning something useful out of the vast amount of data is becoming more and more challenging. And the amount of data is increasing still.

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Of course, investment management is no exception. With more and more data available, quantitative managers can significantly broaden their research base. In the past, they looked at traditional financial indicators like net present value (revised yearly), and focused on monthly price movements. Today, 'non-traditional' indicators are becoming more important, since they often complement traditional analysis. However, due to their complexities, non-traditional data is still not used ubiquitously.

Examples of non-traditional indicators include: investor sentiment, the credibility of accounting information, patent statistics, R&D activities or even the frequency of the company management playing golf or bridge.

Traditional investment managers have long made occasional use of non-traditional indicators. But only with today's methods and technologies can they be assessed systematically. In this study, we look at a specific example, Benford's law, and explain how it could be adopted in quantitative asset management.

What is Benford's law?

Benford's law, otherwise known as the first-digit law, states that, in various data sets, the numbers from 1 to 9 have different probabilities of occurring in the lead digit of a figure. Specifically, in a set of numerical data, such as stock prices and population figures, the individual numbers from 1 to 9 do not appear with an equal probability of 1/9 (or 11,1%). Rather, the '1' appears substantially more often, with a probability of around 30%; in about 18% of all cases, the leading digit is a '2'. The least frequent leading digit is the '9', with a probability below 5%.

> Approximately 50% of all figures start with a '1' or '2', and numbers starting with a '9' are very rare.

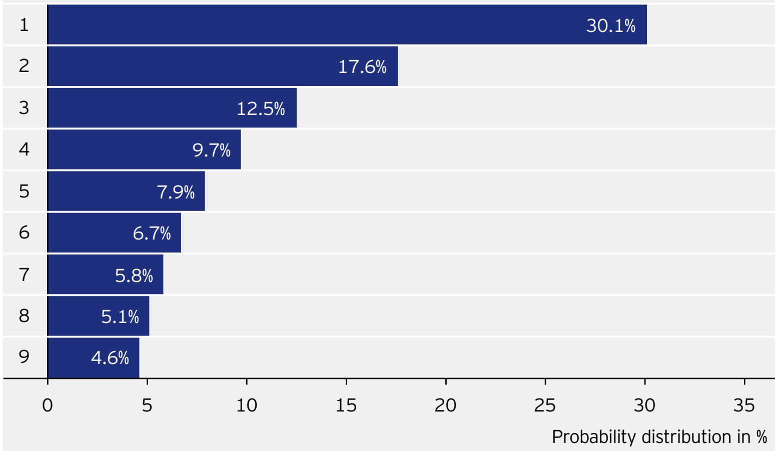
That is to say, the probability of the first digit of a randomly picked number being a '1' is significantly higher than the probabilities of the other numbers. Approximately 50% of all figures start with a '1' or '2', and numbers starting with a '9' are very rare.

This phenomenon, which appears astonishing at first sight, was first discovered by the astronomer Simon Newcomb in 1881. In a library, he noticed that the first part (the part starting with 1) of a table of logarithms had been referred to so frequently that it was well-thumbed. He investigated the possibility of a bias in the appearance of the first digit, and ultimately discovered the law. Later, in 1938, the law was rediscovered by the physicist Frank Benford. He found that the probability of appearance as the first digit had a similar pattern across a variety of data sets. The observation was generalized with the following formula:

$$P(d)=\log_{10}\left(\frac{d+1}{d}\right)$$

where the first digit $d \in \{1, 2, ..., 9\}$

Figure 1
Probability distribution of the first digit according to Benford's law



Source: Invesco. For illustrative purposes only.

Figure 1 shows the probability distribution of the first digit implied by the formula.

Though the exact proof of Benford's law is mathematically complex, the intuition behind it can be explained with the following simple example:

- Assume a quantity growing at a constant monthly rate of $2^{(1/12)} - 1$ (= 5.95%).
- Under this assumption, the quantity will always double in 12 months' time. Table 1 shows the development of the quantity for an initial value of 100.
- During the first 11 months, the leading digit of the quantity is always '1'. In the next 8 months, it is always a '2', followed by a '3' in the next 4 months. 39 months later, it is '9' – but this is the only case of a '9' in the example period.

Table 1
Growth of 100 with a constant monthly growth rate
Growth rate = 5.95%, initial value = 100

Months later	Value	Months later	Value	Months later	Value	Months later	Value
1	**105.9**	13	**211.9**	25	**423.8**	37	**847.6**
2	**112.2**	14	**224.5**	26	**449.0**	38	**898.0**
3	**118.9**	15	**237.8**	27	**475.7**	39	**951.4**
4	**126.0**	16	**252.0**	28	**504.0**	40	**1007.9**
5	**133.5**	17	**267.0**	29	**533.9**	41	**1067.9**
6	**141.4**	18	**282.8**	30	**565.7**	42	**1131.4**
7	**149.8**	19	**299.7**	31	**599.3**	43	**1198.6**
8	**158.7**	20	**317.5**	32	**635.0**	44	**1269.9**
9	**168.2**	21	**336.4**	33	**672.7**	45	**1345.4**
10	**178.2**	22	**356.4**	34	**712.7**	46	**1425.4**
11	**188.8**	23	**377.5**	35	**755.1**	47	**1510.2**
12	**200.0**	24	**400.0**	36	**800.0**	48	**1600.0**

Source: Invesco. For illustrative purposes only.

- If the quantity in this example is observed at an arbitrary point in time, the probability that the leading digit is a ‘1’ or a ‘2’ is higher, whereas the probability of an ‘8’ or a ‘9’ is lower.

Benford’s law works particularly well for any data set that is subject to natural growth processes. This may be the population of cities or countries, the prices of goods or, of course, stock prices. The law should hold regardless of the time period considered – and data sets that follow Benford’s law are what we call ‘scale-invariant’. This means that when a sufficiently large data set is multiplied by a constant, the resulting modified data still follows Benford’s law. For example, a data set denominated in euro would still follow the Benford distribution if converted into US dollars, as long as an identical exchange rate is used for all data points. Be warned, however, that Benford’s law is not valid at the roulette table. The data has to be taken “from nature”.

How does Benford’s law affect our life?

An important consequence is that, in any set of data which is large enough and not artificially manipulated, the leading numbers are likely to conform to Benford’s law. Or, conversely, when someone intentionally manipulates numbers in a set of data, they will potentially no longer conform to the law. Thus, when analyzing a set of data, any deviation from the distribution postulated by the law can have two sources: either the set of data is not ‘natural’ (i.e. it is too small or biased by some external effect), or it has been modified or manipulated inappropriately. If the first possibility can be ruled out, any deviation from Benford’s law may point to covert data manipulation.

> When someone intentionally manipulates numbers in a set of data, they will potentially no longer conform to the law.

Today, this logic is actually widely exploited in various situations in our daily life. Needless to say, this typically not loudly disclosed to the public. Here are some examples:

- **Tax declaration:** In some countries, fiscal authorities seem to utilize the law as one way to figure out irregularities in the tax declaration. This way, potential tax evasion can easily be identified if datasets have been manipulated and the deviation from Benford’s law is significant.

- **Students’ thesis:** Some universities are exploiting the law to detect anomalies and fraudulence in the results of thesis experiments and surveys.

- **Price analysis:** When the euro was introduced, it was possible to assess whether prices were adjusted or simply converted from the former local currency into euros. The basic idea is scale invariance, meaning that a data set which follows Benford’s law still follows it when multiplied by a constant factor (or converted into another currency). Where the new euro prices no longer followed Benford’s law, price adjustments had taken place with a clear tendency towards psychological pricing.[1]

Four more detailed examples

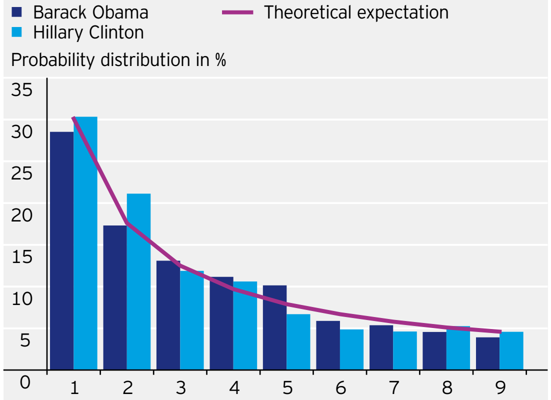
Analysis of Barack Obama and Hillary Clinton tax declarations

We have analysed the politicians tax statements for the years 2011 to 2015, in which their declared income, as well as their donations and other figures, varied considerably. However, when looking at the leading numbers of all those figures, Benford’s law seems to hold fairly well (figure 2). This implies that their tax reports are reasonably correct – though this is not definitive proof.

Disbursement statements from the US House of Representatives

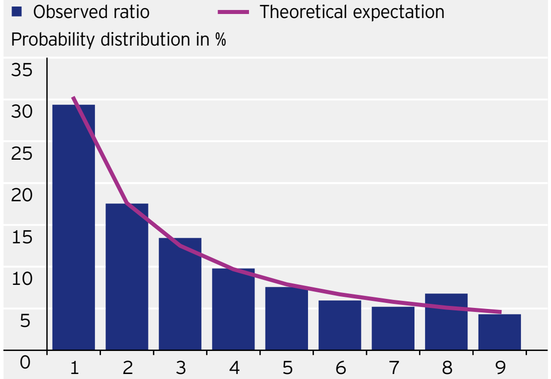
We have also analyzed the disbursement statements from the US House of Representatives.[2] The statement of disbursement is a quarterly public report issued by the Chief Administrative Officer of the House. The document is used to report all receipts and expenditures of the US House of

Figure 2
Test of Benford’s law for Barack Obama and Hillary Clinton tax declarations



Source: Invesco.

Figure 3
Test of Benford’s law for the US House of Representatives statement of disbursements



Source: Invesco.

Representatives. We looked at the data for the second quarter of 2017. Again, there is no clear evidence of fraud (figure 3).

Population of German cities

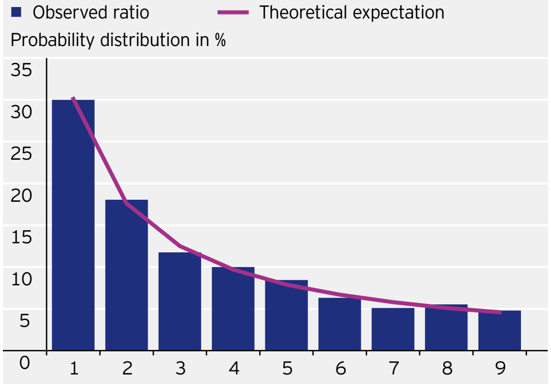
For 2060 German cities,[3] we have analyzed whether the number of inhabitants across municipalities follows Benford's law. As one can see in figure 4, it does. The distribution is not distorted, as the list contains all cities from the largest (Berlin: 3.5 mn inhabitants) to the smallest (Arnis: population 279). The closeness of the distribution to the theoretical expectations indicates that the population of German cities is still able to grow normally without any constraints.

If, on the other hand, one only looks at cities with a population above 20,000, the data is truncated to 655 cities, and Benford's law no longer holds (figure 5).

Surface area of German cities

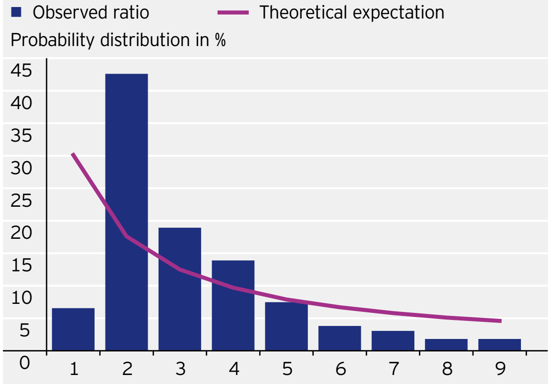
For 2060 German cities,[4] we also analyzed whether the surface area of the cities follows Benford's law. According to figure 6, it obviously doesn't. While population seems to be able to grow without any constraints, this does not seem to apply to the surface area of cities. This is a natural consequence of limited space availability or topographical constraints.

Figure 4
Test of Benford's law for the population of German cities



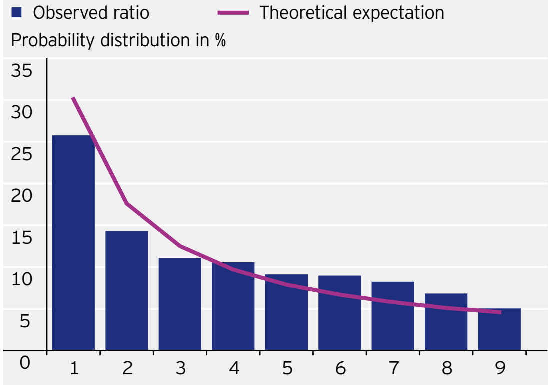
Source: Invesco.

Figure 5
Test of Benford's law for the population of German cities above 20,000 inhabitants



Source: Invesco.

Figure 6
Test of Benford's law for the surface of German cities



Source: Invesco.

Benford's law in the financial world: a test for accounting manipulation

As the financial world is packed with numbers, it is only natural to apply Benford's law to financial data. Indeed, some auditors and governmental institutions have utilized the law. For us, as asset managers, the law may also prove valuable. For instance, can we use Benford's law ourselves to detect fraud when analyzing the financial statements of companies? And, can we exploit this information for stock selection and risk management?

An empirical exercise

To start with, we define a metric for the deviation of a set of numbers from Benford's law. The so-called Mean Absolute Deviation (MAD) is defined as the average difference between the observed probabilities (*OP*) and the theoretically expected probabilities (*TP*).

$$MAD = \frac{1}{N} \times \sum_{k=1}^{N} \left| OP_k - TP_k \right|$$

Let us look at the December 2014 financial statement data from Microsoft, Inc. as an example. We compute the MAD with the following procedure (table 2):

1. Compile the financial statements including balance sheet, income statement and cash flow statement.

2. Collect the first digit of all of the numbers of the items on the statements, then count the number of observations per digit.

3. Observe the probability of appearance of the numbers 1 to 9.

4. Compute the differences between the observed probabilities and the theoretical values; take the average of the nine numbers to obtain the MAD.

Consequently, the MAD for Microsoft's financial statement as of December 2014 is 0.040.

Table 2
An example of MAD calculation

d	# of observations	P(d) - actual	P(d) - theoretical	Difference
1	14	18.2%	30.1%	0.119
2	18	23.4%	17.6%	0.058
3	9	11.7%	12.5%	0.008
4	4	5.2%	9.7%	0.045
5	7	9.1%	7.9%	0.012
6	5	6.5%	6.7%	0.002
7	6	7.8%	5.8%	0.020
8	11	14.3%	5.1%	0.092
9	3	3.9%	4.6%	0.007
			Average difference	**0.040**

Source: Invesco.

We can now apply this procedure to the financial statements of all companies in our investment universe. Specifically, we would like to validate the following two hypotheses:

- Hypothesis 1:
  A larger MAD might be an indication of inappropriate accounting manipulations. Though not necessarily illegal, such manipulations are likely to be unsustainable, so that the companies' long-term business performance may suffer. Thus, the signal could be useful for stock selection, indicating lower alpha potential.

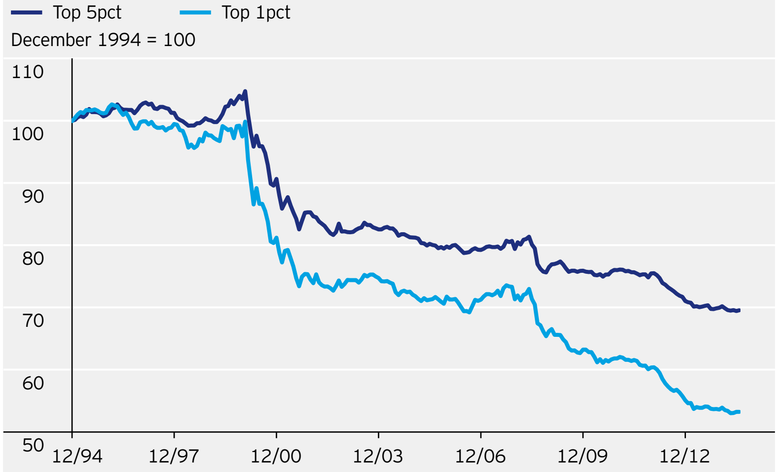
- Hypothesis 2:
  An abnormally large MAD might be an indication of highly intentional accounting manipulations, and even imply accounting fraud. From a risk management perspective, we should probably avoid investing in such companies.

Validation of hypothesis 1:
MAD as a signal for stock selection
If hypothesis 1 is true, high MAD values would imply lower future stock returns.

The downward slope suggests that stocks with high MADs performed worse (figure 7). Furthermore, performance of the top 1% was worse than that of the top 5%. The results are statistically significant and consistent with our initial hypothesis. We may thus exploit this finding to eliminate risky stocks from our universe.

Validation of the hypothesis 2:
MAD as a signal for risk management
When accounting frauds become public, the companies involved usually lose credibility among investors and suffer fatal damage. We found that those companies often have abnormal MAD values. Figure 8 is an example of a company with a rising MAD – and subsequent accounting irregularities.

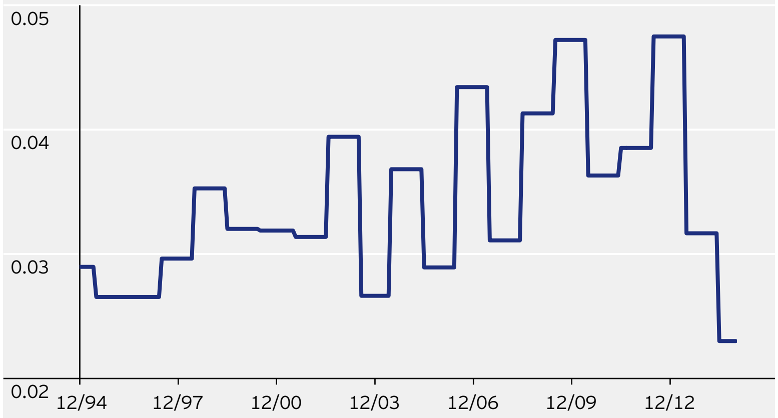
Figure 7
Indexed performance of high MAD companies



The performance was calculated under the following assumptions:
- Universe and period: Invesco Quantitaive Strategies developed markets universe from December 1994 to March 2014.
- Rebalancing frequency: monthly; return scheme: neutralization of regional and industrial effects in the individual stock returns.

The stocks' MADs were calculated monthly, based on the latest financial data then available. The Top 5% portfolio consists of the 5% stocks with the highest MADs at the dates shown on the x-axis; the Top 1% portfolio consists of the 1% stocks with the highest MADs. The graph shows the subsequent 1-month returns of the two portfolios.
Source: Invesco. Data as at July 2014.

Figure 8
Development of MAD – Olympus Corp.



Source: Invesco. Data as at December 2014.

Of course, an abnormally high MAD is not definitive proof of accounting fraud. It merely indicates some oddness in the financial statements. Nevertheless, we may be able to exploit this metric to detect accounting manipulation. This would help in risk management.

Conclusion
Data analysis is becoming more varied and focused. Numerous ideas that were considered unrealistic in the past are going to be much easier to implement over time. In this study, we have discussed Benford's law as an example of focused data analysis. Revealing hidden intentions behind ostensible figures can potentially enhance the predictive power of our stock selection models. Furthermore, figuring out underlying risks in relation to specific companies can contribute to more robust risk management.

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Notes

1 Tarek el Sehity, Erik Hoelzl, Erich Kirchler (2005): "Price developments after a nominal shock: Benford's Law and psychological pricing after the euro introduction", International Journal of Research in Marketing 22(4), pp. 471-480.
2 http://disbursements.house.gov/
3 Statistisches Bundesamt https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/Gemeindeverzeichnis/Administrativ/Aktuell/05Staedte.html, download on 20 September 2017.
4 Statistisches Bundesamt https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/Gemeindeverzeichnis/Administrativ/Aktuell/05Staedte.html, download on 20 September 2017.

Securitized assets: what you didn't know you've been missing

By Glenn J. Bowling, Kevin M. Collins, David Lyle and Anthony R. Semak

In brief
We show that US Agency MBS boast a higher risk-adjusted return than US Treasuries and US investment-grade corporates over the preceding 10- and 15-year periods, each capturing a full market cycle and the effects of the great recession. Then we go on to describe how the market for non-Agency RMBS has developed. We also highlight the yield, duration and collateral advantages of investment-grade CMBS over US investment-grade corporates. Finally, we explain the historically defensive profile of ABS and the unusual breadth of the ABS market.

Ten years after the peak of the global financial crisis, many investors are still wary of securitized assets. But a lot has changed since then. We believe the time has come to rediscover an asset class that may offer multiple advantages, in terms of both diversification and risk-adjusted returns. In this article, we describe four types of US securitizations in detail: Agency MBS, non-Agency RMBS, CMBS and ABS.

It's a familiar admonition: "We're optimistic about the outlook, but if you want to protect your assets and minimize your downside risk, your investments must be properly diversified." Upon hearing the advice, the investor generally agrees it makes sense, and the asset manager will often suggest a targeted allocation across stocks, bonds and money market instruments as the most common pillars of a traditional diversified portfolio. The stock allocation provides the opportunity for portfolio growth, perhaps contributing some income, while the money market allocation serves as the source of capital preservation. The bond allocation is often a mechanism for generating income and some capital appreciation potential. After considering the universe of fixed income asset types, the fixed income portfolio manager chooses from an array of corporate and government bonds for the bond allocation, but there's often something missing: the fixed income class with the highest risk-adjusted returns over trailing 10- and 15-year periods and the strongest performance among major bond types during the global financial crisis in 2008 and the European sovereign credit crisis in 2011 – US mortgage-backed securities.[1]

Since the global financial crisis, the suggestion to include securitized assets, including US mortgage-backed securities, as a foundational component of a well-diversified portfolio, has been met at times with great scepticism. Investors may ask, "But what about the mortgage-led credit crisis in 2008? Aren't mortgage-backed securities responsible for causing one of the most dramatic declines in capital markets in modern history? Why should I think the risks of mortgage-backed securities are any different today?" These questions may appear reasonable. But the truth dispelling the myths is not often well understood.

> Since the global financial crisis, the suggestion to include securitized assets has been met at times with great scepticism.

The empirical data is clear. Securitized assets, such as US Agency mortgage-backed securities (Agency MBS), non-Agency residential mortgage-backed securities (non-Agency RMBS), commercial mortgage-backed securities (CMBS) and asset-backed securities (ABS), exhibit an unusual degree of diversity in cash flow, credit and interest rate risk characteristics that make them highly conducive to portfolio customization.

> Securitized assets exhibit characteristics that make them highly conducive to portfolio customization.

US Agency MBS: Why consider owning them?
US Agency MBS are instruments whose cash flows are determined by borrower payments on an underlying pool of mortgage loans. US Agency MBS are guaranteed by Fannie Mae (FNMA), Freddie Mac (FHLMC) and Ginnie Mae (GNMA), meaning that these entities are responsible for the timely payment of principal and interest on the bonds, and bear the credit risk of the underlying loans. By relieving investors of this risk, they open the mortgage market to a much deeper pool of capital and facilitate the availability of mortgage loans at potentially more attractive rates. But what features suggest US Agency MBS may be a good idea for investors?

> What features suggest US Agency MBS may be a good idea for investors?

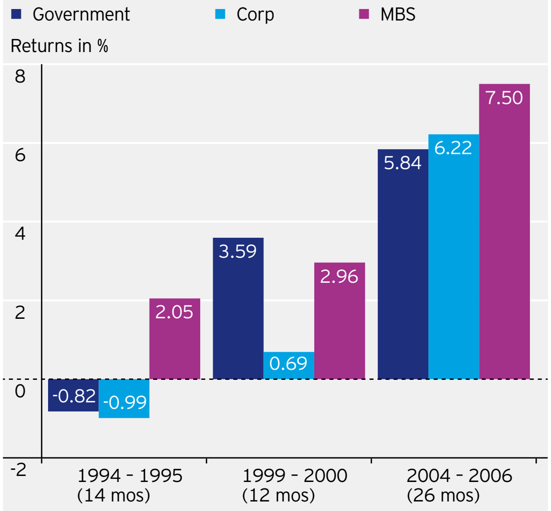
- **Credit quality / government sponsorship:** FNMA and FHLMC are US government-sponsored enterprises (GSEs). They are private companies that are not part of the US government, though they are currently under the conservatorship of the US Treasury. However, they are considered to have an implicit guarantee from the US government, with financial support in the form of a line of credit with the US Treasury. GNMA is part of the US Department of Housing and Urban Development, and is thus backed by the full faith and credit of the US government, resulting in a credit risk on par with US Treasuries.
- **High liquidity:** With USD 5 trillion in issuance outstanding and average daily trading volume year-to-date in excess of USD 200 billion, US Agency MBS constitute one of the world's largest and most liquid bond markets.[2]
- **Lower duration:** Over the past 10 years, the Bloomberg Barclays US Agency MBS Index has had an average duration profile of 3.7 years.[3] This is comparatively shorter than the Bloomberg Barclays US Investment-grade Corporate Index average duration of 6.7 years and the US Treasury Index average duration of 5.4 years during the same timeframe.[4]
- **Attractive risk-adjusted return history:** In US dollar terms, the Bloomberg Barclays US MBS Index produced positive total returns in nine of the 10 calendar years between 31 December 2006 and 31 December 2016. Furthermore, the annualized risk-adjusted returns of the Bloomberg

Table 1
US MBS have historically higher risk-adjusted returns and lower volatility than US Treasuries and US corporate

	10-year annualized return (%)	10-year annualized volatility (%)	Return per unit of risk (10 years)	15-year annualized return (%)	15-year annualized volatility (%)	Return per unit of risk (15 years)
US Treasuries	4.06	4.06	**1.00**	4.07	4.50	**0.91**
US Corporates	5.79	4.42	**1.31**	5.71	5.16	**1.11**
US MBS	4.31	3.19	**1.35**	4.25	2.95	**1.44**

US Treasuries is the Bloomberg Barclays US Treasury Index; US Corporates is the Bloomberg Barclays US Corporate Index; US MBS is the Bloomberg Barclays US Mortgage-Backed Securities Index.
Source: Bloomberg Barclays Global Indices, Invesco. Data as at 30 June 2017. Total return in USD.

Figure 1
US Agency MBS have historically outperformed US Treasuries and corporates during Fed tightening cycles



Source: Bloomberg Barclays US Government, US Corporate and US MBS Indices for the Fed tightening cycles, including from 4 February 1994 to 1 February 1995, from 30 June 1999 to 16 May 2000 and from 30 June 2004 to 29 June 2006. Total return in USD.

Barclays US MBS Index have exceeded the annualized risk-adjusted returns of the Bloomberg Barclays US Corporate and US Treasury Indices on a trailing 10- and 15-year basis, as shown in table 1.

- **Outperformance in Fed tightening cycles:** US Agency MBS have fared well in past tightening cycles. Since 1990, there have been three episodes when the US Federal Reserve (Fed) raised the US federal funds rate more than once before subsequently lowering it. The Bloomberg Barclays US MBS Index generated positive total returns of 4.2% on average during the three tightening cycles since 1990.[5] These returns exceeded total returns of the Bloomberg Barclays US Corporate Bond Index in all three tightening cycles and outperformed the Bloomberg Barclays US Government Index in two of the three tightening cycles by at least 100 basis points (figure 1).

US non-Agency RMBS: How have they evolved since the credit crisis?

Non-Agency RMBS are mortgage-backed securities collateralized by pools of residential mortgages that are not guaranteed by a US government agency or a federally chartered corporation. They come in a variety of forms as outlined in table 2.

The profile of the non-Agency residential mortgage-backed securities market has changed dramatically since the global financial crisis. In contrast to the subprime bubble, mortgage credit conditions are now tight and the underwriting process is rigorous. Most new loans conform to guidelines developed by the government-sponsored enterprises (GSEs, Fannie Mae and Freddie Mac) or a US government agency (Ginnie Mae), and are securitized and guaranteed through these entities, so that, ultimately, their credit risk equals that of the US government. Prime-quality loans that exceed conforming balance limits are sought after by banks, both for their return profile and the customer relationships. This leaves a relatively small share of the origination for traditional non-Agency securitization.

Nevertheless, a new generation of securities designed to provide credit exposure to residential mortgage loans has emerged. These securities represent a growing component of the US fixed income market, and offer investors a range of potential advantages.

GSE credit risk transfer (CRT) securities constitute the most dynamic of emerging residential credit subsectors. They were first issued in 2013 to shift

Table 2
Non-Agency RMBS security types

Pre-crisis legacy RMBS - Re-REMICs - RPLs/NPLs	- Re-REMICs are securitizations of a non-Agency security, typically a pre-crisis/legacy bond. - Re-performing and non-performing loans that are new securitizations of old loans. Re-performing loans include borrowers that have previously been delinquent, but have returned to current while non-performing loans include borrowers no longer making payments.
Post-crisis Prime Jumbo	Mortgage loans originated after the credit crisis with a loan amount above the conforming loan limit established by the Federal Housing Finance Agency (FHFA) and involving a borrower with a prime credit score.
Government-sponsored enterprise credit risk transfer bonds (GSE CRTs)	CRT's are general obligations of FNMA and FHLMC created in 2013 to effectively transfer a portion of the risk associated with credit losses within pools of conventional residential mortgage loans from the GSEs to the private sector.
Single family rental securitizations (SFRs)	Debt securities backed by rent payments from portfolios of thousands of single family rentals.

much of the credit risk associated with guaranteed loans from US taxpayers to private sector investors. Since then, the GSEs have transferred risk on over USD 1.6 trillion worth of loans through CRT issuance in excess of USD 48 billion.[6] Floating-rate coupons and a range of options for both ratings and maturities have precipitated growing investor interest in the sector. Thanks to healthy home price appreciation and strong underwriting, loans referenced by CRT securities have demonstrated strong credit performance to date, contributing to a cycle of rating upgrades in the sector.

Meanwhile, traditional securitization has made a notable recovery over the past year. With credit spreads declining for securities backed by prime loans that exceed GSE balance limits, originators are increasingly packaging loans into bonds, in lieu of selling to banks.[7] As a result, issuance in the subsector is set to roughly double this year compared to 2016. At the same time, originators and investors are increasingly focused on lending to qualified borrowers who do not meet GSE requirements because they are self-employed or have yet to fully repair their credit profiles following a past bankruptcy or foreclosure.[8] The volume of bonds collateralized by these so-called 'non-qualified mortgage' loans is likely to exceed USD 3 billion this year, tripling the 2016 total.

Turning from new issuance markets, there remains approximately USD 500 million of pre-crisis non-Agency RMBS outstanding.[9] While uncertainty around underlying loan performance drove volatility during the decline of the housing market, the return profile of the subsector stabilized as the recovery progressed. Today, pre-crisis securities offer investors an opportunity to gain exposure to housing market strength with limited interest rate risk.

The US housing market was one of the last asset classes to turn the corner following the global financial crisis. With memories still fresh, credit remains tight and borrower performance has been excellent. Furthermore, the limited supply of housing against a backdrop of strong demand continues to push home prices higher, benefiting residential credit securities. The diversity of rating and maturity profiles available in the sector allows investors to modulate risk and return to suit their individual objectives, allowing non-Agency RMBS to play a valuable role in fixed income portfolios.

Non-Agency RMBS can provide many advantages to a fixed income portfolio.

Non-Agency RMBS can provide many advantages to a fixed income portfolio, including (i) a broad array of credit quality options, (ii) floating rate availability, (iii) investor alignment with real estate market conditions and (iv) securities secured by real assets, allowing them to serve as a key portfolio customization component.

US CMBS: A fixed income allocation booster

The US CMBS market is an important sector in the global fixed income market. It enables a wide range of investors to gain exposure to the US commercial real estate debt market and facilitates financing to real estate property owners. With more than USD 100 billion in annual issuance during the last five years, the CMBS market provides investors with a broad array of duration and risk-adjusted return profiles.[10]

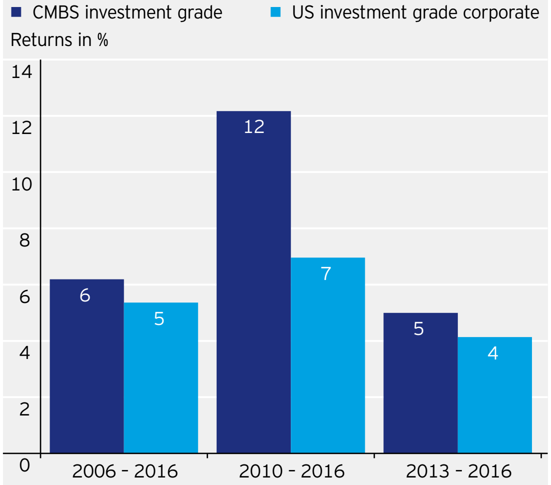
Unlike other securitized assets, many CMBS bonds offer bullet-like structures with defined, relatively tight principal maturity windows which help minimize reinvestment risk (table 3). As most residential mortgage-backed and asset-backed securities are collateralized by underlying loans with a prepayment option available to the borrower, the timing of the return of principal to the residential mortgage-backed or asset-backed securities investor can often change meaningfully as vacillations in interest rates increase or slow the pace of prepayments. Conversely, most CMBS bonds are collateralized by underlying loans with very punitive prepayment penalties, which tend to reduce prepayment activity and lower volatility in the timing of principal repayment, often resulting in a return of principal closely in alignment

Table 3
Yield-to-maturity and duration comparisons of CMBS vs. US corporate bonds

Features	US CMBS	US corporate bonds
AA rated yield / duration	3.49% / 6.29	2.64% / 6.70
Single-A rated yield / duration	3.87% / 5.79	2.97% / 7.58
BBB rated yield / duration	5.82% / 5.78	3.49% / 7.44
Maturity profile	Bullet-like	Bullet
Prepayment protection	Yes	Limited call protection
Collateral	Secured by real property	Limited
Typical investor base	Sophisticated institutional	Broad institutional and retail

Source: Invesco Fixed Income and Barclays Live, as at 30 June 2017. CMBS are Bloomberg Barclays CMBS Indices (AA, A, and BBB). Corporate Bonds are Bloomberg Barclays US Corporate Indices (AA, A, and BBB).

Figure 2
US investment grade CMBS have historically outperformed US investment-grade corporate bonds



Source: Barclays Live, as at 31 December 2016. US CMBS investment grade is the Bloomberg Barclays CMBS Investment-grade Index. US investment grade corporate is the Bloomberg Barclays US Corporate Index. Returns represent the geometric average of the total USD returns for each calendar year during the period specified.

with the scheduled maturity date of the bond. Most CMBS bonds benefit from geographic, property type and tenant diversification. However, opportunities also exist in single asset investments where one property serves as the collateral. CMBS assets can be structured as either fixed- or floating-rate investments, and are secured by interests in real property, which differentiates them from unsecured corporate bonds.

Exposure to commercial real estate may help investors diversify and provide exposure to an improving economy and real estate market. CMBS can offer incremental returns over comparably rated opportunities in the US investment-grade corporate bond market (figure 2) while providing potentially better yields, lower duration risk, stronger prepayment protection and collateral backing.

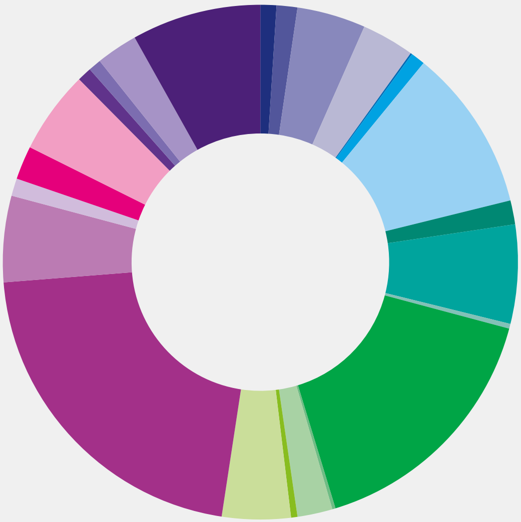
US ABS: What can make them a good portfolio addition?

ABS may offer investors an opportunity to further diversify their fixed income exposures into an historically defensive asset class backed primarily by consumer-related credit. ABS offer modest yield, but significantly lower historical volatility than competing asset classes. The breadth of the asset-backed market composition is unusual, with 24 subsectors, as shown in figure 3.

Benefits of investments in ABS may include access to seasoned sponsors of consumer-related assets, exposure to assets with high credit quality and structural protection against losses, a deep investor base, liquidity and consistent supply, as well as, in the past, lower spread volatility with higher income levels over US Treasuries and Agency MBS.[11]

ABS have benefited from adjustments made post-crisis by both rating agencies and regulators. Required credit enhancement levels rose as rating agencies adjusted their models, and most issuers chose to maintain those levels even after they tightened underwriting standards. Further, auto loan ABS transactions specifically tend to quickly de-lever as the underlying loans are repaid and credit enhancement grows in the face of declining loan to value ratios. Indeed, this rapid de-levering and associated improvement in deal

Figure 3
US ABS sector share outstanding



■ RRB	1.0%
■ Fleet lease	1.3%
■ Floorplan	4.3%
■ Auto lease	3.3%
■ Motorcycle	0.1%
■ Near prime auto	0.9%
■ Prime auto	10.2%
■ Rental vehicle	1.5%
■ Subprime auto	6.2%
■ Other auto	0.3%
■ Bank card	16.1%
■ Charge card	0.2%
■ Retail card	2.2%
■ Equipment floorplan	0.4%
■ Equipment transport	4.3%
■ FFELP SL	21.3%
■ Private SL	5.4%
■ Cell tower	1.1%
■ Franchise loan	2.1%
■ SBA	5.2%
■ Str. settle	0.9%
■ Timeshare	0.8%
■ Consumer	2.6%
■ Other ABS	8.1%

Source: SIFMA. Data as at 31 March 2017.

How can a portfolio of securitized assets be customized to provide client solutions?

Due to the diverse asset characteristics across the structured securities market, we find that these security types lend themselves to creating a discretionary multi- or single-asset strategy that can deliver an array of income and duration profiles via debt instruments that are backed, unlike most corporate bonds, by real assets. The table below shows a cross-section of custom strategies comprised entirely of structured securities we believe may be well-suited to achieving common investor objectives, particularly with respect to yield, quality, liquidity and collateral protection.

Custom structured securities investment strategies overview

	US mortgage-backed Agency focused	***US mortgage-backed securities***	***Structured credit limited***	***Real estate fixed income opportunity***	***High-quality variable rate bond***	***Opportunistic mortgage***
Summary of strategy	*A very high-quality government-backed MBS strategy designed to provide safety and liquidity*	*A high-quality, income-generating strategy well-suited for core fixed income allocations*	*A very high-quality, low-duration strategy focused on enhancing income and minimizing downside risk*	*A high-income strategy utilizing a diversified portfolio of commercial and residential real estate debt*	*A high-quality, multi-asset, variable-rate strategy designed to enhance yield and protect against rising rates*	*A high-income, leveraged multi-asset strategy utilizing a breadth of real estate debt investments*
Benchmark	*Bloomberg Barclays US Mortgage Backed Securities Index*	*Bloomberg Barclays US Mortgage Backed Securities Index*	*80% Bloomberg Barclays ABS AAA Index and 20% US CMBS 2.0 AAA Index*	*None*	*Bloomberg Barclays Floating Rate Notes TR Index Value Unhedged USD*	*None*
Asset classes	*Agency MBS*	*Agency MBS, RMBS, CMBS, ABS*	*ABS, CMBS, CMO*	*CMBS, RMBS, corporate debt and preferreds*	*Treasuries, Agencies, MBS, IG corporates, ABS, Pfandbriefe*	*Agency MBS, RMBS, CMBS, commercial loans*
Average quality	*AAA*	*AA*	*AAA*	*BBB*	*High A*	*A*

Source: Invesco. Data as at 3 October 2017.

performance has led to numerous credit rating upgrades of subordinate auto loan ABS tranches.

Conclusion: Why consider securitized assets in a fixed income portfolio allocation?

We conclude by answering the question we believe every investor should ask: "Why should a typical fixed income portfolio include an allocation to structured securities?" We believe the rationale can best be summarized by four reasons:

1. Structured securities introduce assets backed by real assets;

2. The diversity in composition of structured assets is conducive to single- and multi-asset portfolio optionality;

3. Structured securities offer an alternative to corporates and US Treasuries, owned heavily in many core fixed income holdings;

4. Diversity in return, liquidity, credit quality, and duration profiles make the asset class conducive to customization and effectively accomplishing investor objectives.

A word about risk

In this article we have described the potential benefits of investing in different kinds of securitizations. However, this does not mean that such investments are without risks. The following risks are of particular relevance:

- **Agency MBS:**
  MBS are subject to prepayment or call risk, which is the risk that a borrower's payments may be received earlier than expected due to changes in prepayment rates on underlying loans. Faster prepayments often happen when interest rates are falling. MBS also are subject to extension risk. An unexpected rise in interest rates could reduce the rate of prepayments and extend the life of the MBS, causing the price of the MBS to fall and making the MBS more sensitive to interest rate changes. An unexpectedly high rate of defaults on the mortgages held by a mortgage pool will adversely affect the value of MBS and could result in losses.

- **Non-Agency RMBS:**
  As with Agency MBS, non-Agency RMBS are subject to prepayment or call risk. Unlike Agency MBS, principal and interest payments are not guaranteed by the issuer. Changes in the interest rate environment and the credit performance of underlying loans can impact payments, and in some cases result in principal losses. Adverse credit performance can potentially result from a number of factors, including defaults, foreclosure timeline extension, fraud, home price depreciation or unfavourable modification of loan principal amount, interest rate and amortization of principal. The ability of a borrower to repay a mortgage loan secured by a residential property is dependent in part on the income and assets of the borrower. A number of factors over which investors have no control may impair a borrower's ability to repay their loans.

- **CMBS:**
  Investments in CMBS are subject to the various risks which relate to the pool of underlying assets in which the CMBS represents an interest. These include such risks as declines in the value of real estate, declines in rental or occupancy rates or risks related to general and local economic conditions. These and other factors may impact the ability of a borrower to meet its obligations on the loan. CMBS are also subject to the same risks as noted for MBS above.

- **ABS:**
  Investments in ABS are subject to the risks related to losses in underlying collateral pools potentially exceeding the protective credit enhancements of excess collateral, seller residuals and subordination. Rising unemployment levels, declines in underlying collateral values and a general recessionary environment can lead to higher losses in underlying collateral. These and other factors may impact the ability of borrowers to meet their loan obligations and also hinder the value of the assets pledged as collateral, such as vehicles in auto loans.

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Notes

[1] Source: Bloomberg Barclays Global Aggregate Bond Index, Bloomberg Barclays US Aggregate Bond Index, Bloomberg Barclays US Corporate Bond Index, Bloomberg Barclays Euro Corporate Bond Index. Data from 1 January 2008 to 31 December 2008 and 1 January 2011 to 31 December 2011. Risk-adjusted return comparison of the Bloomberg Barclays US Corporate Index, the Bloomberg Barclays US Treasury Index and the Bloomberg Barclays US MBS Index as at 30 June 2017.

[2] Source: BarclaysLive, 28 September 2017. SIFMA, August 2017.

[3] Source: Bloomberg Barclays, 30 June 2016.

[4] Ibid.

[5] Source: Bloomberg Barclays US Government, US Corporate and US MBS Indices for the Fed tightening cycles from beginning to end, including from 4 February 1994 to 1 February 1995, from 30 June 1999 to 16 May 2000, and from 30 June 2004 to 29 June 2006.

[6] Source: Intex, August 2017. GSE balance limits are USD 424,100 for single unit properties in most areas and USD 636,150 for single unit properties in high cost areas. The GSEs have an extensive list of requirements that borrowers and collateral properties must meet in order to qualify for an agency-conforming loan.

[7] Ibid.

[8] Ibid.

[9] Source: Bank of America Merrill Lynch, 12 September 2017.

[10] Source: JPMorgan Research, Commercial Mortgage Alert and Fannie Mae, 2 October 2017.

[11] Structural protection refers to credit enhancement and deal structures that protect investors. The risks are that underlying collateral losses exceed these protections, but that would require losses to increase quite dramatically from the expected case.

"Generation Income" – looking beyond traditional real estate

By Daniel Kubiak, Marc Socker and Darin Turner

In brief
We describe three alternative real estate asset classes that may cater to investors' income needs. European hotels are becoming ever more interesting – not least due to rising tourism. US real estate is particularly compelling if one invests outside the major agglomerations. And, finally, global income securities (aka listed real estate) provide a full range of instruments with diverse risk and return characteristics.

Investors need income, but how can it be generated in a low-return environment? For real estate investors, it may be time to look beyond the well-known. In this article, we present three alternatives that can enhance real estate investments or multi-asset portfolios: European hotels, income-focused investing in the US and global income securities.

Whether it's Generation X, Y or Z, or the iGeneration, one thing that remains steadfast throughout the generations is the need to create income in order to achieve long-term financial goals. Never more so than in today's environment of low returns and increasing financial pressures, which means that savvy investors are increasingly having to look beyond the realms of long-established tradition to find solutions with potential for decent income returns, that match liabilities and may offer lower volatility. It's all about "Generation Income".

It's all about "Generation Income".

Real estate has long been regarded as a complementary investment within a multi-asset portfolio, given its low correlation to bonds and equities in the past. But a deeper look at the asset class reveals that, outside of more traditional core

investments lies a selection of strategies and solutions providing long-term income streams, lower volatility potential and effective liability matching.

Making room for European hotels in a multi-asset portfolio

Hotels have become a new mainstream real estate asset class over the past 10 years, adding complementary attributes to a multi-asset portfolio. Leased hotels' strong income component, relative resilience compared to commercial real estate during the global financial crisis (figure 1), the increased depth of transparent performance data and liability-matching characteristics given the longer-dated income, make for a compelling story.

Since 2008, hotel real estate has accounted for an average of 7% of total European investment volumes in real estate, with EUR 8.5 billion of assets trading in 2016. Since 2010, hotel yields have maintained a premium over comparable quality commercial office or retail assets, despite leased hotels typically offering longer-dated income streams and potentially more stable investment performance.

There are multiple strategic opportunities for investors in hotel real estate, depending on risk/return preference. Hotels comprise both an operating business and an underlying real estate asset. These can be separated and considered as two distinct components.

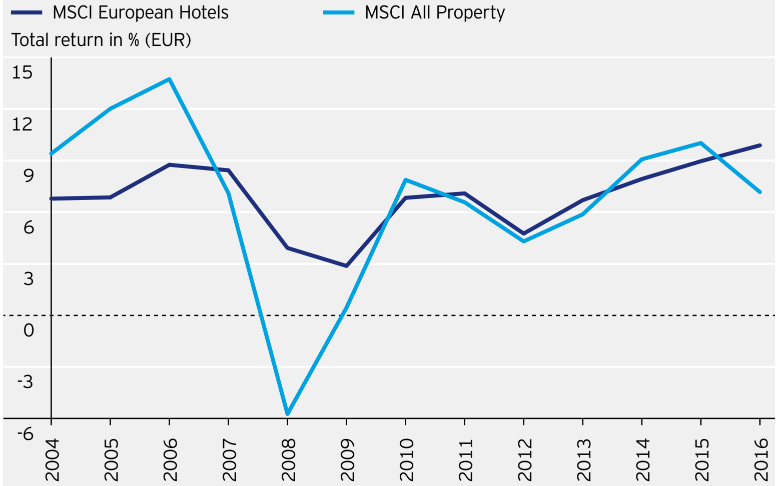
Hotel real estate investors can then consciously take on management agreements with higher operational risk with a view to accessing growth potential, or transfer much of that risk to the tenant and settle for more stable or fixed-lease income. There is also the opportunity to invest into different market positioning, and through branded hotel chains or local hotel operators. The drivers of growth in the hotel sector continue to look positive.

> The drivers of growth in the hotel sector continue to look positive.

Hotels subject to leases (as opposed to management contracts) offer relatively stable income-return potential due to the underlying assets being cash flow generative – a good match for lease liabilities with explicit oversight of rent affordability through the asset's operating performance. In the mid-market segment, hybrid leases which provide a minimum income with the addition of potential turnover performance are common.

The daily pricing of the underlying rooms can then provide inflation protection, with long-term real growth in revenues. Turnover has grown in real terms over 5-, 10- and 20-year periods. Hotels suffer less depreciation than many other real estate assets because it is possible to refurbish rooms on a phased basis while the hotel continues to operate, meaning that hotels are both kept modernized and are very rarely empty or non-income producing.

Figure 1
European hotels can provide relatively stable returns



Source: MSCI. Data as at April 2017. Latest data available.

This is one reason for the relative return stability, alongside higher starting income yields. Values may also be relatively protected due to the long-term nature of hotel leases, derived from a cash flow-generating underlying asset; the high quality real estate (typically hotels are in core Central Business District (CBD) locations, serving tourism and business demand) and lower asset depreciation (ongoing tenant investment into the asset as part of their business maintains quality of real estate).

In addition, hotel real estate adds sector diversification to a core real estate portfolio given the different underlying industry exposure which is otherwise hard to access.

Checking-in to European hotels

Travel within Europe is increasing steadily because of improving economic conditions. Moreover, Europe is also a key beneficiary of the growth in inter-regional travel, especially from China. Low oil prices provide further support for cross-border travel. Growth in supply of rooms continues to lag demand, despite growth in sector disrupters such as Airbnb. Europe remains relatively undersupplied with strong hotel brands, and operators continue to seek opportunities to increase their presence in major cities across Europe.

The extended stay / serviced apartment market is a rapidly growing segment. According to the Global Serviced Apartment Industry Report (GSAIR 2016/2017), the number of serviced apartments in Europe has almost doubled over the past three years, and the number of locations served has increased threefold.

The hotel sector across Europe has exhibited above-inflation growth over the past 20 years. We believe this is set to continue in the prime markets across Europe for the following key reasons:

- Underlying demand is expected to continue: 3.8% p.a. (45% compound) growth in European tourist arrivals forecast between 2010 and 2020.

- Supply response has been muted: 2.8% of stock under construction across EMEA.

- Less than 30% of hotel stock is branded: suggesting room for new supply from the main hotel groups which can provide higher quality assets to capture existing market share.

- 18 quarters of positive revenue growth: since last negative quarter; only two negative quarters in last eight years (source: STR/MKG to September 2017. Negative quarters: Q1 2013 and Q4 2011). In many cases directly feeding through to rental income.

- Evolving tourism industry: and varying consumer preferences facilitating the emergence of hotel sub-sectors, thus providing further opportunities to access market growth.

At Invesco Real Estate, we favour seven-day trading cities, particularly those with well above-average occupancy levels, such as Amsterdam, Paris and Madrid.

Income-focused investment in the US

Another option for achieving income is a more income-oriented "core" approach, which focuses on relatively high current income and cash returns.

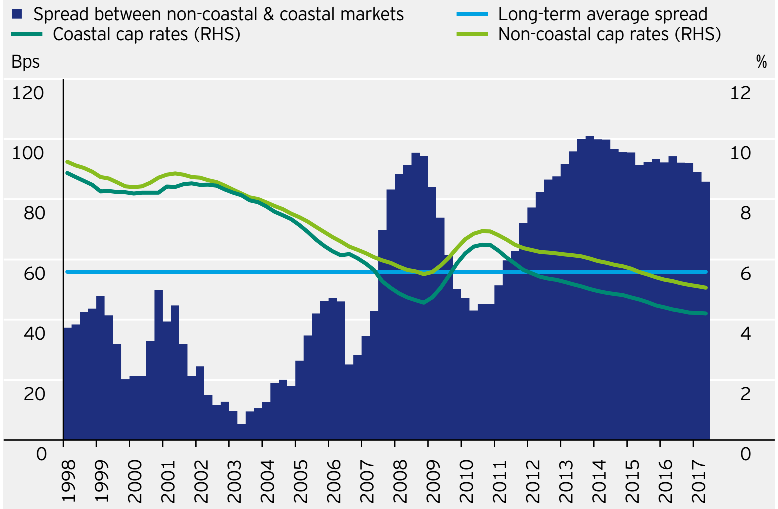
> The US real estate market is a good example of how an income-focused strategy can work.

The US real estate market is a good example of how an income-focused strategy can work. For example, a focus on markets outside the major coastal / gateway markets, such as: New York, Washington, Boston, San Francisco, Los Angeles and Seattle (generally 3% to 4% cap rates), and instead on the 'next set' of well-known primary and select secondary non-gateway markets (such as Dallas, Atlanta, Denver, Houston, Portland and Charlotte – generally 5% to 6% cap rates) is a good place to start. In our view, there is a meaningful, long-term income return spread between US coastal / gateway and non-gateway markets. Currently, income spreads between gateway and non-gateway markets are wider than their long-term average levels (figure 2, top), denoting the ability to not only achieve premium income returns but also potentially realize capital appreciation over time as spreads revert back to their long-term average. However, to manage risk within these non-gateway markets, the focus is exclusively on institutional quality 'core' asset profiles and locations.

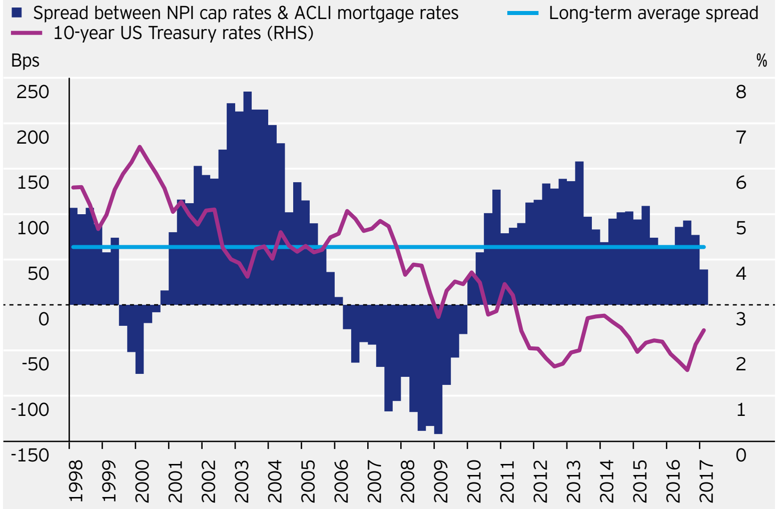
Figure 2

Income returns and leverage in a typical US income-focused programme

Income returns



Leverage



Coastal markets: Boston, Los Angeles, New York, San Francisco, Seattle, Washington, DC, with the industrial sector including the following adjacent coastal markets: Riverside, Orange County, Oakland, Tacoma, Newark, Edison, and Baltimore.
Source: NCREIF Property Index (NPI), Invesco Real Estate, Moody's Analytics, ACLI ("American Council of Life Insurance") mortgage rates, data as at Q2/2017.

At the same time, the ability to prudently take advantage of modest levels of accretive debt financing is key, and can increment unleveraged income returns by 100+ basis points. For example, leverage can be locked in at low fixed-rates for extended time periods, with the available terms exceedingly attractive on both an absolute basis, given historically low US Treasury rates, and a relative basis, with spreads between cap rates and mortgage rates over the near-term generally ranging somewhere near or above their long-term average (figure 2, bottom).

Therefore, a modest leverage level of 40%-45%, can produce prudent debt yield (DY) and debt service coverage ratio (DSCR) metrics in line with those traditional core strategies due to the premium income return levels of an income-focused strategy.

The attributes of an income-focused strategy are such that they offer a complimentary addition to other lower-yielding direct real estate strategies, such as trophy core, value add and opportunistic portfolios. In addition to the focus on relatively high income and cash returns, a strategy would also feature investments in predominantly non-gateway markets, an overweight position in apartments / residential due to their strong income component and a counterbalance underweight allocation to offices, which can be volatile and provide poor cash returns due to capex reinvestment.

Global-listed real estate securities portfolio with income focus

Since the onset of the global financial crisis in 2008, volatility within listed real estate equity has increased. Correlations among common stocks have also been elevated, causing stocks to move up and down together.

A potential solution for investors looking to offset this and the volatility within their portfolio, while continuing to reap the benefits of relatively stable income, can potentially be found by focussing on a listed real estate securities portfolio which invests across the global universe and specifically targets income. In our view, this approach has the following attributes:

- Income focus with the opportunity to capture listed real estate equity returns
- Ability to grow cash flows to help offset potential impact of inflation
- Opportunity to reduce volatility with downside protection potential by investing across the listed real estate capital structure

> It is our belief that the ability to invest across the listed real estate capital structure makes for an attractive risk-return profile.

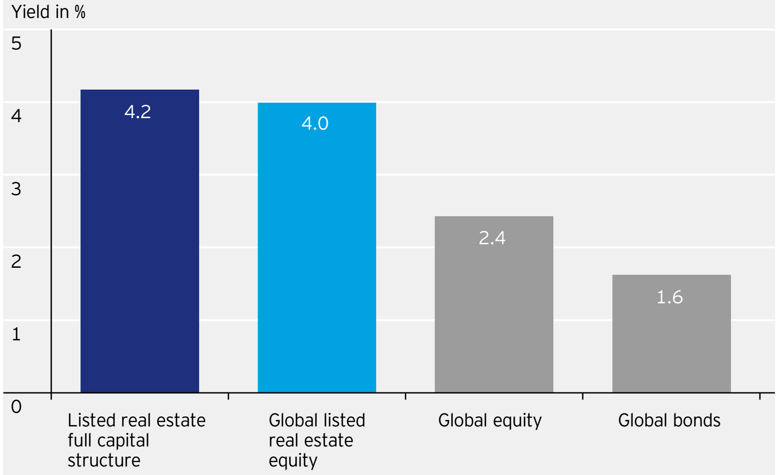
Such an approach could invest across the entire capital structure, including common stock, preferred securities, REIT corporate debt and commercial mortgage-backed securities (CMBS). It is our belief that the ability to invest across the listed real estate capital structure makes for an attractive risk-return profile by potentially lowering volatility. Against an all-equity real estate index, such investments have traditionally provided lower volatility, measured by standard deviation, and a competitive return profile. Since correlations across the capital structure are not as elevated, there is an opportunity to tactically allocate and take advantage of any mispricing in the marketplace.

Should there be a move in interest rates, maintaining low-duration in the fixed income portfolio works well, as low duration securities are traditionally less susceptible to interest rate risk. Additionally, if some securities within the portfolio are floating rate, these will reset periodically as rates rise. Lastly, a listed real estate full capital structure[1] approach has had low correlation with traditional fixed income indices,[2] and may be a good way to diversify an investor's fixed income allocation. From June 2002 to June 2017, the correlation between the index and the listed real estate full capital structure was 0.41 according to StyleAdvisor.

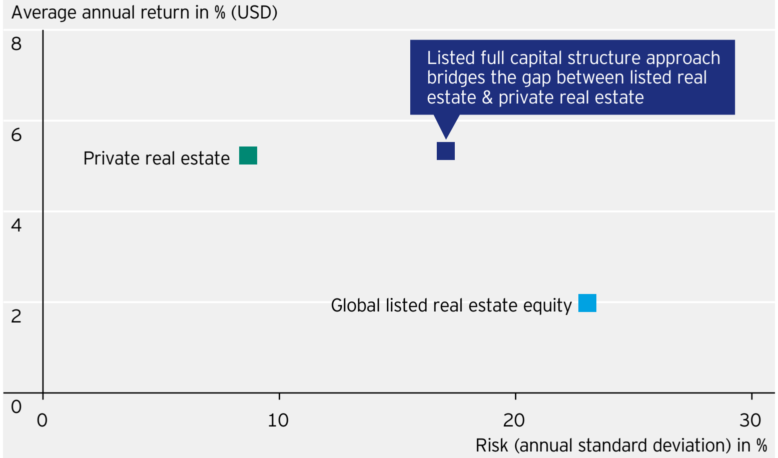
It is reasonable to expect that the path of future rate increases is likely to remain volatile, and that from a risk-return standpoint, the flexibility to invest in stocks and fixed income securities may enable investors to have a lower risk profile than all-equity real estate portfolios, while possibly maintaining competitive risk-adjusted performance and greater downside protection (figure 3).

Figure 3
Full capital structure approach to income-focused securities

Income comparison (30 June 2017)



Shifting the risk-return profile using the listed real estate full capital structure approach (July 2007 – June 2017)



Source: Invesco Real Estate, S&P, Barclays, MSCI, ODCE and FTSE. Data as at 30 June 2017. Listed real estate full capital structure represented by Invesco Global Real Estate Income Composite, gross of fees, none GIPS compliant returns. The GIPS compliant returns, including net of fees returns for the composite, are presented in the Appendix at the end of this article. Private real estate represented by ODCE Core Fund Index Value Weighted Total Return. Global equity represented by MSCI World Index. Global bonds represented by Barclays Global Aggregate Bond Index. Global listed real estate equity represented by FTSE EPRA NAREIT Developed Index (Net of W/H).

Conclusion

Investors need income, and real estate can provide it. In this article, we have described three rather different solutions that have one thing in common: the potential for generating income. This is true for European hotels as well as for income strategies in the US, and global income real estate securities. All three can complement real estate portfolios as well as portfolios consisting of other asset classes.

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Darin Turner works as a Portfolio Manager performing quantitative and fundamental research on real asset securities, including both equity and fixed income instruments.

Notes
1 Represented by Invesco Global Real Estate Income Composite.
2 Represented by Bloomberg Barclays Global Aggregate Index.

Appendix

Invesco Global Real Estate Income Composite

Schedule of Investment Performance

	Gross Rate of Return (%)	Net Rate of Return (%)	Benchmark Return (%)	Composite 3-Year St Dev (%)	Benchmark 3-Year St Dev (%)	Number of Portfolios	Composite Assets (USD Millions)	Total Firm Assets (USD Billions)	Composite Dispersion (%)
2016	6.26	5.42	4.06	8.05	12.38	1	965	599	n/a
2015	-0.17	-0.96	-0.79	8.58	12.46	1	909	575.1	n/a
2014	15.73	14.81	15.02	8.61	11.18	1	1164	584.9	n/a
2013	1.14	0.38	4.39	9.14	11.56	1	1006	572.8	n/a
2012	19.56	18.67	19.63	9.3	10.68	1	737	497.1	n/a
2011	4.99	4.21	4.96	18.99	22.99	1	307	479.8	n/a
2010	20.3	19.4	25.73	27.08	30.48	1	248	475.3	n/a
2009	36.48	35.47	45.6	27.22	31.84	1	180	140.5	n/a
2008	-31.04	-31.55	-28.95	22.09	24.95	1	74	126	n/a
2007	-9.68	-10.35	-15.36	13.18	17.04	1	128	154.8	n/a
2006	30.4	29.43	35.73	15.89	16.51	1	678	143.4	n/a
2005	5.44	4.66	12.13	15.81	15.56	1	903	129	n/a
2004	25.58	24.65	31.49	n/a	n/a	1	1004	137.2	n/a
2003	52.94	51.8	36.74	n/a	n/a	1	917	151.8	n/a
2002 (7 months)	-6.15	-6.56	-6.1	n/a	n/a	1	717	144	n/a

	Annual Compound Rates of Return Ending 31 December 2016		
1 Year	6,26	5,42	4,06
3 Years	7,08	6,23	5,9
5 Years	8,22	7,38	8,05
7 Years	9,4	8,56	9,96
10 Years	4,77	3,97	5,46
Since Inception (05/31/2002)	9,88	9,05	10,65

Invesco Worldwide claims compliance with the Global Investment Performance Standards (GIPS®) and has prepared and presented this report in compliance with the GIPS standards. Invesco Worldwide has been independently verified for the periods 1st January 2003 thru 31st December 2015. The legacy firms that constitute Invesco Worldwide have been verified since 2001 or earlier. The verification reports are available upon request.

Verification assesses whether (1) the firm has complied with all the composite construction requirements of the GIPS standards on a firm-wide basis and (2) the firm's policies and procedures are designed to calculate and present performance in compliance with the GIPS standards. Verification does not ensure the accuracy of any specific composite presentation.

Performance Notes

Invesco Worldwide ("The Firm") manages a broad array of investment strategies around the world. The Firm comprises U.S.-based Invesco Advisers, Inc. (excluding Unit Investment Trusts) and all wholly owned Invesco firms outside of North America (excluding Religare Enterprises Ltd). All entities within the Firm are directly or indirectly owned by Invesco Ltd. Invesco Canada Ltd. is also a GIPS-compliant firm whose assets are managed by a subsidiary of Invesco Ltd. Invesco Senior Secured Management, Inc., Invesco Private Capital, Inc., and Invesco PowerShares Capital Management LLC are affiliates of the Firm. Each is an SEC-registered investment adviser and is marketed as a separate entity. Invesco Great Wall Fund Management Co. Ltd is a fund management company established under China Securities Regulatory Commission's approval, and its assets are excluded from total Firm assets.

The Invesco Global Real Estate Income Composite consists of all fee paying discretionary portfolios whose mandate is to provide high current income with a secondary objective of capital appreciation sought by investing in income-producing equity securities issued by REITs. The composite was created on May 31, 2002. Effective March 12, 2007 the primary underlying portfolio moved from a closed-end mutual fund to an open-end mutual fund. Historical returns for this composite may include the impact of leverage. The Invesco Global Real Estate Income Composite is indexed to the Custom Global Real Estate Income Composite Index which is a custom benchmark that is composed of all former benchmarks and currently 100% FTSE EPRA/NAREIT Developed Real Estate Index.

- Effective April 30, 2010, the AIM Select Real Estate Income Composite was renamed the Invesco Select Real Estate Composite .
- Effective September 1, 2011, the Invesco Select Real Estate Composite was renamed the Invesco Global Real Estate Income Composite

Effective April 30, 2006 the portfolio changed it's benchmark from the MSCI U.S. REIT to the FTSE NAREIT All Equity Index. This benchmark was chosen because it is more widely recognized in the real estate sector. Effective December 31, 2007 the portfolio changed its benchmark from the FTSE NAREIT All Equity Index to a custom benchmark which consists of 50% FTSE NAREIT All Equity Index and 50% Wachovia Hybrid and Preferred Securities REIT Index, rebalanced monthly. This custom index was created to better reflect the balanced nature of the portfolio. Effective September 1, 2011, the custom benchmark consists of the following: 50% FTSE EPRA/NAREIT Developed Real Estate Index and 50% Wells Fargo Hybrid Preferred Securities Index, rebalanced monthly. This change switched the equity portion of the index from US to global. Effective December 21, 2012, the benchmark changed from a balanced benchmark to an equity only benchmark, the FTSE EPRA NAREIT Developed Real Estate Index. This change was made due to the fact that certain data was not always available on the balanced benchmark (i.e. yield, attribution, valuation/growth metrics etc.)

Composite Dispersion is calculated using the asset-weighted standard deviation of the annual returns of all portfolios that were included in the composite for the entire year. It is considered not meaningful for composites with fewer than three portfolios during the year. The three-year annualized standard deviation measures the variability of the composite and the benchmark returns over the preceding 36-month period. The standard deviation is not presented where there is less than 36 months of performance history.

Gross total returns are presented before the deduction of management fees, brokerage commissions, and administrative fees; are net of all transaction costs; and are supplemental to net returns. Net returns include the effect of the maximum annual advisory fee as noted in the accompanying fee schedule. All information is expressed in U.S. dollars. Portfolio returns are net of all foreign withholding taxes, as applicable.

The management fee schedule is as follows: 80 basis points on the first USD 100 million;
70 basis points thereafter.

The minimum portfolio size for the Composite is USD 1,000,000.

The composite creation date is May 31, 2002.

A complete list of composite descriptions is available upon request. Polices for valuing portfolios, calculating performance, and preparing compliant presentations is available upon request.

Important information

All data as of October 30, 2017 unless stated otherwise.

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