

ARCHIVED

LEARNING FROM
ACADEMIA



2019

Risk Factors

The views expressed should not be considered as advice or a recommendation to buy, sell or hold a particular investment. They reflect opinion and should not be taken as statements of fact nor should any reliance be placed on them when making investment decisions.

This communication was produced and approved in 2019 and has not been updated subsequently. It represents views held at the time of writing and may not reflect current thinking.

ARCHIVED

LEARNING FROM
ACADEMIA

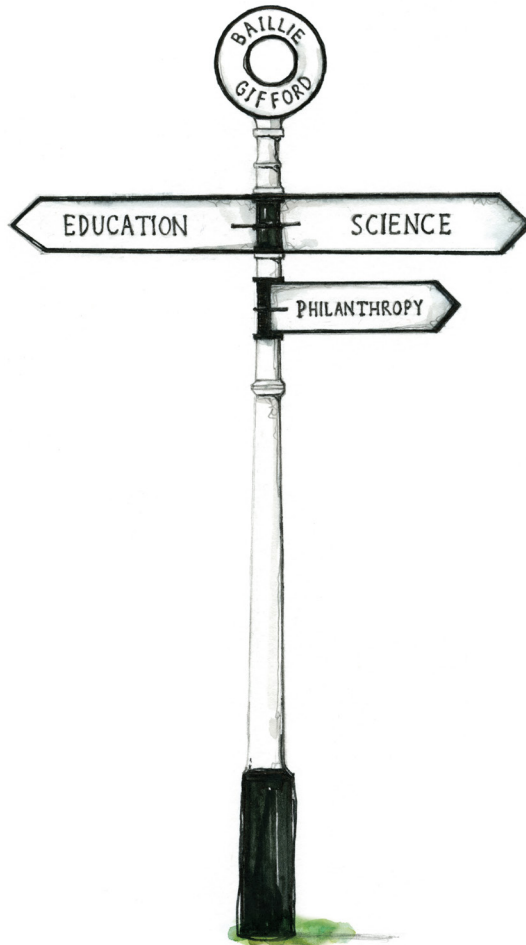


2019



ARCHIVED

LEARNING FROM ACADEMIA



ARCHIVED

WELCOME

Investment managers tend to rely on company and industry research, provided by investment banks. Because these investors use similar information, they often reach similar conclusions.

Baillie Gifford's curiosity led us down a different road, as the articles that follow will show.

A key example of our inquisitive thinking has been our sponsorship of book festivals across the UK. Our support for large and small book festivals throughout the UK allows us to invite authors into our offices to share their views. Among the distinguished thinkers who visited our offices in 2018 were the economist Sir Nicholas Stern, the business strategist Bruno Maçães and the historian Adam Tooze.

We also heard from academics whose research piqued our interest, prompting us initially to form links with educational establishments in Edinburgh and Glasgow. Since then, we have gradually widened our search, including forays to Arizona, New Mexico and the Netherlands, to discover more intriguing, clever people doing intriguing, clever things.

Our funding and support place us at the junction of education, science and philanthropy. We have a firm-wide research budget and take the view that using some of the money to discover new frontiers for ourselves is of greater value than following the herd and buying in research. We see this work as a combination of research, sponsorship and good corporate citizenship.

We hope our links with academia can accelerate the pace of research and bring forward possible benefits for society. That could involve helping to alleviate diseases such as dementia, as in Tara Spires-Jones's Edinburgh-based research project, or understanding the ethical dilemmas of AI like Jeroen van den Hoven in Delft. These collaborations fit with our long-term approach to investing, which is geared to supporting projects that take many years to reach fruition. Security of funding over such a timescale is rare in academia.

Baillie Gifford has no desire to influence or control this research. Our aim is to encourage experimentation, diversity and autonomy. The interest we show leads academics to appreciate that our partnerships are about more than just financial aid. This helps differentiate us from our competitors.

By its very nature, a long-term research programme may never deliver on its promises. But those projects that come to nothing should be seen as experimentation, not failure. Those that do work could be hugely valuable in developing our thinking on a range of subjects.

We are delighted to share these views on some of the areas we are working on, as well as the thoughts of some of those academic partners.

Nick Thomas
Partner

CONTRIBUTORS

Nick Thomas

is a partner at Baillie Gifford and joint leader of the firm's academic collaboration and literary sponsorship programme. He is also chair of the board of Edinburgh's Fruitmarket Gallery.

James Anderson

has managed Scottish Mortgage Investment Trust since 2000. James is a partner at Baillie Gifford and was a member of the advisory board of the Kay Review into financial services.

Nicola Ragge

is a professor in Medical Genetics at Oxford Brookes University and consultant clinical geneticist at Birmingham Women's and Children's NHS Foundation Hospital Trust.

Tara Spires-Jones

is professor of Neurodegeneration and deputy director of the Centre for Discovery Brain Sciences at the University of Edinburgh. She also leads one of the research programmes in the UK Dementia Research Institute.

Paulina Sliwinska

is an investment manager at Baillie Gifford. She is a graduate of the University of Edinburgh, where she studied Arabic and politics. She is an analyst in the International Growth team and co-manager of the International Concentrated Growth strategy.

Lawrence Burns

is co-manager of the International Concentrated Growth strategy as well as a member of the International Growth Portfolio Construction Group. He graduated in Geography from the University of Cambridge in 2009 and joined Baillie Gifford in the same year.

Tom Coutts

joined Baillie Gifford in 1999 and worked in the UK and European Equities teams before moving full-time to the International Growth team in 2017. He became a partner in 2014 and is joint leader, with Nick, of the firm's academic collaboration.

Illustrator: Shen Foo

joined Baillie Gifford as a member of the Creative Multimedia team in 2019. He graduated from the University of Edinburgh with a first class degree in Visual Communication.

ARCHIVED

C O N T E N T S

Global Links

Baillie Gifford's world of partnerships 4

At The Extremes

James Anderson's search for the 4 per cent 6

Eyes On The Prize

Pioneering optical genetics in Oxford 12

Desert Dialogues

Learning from the Santa Fe Institute 16

Future-Focused

Brian Arthur shares his vision 22

Defying Dementia

University of Edinburgh at the frontline 26

Going Dutch

Delft University's cutting edge 30

Last Word

Why we love academic collaboration 34

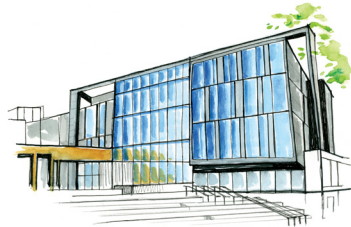
BAILLIE GIFFORD'S ACADEMIC LINKS

*We are supporting or have consultancy agreements
with the following academics and universities.*

UNITED KINGDOM

Oxford Brookes University

The goal of Professor Nicky Ragge at Oxford Brookes University is to understand the numerous genes responsible for the underdevelopment of the eye in children, and to research possible treatments.



University of Oxford

We are supporting Professor Doyme Farmer, an expert in complexity economics, whose work aims to transform standard economic modelling. His current research is in agent-based modelling, financial instability and technological progress.

University of Cambridge

We have sponsored the newly-created role of programme director on Responsible Artificial Intelligence at the Leverhulme Centre for the Future of Intelligence, University of Cambridge.

London Mathematical Laboratory

The Ergodicity Economics programme at the London Mathematical Laboratory is run by Ole Peters, an expert on randomness in the context of economics.

University of Sussex

The Science Policy Research Unit in the School of Business, Management and Economics at the University of Sussex researches deep transitions to understand how past trends can help to imagine the future.

University College London

University College London's Institute for Innovation and Public Purpose was established by Mariana Mazzucato to rethink how public value is created, nurtured and evaluated.

University of Edinburgh

We are helping to fund a Chair and a ten-year research programme into data and AI ethics. Baillie Gifford is also supporting the Centre for Dementia Prevention, which studies Alzheimer's.

ARCHIVED



FRANCE

Toulouse School of Economics

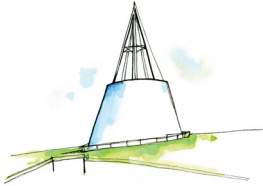
Toulouse School of Economics is one of Europe's leading economics institutions and we are helping it establish a Sustainable Finance Centre.



CHINA

Tsinghua University

Baillie Gifford is partnering with Tsinghua University to fund research into the fascinating area of computational biology, which gathers insights from data to diagnose disease.



NETHERLANDS

Delft University of Technology

Delft University of Technology in the Netherlands is renowned as a leading centre for engineering and technology. The collaboration gives us access to innovative thinkers.



UNITED STATES

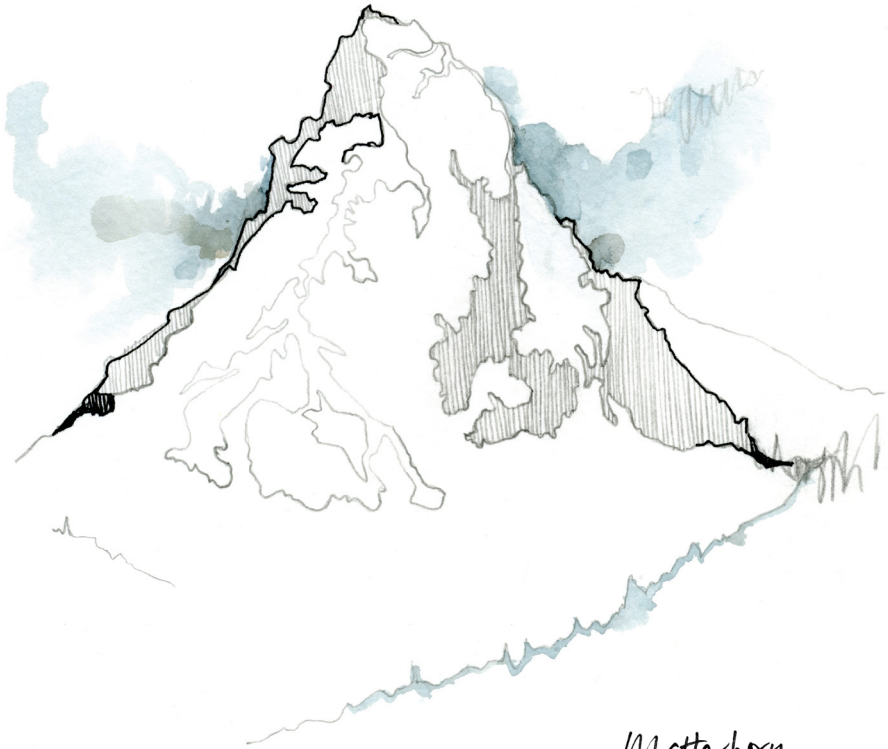
Santa Fe Institute

Baillie Gifford is a member of the Santa Fe Institute's Applied Complexity Network. The network is a platform for exchanging ideas with global leaders in science and technology.

Arizona State University

Professor Hendrik Bessembinder at Arizona State University is the author of groundbreaking research on historical stock market returns in the United States.

LEARNING FROM ACADEMIA
ARCHIVED



Matterhorn
4,478m

ARCHIVED

EXTREME RETURNS

James Anderson, partner, talks about the implications of Hendrik Bessembinder's extraordinary research.

Generally I prefer our research to appear irrelevant. The further it is from being a direct debate about the merits of a company as an investment the happier I tend to be. Obliquity is superior to confrontation. Walking is preferable to staring at a computer screen. Much of the most valuable research is deeply indirect in its investment implications and surprising in its eventual impact. Most commentators, brokers, intermediaries and consultants are deeply offended by such musings. That's their problem.

But occasionally direct assault has its virtues. This particularly applies to academic input. It can have the ability to stand outside the moment. It certainly has the ability to free itself from the preconceptions, self-interest and necessary operating dogma of practitioners and industry insiders. The very absence of skin in the game can be a virtue. Radical reappraisal is possible. Sometimes external authority gives the necessary evidence and context to build on uncomfortable and unexpected rumblings of our own.

Such has been our experience of working with Hendrik Bessembinder of Arizona

State University. In early 2017 Professor Bessembinder released his initial drafts of a paper entitled *Do Stocks Outperform Treasury Bills?* The title itself is heretical. It is a central assumption of Modern Portfolio Theory as taught to all students that because equities are more risky they must have higher rewards. This is drummed into the heads of the record 227,031 candidates who registered for the Chartered Financial Analyst (CFA) exams in June 2018. But Bessembinder showed that “slightly more than four out of every seven common stocks have lifetime buy-and-hold returns, inclusive of reinvested dividends, of less than those on one-month Treasuries.

“When stated in terms of lifetime dollar wealth creation, the entire gain in the US stock market since 1926 is attributable to the best-performing 4 per cent of listed companies.”

As he put it to me, this is “just a collection of facts”. It's not fake news. If this was the character of the US market in the past, how much more might it be the path in the global and digital future?

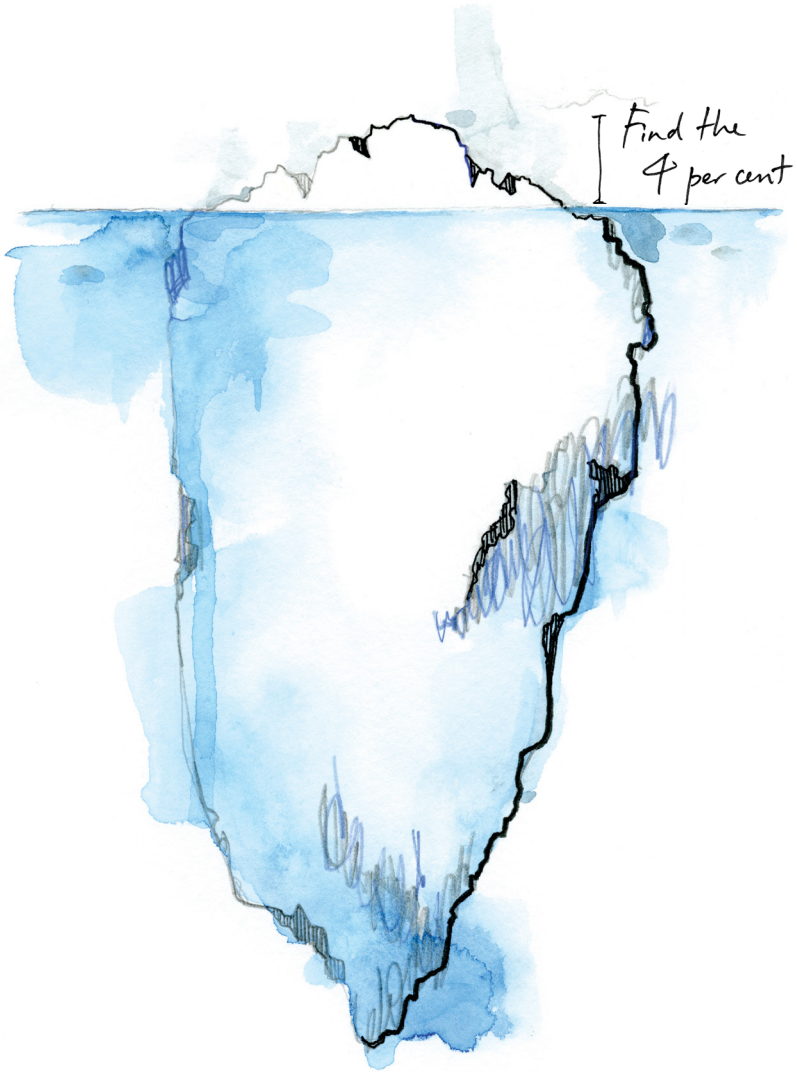
But if this is right then our task is transformed. Our job is solely and simply to find and invest in the stocks that are capable of producing the extraordinary returns of the 4 per cent. Everything else is best put aside. But what characteristics might the companies need to produce these returns? What attributes in turn do we need to hope to identify them? As Bessembinder writes, “The returns to active stock selection can be very large. If the investor is either fortunate or skilled enough...”

So the natural course of affairs was for us to build a relationship with the Professor so that we could learn how to become skilled (or lucky). Fortunately my colleagues are now expert in providing sufficient freedom and support, both financial and intellectual, that we can progress towards regular contact in such instances. So in March 2018 I found myself sweltering in Tempe rather than freezing in Edinburgh in order to discuss these matters. Tom Slater, joint manager of Scottish Mortgage Investment Trust, had preceded me. Although we both found that Professor Bessembinder veered to academic caution rather than fund manager exuberance there was still a great deal of importance to digest.

The two main areas of research that we have agreed to work with the Professor on at this early stage are focused on expanding data to the rest of the world (we are helping with the limited data sources) and trying to find common factors behind both the 4 per cent of the companies that have created all the return and the even more remarkable 90 companies (out of over 24,000) that have contributed half the wealth created in US equities since 1926. It's this second question – in both versions – that has begun to unearth potentially crucial insight. It looks as if there could indeed be common factors behind the brilliance. Although many stocks with the most stellar returns now appear ex-growth (Exxon Mobil) or once mortally wounded but now surgically reassembled (General Motors), at the start of their lives they were all participants in markets that would become very large and that they entered if frequently not first then at early stages (this has been the case from Exxon Mobil to Google). As these names indicate, titanic founder-owners or at least missionary leaders are the enduring pattern.

An assemblage of FTSE 100 style companies boasting chief executives with three-year tenure does not feature.

ARCHIVED



ARCHIVED

LEARNING FROM ACADEMIA

...the skills we need are centred on dreaming of a grand future, backing great people and coping with twists and turns and ups and downs.

ARCHIVED

Moreover these companies have not been run with slide rules or their ancient and modern equivalents. They are companies that acknowledge doubt and embrace emerging opportunities. As Hendrik Bessembinder was talking about this my mind went automatically to Jeff Bezos 20 years ago enthusing about the ‘weirdness’ of how the inputs to his business got better and cheaper every year – but that even he had not a clue of what that would mean.

Now in a sense much of this is predictable even if it’s more acute and structural than we surmised. What is more striking and even more exciting is the attributes that the Professor believes that investors in their turn need to possess in order to identify the truly great potential companies. Just like the company founders themselves he thinks the skills we need are centred on dreaming of a grand future, backing great people and coping with twists and turns and ups and downs.

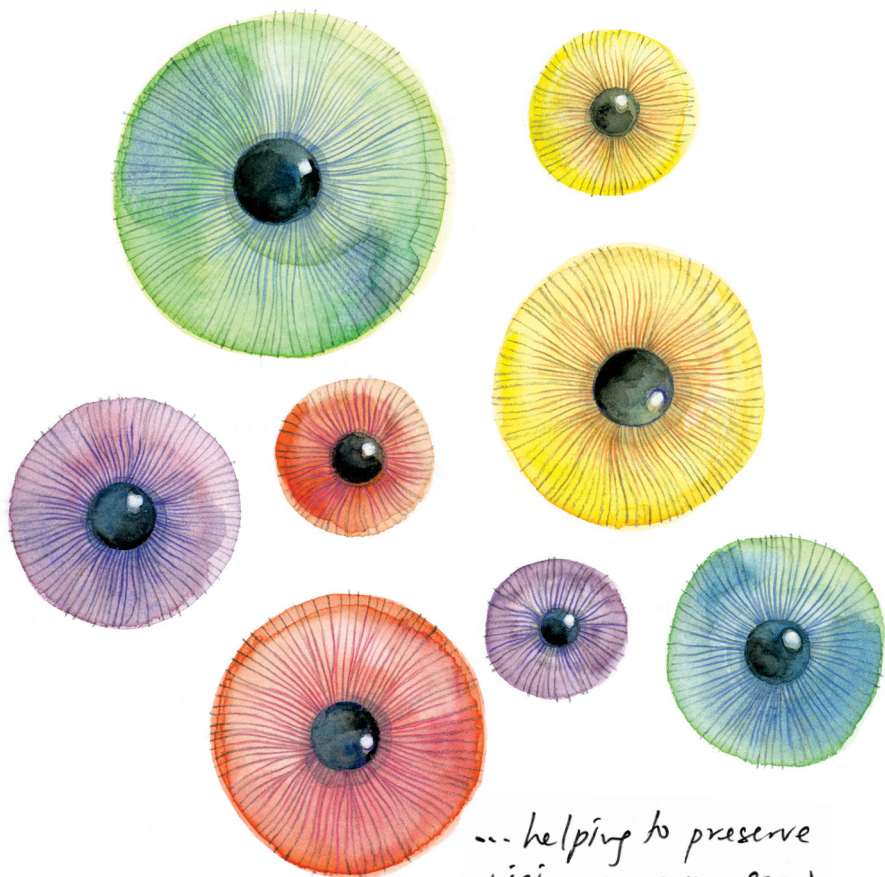
His explication seems to us to run very counter to the perceived market wisdom. It certainly casts doubt over the strong preferences of most investors for predictability and certainty. But still more his perceptions indicate that our job is much more about the imagination of the future

that can envisage brave new worlds and the qualitative assessment of leadership skills than about the hard analytic numbers and confident financial mastery that the 227,031 are being examined on for the CFA. So to us the hope – or inspiration – that Professor Bessembinder provides is that as our financial industry marches firmly and unanimously up one hill, we’re running determinedly in the opposite direction. If we are right that is a compelling competitive advantage.

But there’s one last essential to the Professor’s current thinking. Identifying the great investments isn’t enough. As Hendrik Bessembinder makes plain it is the long-term compounding of their share prices that matters. This seems to us to require an additional set of skills such as the creativity to imagine greatness discussed above. The compelling urge amongst ordinary humans for sure, but far more damagingly amongst that odd sub-breed that are fund managers, is to take profits and lock in performance. As the old saying goes: ‘it’s never wrong to take a profit’. But it is often not just wrong but the worst mistake that can be made. Professor Bessembinder is reinforcing such convictions.

ARCHIVED

LEARNING FROM ACADEMIA



... helping to preserve
vision or even grow
parts of the eye

ARCHIVED

FOCUSED ON VISIONARY RESEARCH

A rare mix of clinical experience and theoretical insight makes Oxford Brookes University's work on the genetics behind congenital eye disorders especially exciting. We speak to Professor Nicola Ragge, the ground-breaking geneticist leading the research programme.

Tell us about your work

For over two decades I have been researching the genes controlling the development of the eyes. My goal is to improve genetic diagnosis and in future to develop treatments that can compensate for missing or malfunctioning genes and thus help preserve vision or even to grow parts of the eye.

How did you come to study the genes responsible for the development of the human eye?

I'm actually a trained paediatric ophthalmologist, an eye surgeon. I worked in several top centres in the United States doing specialist training in paediatric ophthalmology and ophthalmic genetics and then returned to the UK and did further training at Great Ormond Street and at Moorfields Eye Hospital, where I trained in oculoplastics and reconstructive surgery.

When I was at Moorfields I came across families where the children had been born with tiny eyes, or sometimes no eyes at all. The specialist I trained with, Professor Richard Collins, had an interest in reconstructing the sockets of these children's eyes. He had been following these families for about 25 years, trying to understand the basis of the eye malformations and whether there were environmental factors at play.

What was your own contribution to this research?

Because of my quite unusual background – I had trained in paediatrics, genetics and molecular genetics as well as ophthalmology – I started looking in a different way at these families. Specifically, I started to gather them together to see if there were any clues that would enable me to identify the gene or genes underlying these conditions. For example, I was looking to see if any of these children had an unusual rearrangement of their chromosomes that might have disrupted a particular gene.

I focused on families in which children were born with the same small or underdeveloped eyes, characterised the precise problems that were affecting the eyes and other parts of the body and gathered family histories to see if the conditions were inherited. I grouped together families where there was more than one affected child to perform mapping studies and establish whether they had inherited the same chromosome region that might harbour a gene responsible for the condition. I also obtained detailed chromosome studies to see if there was a rearrangement of chromosomes that might have 'knocked out' a particular gene that could provide a clue.

What were the main obstacles to progress?

Mainly the limited resources available to support my work. Ironically, my multi-disciplinary approach as a scientist and a practising surgeon made it challenging to secure funding against specialists able to commit all their efforts to a single scientific aspect. But gradually my persistence paid off.

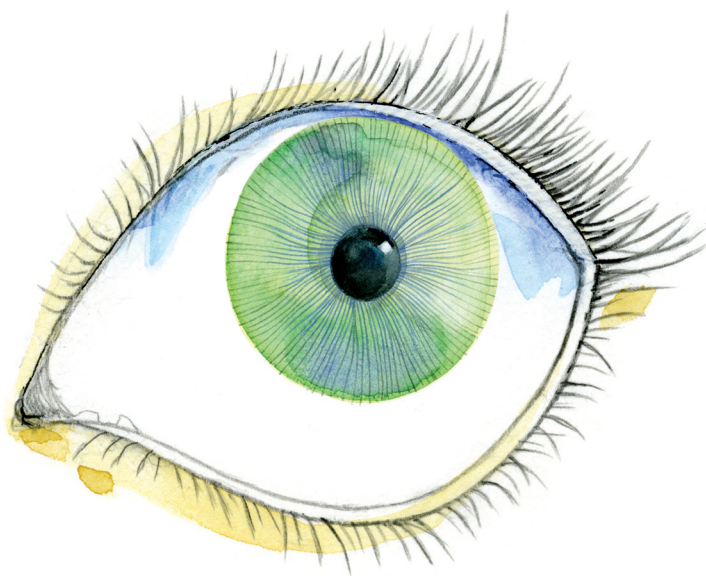
Bit by bit I made a breakthrough and I obtained some funding. I received a Senior Surgical Scientist Award from the Academy of Medical Sciences and the Health Foundation that enabled me to set up my own lab and research group here in Oxford. I was the sole member of my research group initially. I then started to identify genes using different techniques. I was undertaking the molecular studies myself, quickly learning new techniques to keep up with state-of-the-art technology. At the same time I was working as a consultant eye surgeon at Moorfields, operating as a consultant paediatric ophthalmologist in Birmingham, and working in my Oxford lab – so I was working in three cities each week!

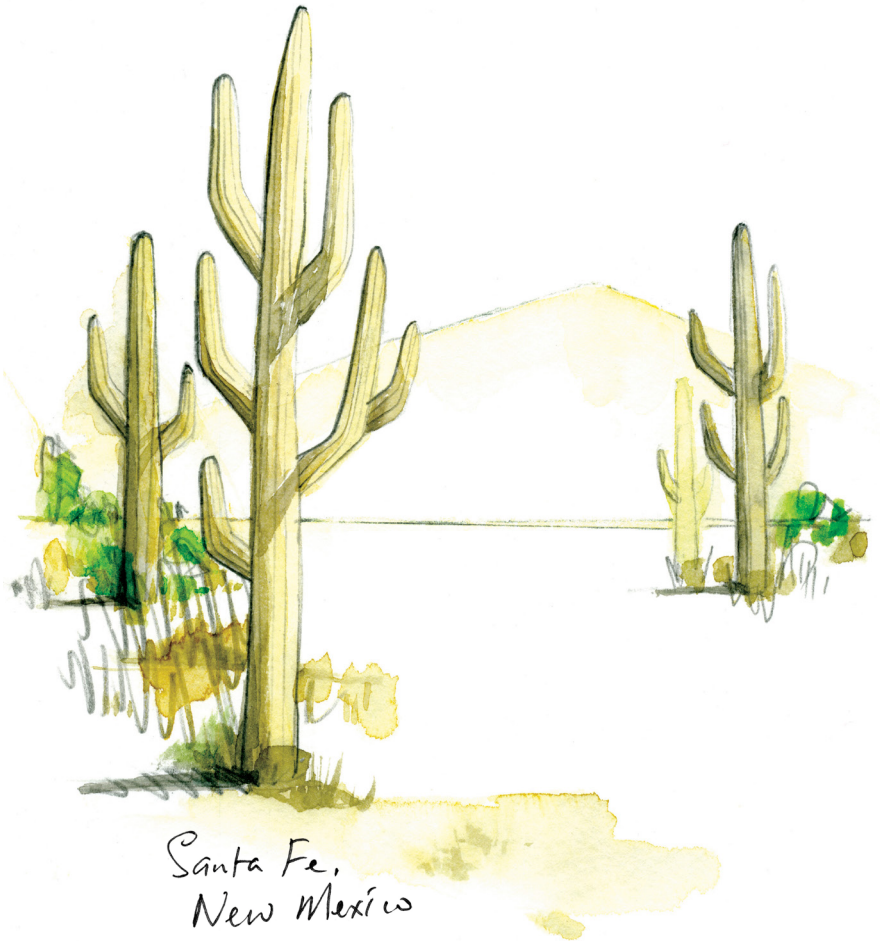
How did the connection with Baillie Gifford come about?

I heard about Baillie Gifford's academic support programme and sought assistance. The funding has just been transformative. It has enabled me to build up a team of researchers in the lab and for us to identify new genes. We have been able to construct a brand-new gene panel that has enabled us to pioneer very rapid genetics diagnoses for families in the UK. In this way, the whole foundation of the research is now translated into diagnostic testing that will benefit everyone. And, of course, the gene diagnoses themselves, once they get published, help clinicians and scientists the world over. It means that clinicians can spot the relevant genes to look for in their patients.

The support has enabled me to build up these worldwide collaborative networks, so I am aware of, and can work with, many scientists and clinicians around the world.

ARCHIVED





Santa Fe,
New Mexico

ARCHIVED

THE SANTA FE WAY

The mission of the Santa Fe Institute is to search for order in the complexity of evolving worlds. It's an ambitious mission. James Anderson, partner, visited the Institute earlier this year and explains why it's one we support.

For a long time I've thought that the Santa Fe Institute was the best academic link that we have. 'Best' in almost every sense: highest intellectual calibre (as partially evidenced by how little I grasp), interdisciplinary devotion, collegiate atmosphere and obliquity. Yet Santa Fe has turned out to be directly relevant to how I, at least, invest. Indeed I can scarcely think of any significant investment I've made that hasn't been fundamentally driven by ideas emanating from Santa Fe. From Brian Arthur's views on the economics of increasing returns to Geoffrey West's work on scaling, to Jessika Trancik's tracking of innovation rates (especially in energy), to the basic notion of complexity itself, their thoughts have altered my mind a lot. In fact it's simply been the most important material I've come across.

But by chance and clash of dates, though I've had plenty of meetings with them, I'd never been to the Institute before. I'm envious of their set up. It's much more likely to provoke deep thought than our own. It's much more likely to have good voluntary interaction than our forced noise

and no privacy model. It's some distance from even the modest, if striking, urban centre of Santa Fe and on top of a mountain. Even the design of the building is so much more thoughtful than our own. It combines wide open spaces, wide corridors, offices (but with an open-door encouragement), glass partitions to write on and access to the outside in a way I haven't really come across anywhere else. Only the latter would be hard for us if we ever abandoned our absurd preference for looking like an investment bank trading floor. There is a tea-party every day at 3pm for all researchers. There's a much bigger external professoriate (100 plus) of occasional visitors than regular faculty. The regular faculty appointment is only for five years. There's no tenure. This doesn't stop mutual encouragement of long-term connections (the American physicist Murray Gell-Mann was a regular visitor until shortly before his death in 2019 and our friend Ole Peters of the London Mathematical Laboratory shared an office with him a summer or two back).

Santa Fe people: David Krakauer

But I digress. I first had a chat with David Krakauer who is the President. I'm not very familiar with his work but I ought to be as he's principally focused on a topic of concern to us all: stupidity. He thinks there should be Professors of Stupidity. Finance would be a major research field for such experts. Krakauer defines stupidity as any system or belief set that is characterised by more information making conclusions and decisions less accurate. To him it's entirely natural that fund managers who seek out more and more financial information and 'corporate knowledge' will have worse and worse individual and systemic results. What we call long-termism he would call a beneficial acceptance of ignorance.

He's also a proselytiser for inter-disciplinary perspectives. He's written a fair amount about this in the context of historical studies but he'd assuredly apply it to us too. His current analogy is drawn from his interest in the universe and space travel. His point is that if you ask anybody who they would put on a first journey to colonise Mars who

would you select? It would be individuals of different talent, training, temperament and expertise. It wouldn't be one dimensional. So having people who all want to be (and usually think they are) experts in finance is not likely to be successful. Santa Fe doesn't allow scientists who aren't interested in the humanities.

Krakauer believes in the absolute power of culture and missions. He applies this to his own organisation: Santa Fe keeps changing, innovating and refuses to become normal because that's the foundational idea. He's contemptuous of those who think that there are low-risk options: "That's the surest way to death". He's got absolute authority as President to pursue this mission (how different from Oxbridge). But this isn't just about Santa Fe. Krakauer is convinced that culture controls all – he suggests we concentrate on this at the cost of financial metrics: "Culture – and that includes your attraction for great people – is the only alpha".

ARCHIVED



"there should be Professors of Stupidity"

...the elite universities have allowed being top
of the rankings to become their actual rather
than stated mission.

ARCHIVED

Santa Fe people: Geoffrey West

Geoffrey West's team is now working on a series of scaling projects. The one that he and colleagues are keenest to discuss is applying scaling rules to universities. Actually, the principal conclusion turned out to be less about scaling than the critical importance of mission. This is similar to the Krakauer perspective. West's team find that whatever the scale the crucial role of mission persists. Thus community colleges do educate the communities and continue to do so and at low cost even once the local aspect is outgrown (Pasadena was cited). But the elite universities have allowed being top of the rankings to become their actual rather than stated mission. This requires lots of money and not necessarily much education or research.

The less successful project thus far has been one of potentially great importance. West led an application to get a national grant to study the scaling of bureaucracy. This was rejected by the national bureaucracy. They wanted much more bureaucratic detail before they would be willing to authorise

the study. The project is especially dear to West as he sees the rise of bureaucracy as being a much more serious (as well as personally annoying) topic than it's portrayed as being. He supposed it's at the heart of the difficulty most organisations have in scaling and that it's totally wrong to excuse it as 'necessary'. He wants to see if there are rules as to both what appears to happen and what actually is necessary – let alone beneficial.

Support

Although Santa Fe has had many supporters in recent years it's expanded primarily on the back of major support by Bill Miller, chief investment officer of Miller Value Partners. He's currently financing a second location a few miles deeper into the hills. Geoffrey West described him as the model of an old-fashioned patron. Bill Miller himself says Santa Fe is by far the best project and the best use of his resources he's ever been involved with. I'm glad we're supporting Santa Fe a bit more from this year.

**FOUR THINGS WE LEARNED
FROM BRIAN ARTHUR**

In July 2018, Baillie Gifford investment managers Paulina Sliwinska and Lawrence Burns spent time in Palo Alto Research Centre (PARC) in California with Professor Brian Arthur, the pioneering theorist of technological evolution. Here's what they learned from him.

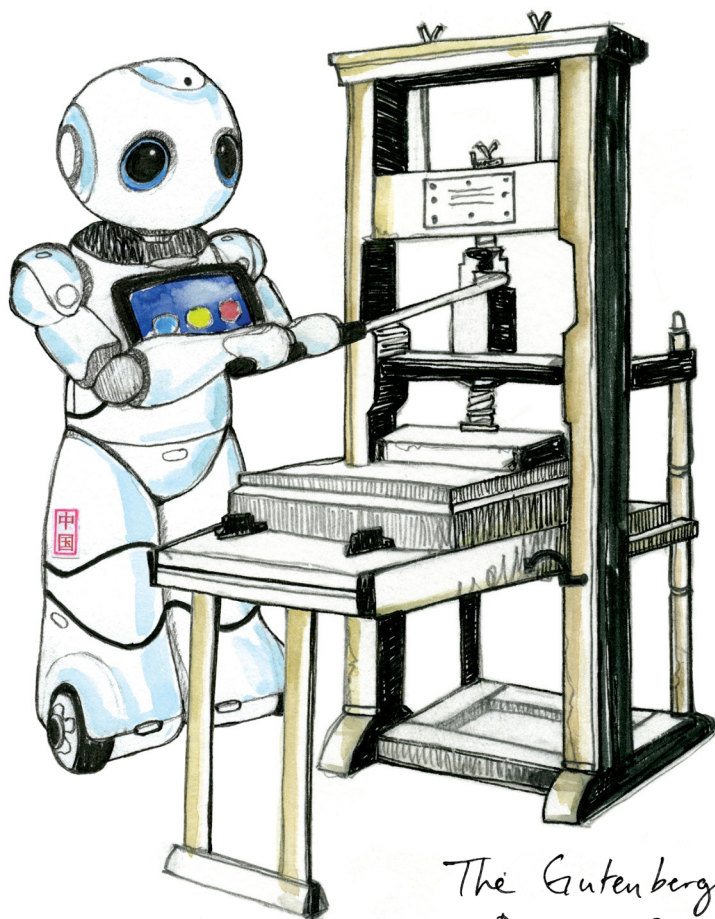
1. Artificial intelligence (AI) could have the biggest impact on humanity in 500 years.

Johannes Gutenberg's printing press in the 15th Century spread knowledge and made it readily available. Brian sees AI doing the same thing for intelligence. Making intelligence available on-demand should change the world in ways hard to imagine.

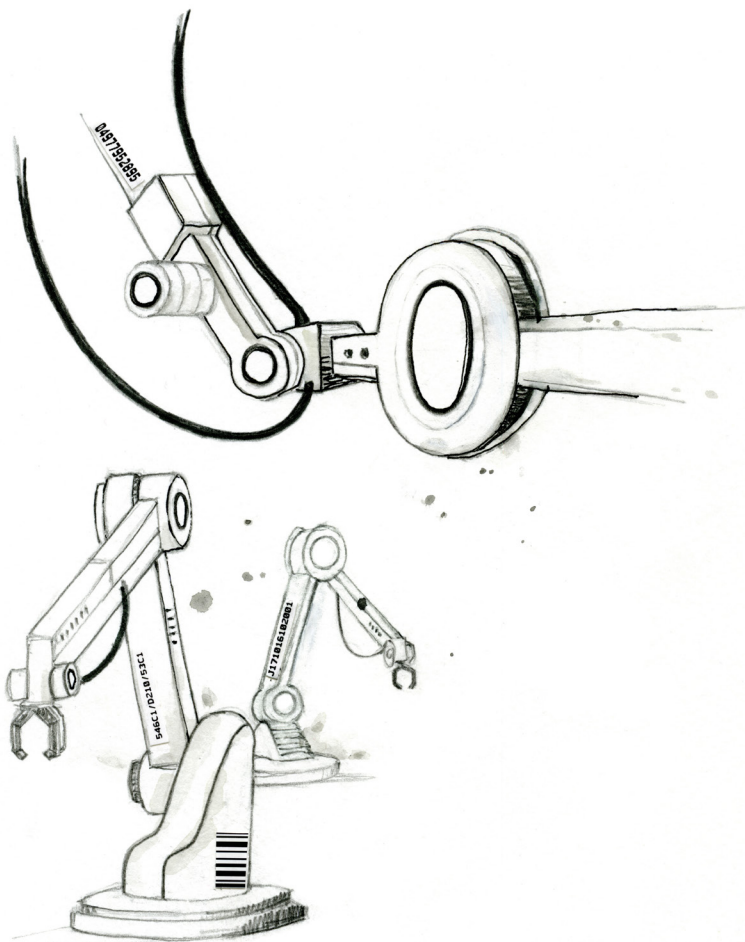
2. China may lead in applying knowledge, but invention could prove harder.

Brian thinks China is only two years behind the US in AI and could do a better job in innovation – the adaptation and application of inventions. But he sees the Americans having a culturally-rooted advantage in invention, which is akin to a skilled craft built up over decades.

ARCHIVED



*The Gutenberg
Printing Press*



ARCHIVED

3. Western banks may be able to adapt to the FinTech revolution.

In China the online financial disrupters are the likely winners (e.g. Ant Financial). In the West meanwhile, Brian thinks the incumbents could gradually adopt AI for specific tasks.

4. In the world of tech breakthroughs, we ain't seen nothing yet.

Emerging technologies in the field of AI and automation could create a world unrecognisable today. To cope we will need new ways to distribute wealth. A universal income is a plausible and possibly necessary solution.

Professor Brian Arthur

Based in the US since the 1970s, Belfast-born Professor Brian Arthur is a visiting researcher in the Intelligent Systems Lab at PARC in Palo Alto, California, an external faculty member at the Santa Fe Institute, and an IBM Faculty Fellow.

From 1983 to 1996 he was Morrison Professor of Economics and Population Studies at Stanford University and holds a PhD from Berkeley in Operations Research. He also has other degrees in economics, engineering and mathematics.

Professor Arthur is credited as a pioneer in the science of complexity and its relationship to the high-tech economy. In the field of economics he has specialised in the ability of increasing returns to magnify the effects of small, random events on the comparative advantage achieved by some businesses. His 2009 book *The Nature of Technology: What It Is and How It Evolves* has been described as “an elegant and powerful theory of technology’s origins and evolution”.

LEARNING FROM ACADEMIA
ARCHIVED



ARCHIVED

DARING TO DEFY DEMENTIA

A new dementia research fund will support a three-year programme to investigate one of the world's least understood but most common degenerative diseases. Professor Tara Spire-Jones of the University of Edinburgh reports from the front line of research.

The brain: human biology's final frontier.

Fully accessible only after death or with low accuracy via brain scans in living people, we do not yet understand how 100 billion brain cells and their 100 trillion connections work together to create thought, memory and the mind's countless other intricate functions.

Today, 50 million people around the world are living with dementia. By 2050, the figure is expected to triple to about 150 million. Yet the medical response still lags that to another universal killer, cancer. As of March 2019, there were only around 550 clinical trials taking place for dementia, compared to over 7,500 for cancer, in the EU and European Economic Area. America's National Institutes for Health estimated that in 2017 funding for cancer research was seven times that for research into Alzheimer's Disease, the most common form of dementia.

To tackle the brain diseases collectively known as dementia, we need to know more about how the brain works and how damage occurs. Armed with a clearer understanding of the mechanisms at play, we would stand more chance of developing new, effective treatments.

At the University of Edinburgh, we are making advances on this front. As one of the six universities forming the UK Dementia Research Institute, we lead research into the causes of dementia and how to prevent or reverse them.

We learn new things every day: for example, how toxic proteins spread between brain cells in dementia patients. Research led by our scientists, analysing the DNA of more than 300,000 people, has uncovered three gene variants that may increase the risk of Alzheimer's, which accounts for up to 70 per cent of dementia cases.

Discoveries such as these provide vital clues to the biological processes involved and suggest potential new approaches for future dementia research. As two of the newly discovered genes are already targeted by drugs used to treat other conditions, it is more likely that future therapies can target the causes of Alzheimer's, not just treat the symptoms.

The discovery also raises the tantalising prospect that one day we will have the tools to cure the disease and even prevent it from developing.

This is an exciting time to be involved in such research. Analyses of many global studies indicate that up to a third of dementia cases could be prevented by modifying lifestyle factors, such as reducing obesity, treating hearing loss and leading a more active lifestyle.

Science now tells us that diseases that cause dementia start in the brain in mid-life – decades before symptoms appear. This makes it more likely that any future treatments will be most effective early in the disease process. So in addition to moderating lifestyle factors to prevent a third of dementia cases, early treatment could help prevent the other two-thirds.

Progress in understanding Alzheimer's is made not just by scientists in laboratories, but through patients, their families and even healthy volunteers participating in clinical studies and trials. These are vital in establishing how Alzheimer's progresses over time and in ascertaining whether potential new treatments will be effective.

Edinburgh's Centre for Dementia Prevention hosts and leads the world's largest single Alzheimer's disease study, the European Prevention of Alzheimer's Disease (EPAD) project. This draws on existing national and regional registers of people at risk of developing Alzheimer's to create a

single pan-European register. Those deemed most at risk of developing Alzheimer's will be invited to undergo standardised tests, repeated on an ongoing basis, to help medical professionals understand changes within the brain.

EPAD is pioneering a novel, more flexible approach to the clinical trials of drugs designed to prevent Alzheimer's. Using an 'adaptive' trial design, where several candidate drugs are simultaneously compared to each other and to a placebo, this approach should deliver better results faster and at lower cost, with more patients benefiting from a potentially active treatment. EPAD's proof-of-concept drug trial platform is due to be launched this year.

Edinburgh University is also home to the UK- and Ireland-wide PREVENT Dementia study, now also recruiting healthy middle-aged volunteers in Oxford, Cambridge, London and Dublin. Volunteers will be given a range of tests including blood tests, brain scans and cognitive assessments. The study will follow how their brain health develops over time, with a view to identifying biological and psychological factors that may increase the risk of dementia in later life. The goal is to develop lifestyle programmes and medical treatments that would prevent the disease taking hold.

ARCHIVED

Another key obstacle to finding treatments is translating what we learn about the brain in the lab into actual treatments for patients, often referred to as the 'translational gap'. This gap has arisen because traditional research has operated in silos – self-contained pockets of expertise. But the complexities of the brain and of Alzheimer's suggest that a range of treatments and therapies will be necessary to beat this disease. A more holistic approach is needed from researchers and clinicians.

By collaborating across academic disciplines and doing what we can to bridge the division between experimentation and treatment, we can improve our chances of tackling the disease. And because many neurodegenerative diseases share common mechanisms, this integrated approach extends far beyond dementia.

Recent investments in research at Edinburgh, and the close relationships between our scientists, researchers and the patients under our care, mean that every day we edge closer to unravelling the brain's secrets and finally turning the corner on dementia.





ARCHIVED

THE DELFT DIFFERENCE

A relationship with one of the world's most advanced engineering universities offers unique opportunities to understand technologies that will transform our world, writes Paulina Sliwinska, an investment manager at Baillie Gifford.

Its famous Delftware once led Europe's production and export of pottery. Now the Dutch city of Delft's claims to technological leadership rest on its university's academic capabilities and industrial partnerships.

Delft University (TU Delft) is one of the largest and oldest technological universities in the Netherlands, and one of Europe's best. In Baillie Gifford's view its research has attracted far less attention than it deserves.

Although TU Delft holds its own against higher-profile institutions such as Stanford, Oxford and Cambridge universities, modesty about its own achievements might cause it to be overlooked. But Delft has world-class aeronautics and artificial intelligence facilities, a Microsoft-funded quantum computing centre, as well as a highly-rated architecture school.

Our relationship allows us access to valuable expertise on robotics, drones and autonomous vehicles. It also allows us to spend time with teachers and students learning about the latest advances in robotics.

The value of this arrangement, and others like it, has been evident from the outset, as was the enthusiasm of the TU Delft academics whose work has stimulated our thinking.

The university has set the pace in drone technology, pioneering the design of a miniature unit capable of interacting with other drones, which has great potential for agricultural use. TU Delft was ahead of its time in seeing the wider application of drones while others viewed them as mere toys, and it is consequently more advanced in the field than almost any other global institution.

We have also had access to multi-disciplinary student groups working on projects ranging from robots that can pick cucumbers to automated clothing racks fitted with tracking devices. The scope of these projects may seem unusual – even eccentric – but they illustrate the creative freedom that lies behind the institution's success and they explain how much of its work breaks new ground. That small groups of undergraduate students are capable of such advanced work is a testament to the university's capabilities.

One of the academics we met is Jeroen van den Hoven, TU Delft's Professor of Ethics and Technology. His interest in the new challenges posed by artificial intelligence (AI) led him to focus on the ethics of IT. He works closely with other universities around the world and advises the United Nations.

The ethics of AI concern Baillie Gifford because of the implications the subject has for some of the companies in which we invest. Professor van den Hoven takes the view that making profits brings social responsibilities, a position we wholeheartedly share.

Other laboratories at TU Delft include those dedicated to autonomous vehicles, where the development efforts are funded by Nissan and are focused primarily on safety features.

TU Delft's robotics researchers have also been working on a 'smart skin' which

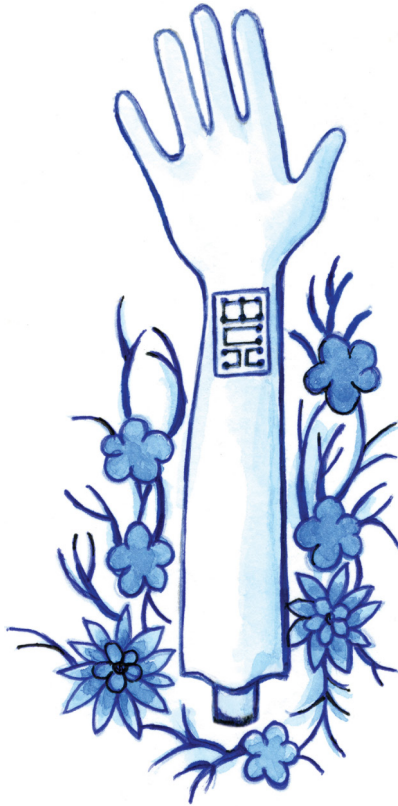
wraps around prosthetic limbs and is able to sense touch and warmth, as well as to judge distance. The material used is currently extremely expensive, but the new 'skin' promises safer cooperation between humans and robots when prices fall and the capability becomes more widely available.

This broad range of creative thinking, be it around new computing platforms or emerging technologies such as machine learning, gives us the opportunity to inform ourselves more deeply about the areas in which we invest.

Our agreement with TU Delft allows us three days' access each year to explore any topic of our choosing, in addition to the opportunity to attend conferences or symposiums that catch our interest. We look forward to learning more about future technological changes from the people making it happen.

The ethics of AI concern Baillie Gifford because of the implications the subject has for some of the companies in which we invest.

ARCHIVED



working on a 'smart skin'

LAST WORD

Baillie Gifford partner Tom Coutts reflects on the exciting prospects opened up by academic collaborations.

The articles you have read reflect some of the work Baillie Gifford has undertaken in recent years to learn from experts. Our focus has been on supporting academics, either individuals or the institutions to which they belong. We think this approach is unusual, and merits a brief explanation.

First, we make no attempt to calculate a return on investment on the financial support that underpins these relationships. We see this as a philanthropic endeavour as much as one from which we, or ultimately our clients, will gain. Researchers at universities we are supporting have asked us more than once: “What do you hope to get from this?” Our answer is simply: “The chance to talk to interesting people and support their work.”

At a time when traditional academic funding sources are constrained and what funding is available often requires tightly defined research outcomes, the ability to support people doing work that is foundational or which questions the conventional approach is increasingly valuable.

Second, we are engaged supporters. This means having a genuine interest in the field and being willing to learn from – and be challenged by – the people pushing it forward, like Hendrik Bessembinder at Arizona State University or Nicola Ragge at Oxford Brookes.

Finally, we are not imposing any internal constraints on which academics or institutions we support. Any colleague proposing that we establish a relationship need only show a committed engagement from that person and their institution, some plausible relevance to what we do at Baillie Gifford (however tangential), and the confidence that we are being ambitious in seeking out the best and most interesting people in their field, wherever they may be.

We are still at the early stages of expanding our efforts to support academics around the globe, but we are hugely excited about the opportunities to learn from brilliant people and to improve the way we think about the world, to the ultimate benefit of our clients.

Important information

Baillie Gifford & Co and Baillie Gifford & Co Limited are authorised and regulated by the Financial Conduct Authority (FCA). Baillie Gifford & Co Limited is an Authorised Corporate Director of OEICs.

Baillie Gifford Overseas Limited provides investment management and advisory services to non-UK Professional/Institutional clients only. Baillie Gifford Overseas Limited is wholly owned by Baillie Gifford & Co. Baillie Gifford & Co and Baillie Gifford Overseas Limited are authorised and regulated by the FCA in the UK.

Persons resident or domiciled outside the UK should consult with their professional advisers as to whether they require any governmental or other consents in order to enable them to invest, and with their tax advisers for advice relevant to their own particular circumstances.

Financial Intermediaries

This communication is suitable for use of financial intermediaries. Financial intermediaries are solely responsible for any further distribution and Baillie Gifford takes no responsibility for the reliance on this document by any other person who did not receive this document directly from Baillie Gifford.

Important Information Europe

Baillie Gifford Investment Management (Europe) Limited provides investment management and advisory services to European (excluding UK) clients. It was incorporated in Ireland in May 2018. Baillie Gifford Investment Management (Europe) Limited is authorised by the Central Bank

of Ireland as an AIFM under the AIFM Regulations and as a UCITS management company under the UCITS Regulation. Baillie Gifford Investment Management (Europe) Limited is also authorised in accordance with Regulation 7 of the AIFM Regulations, to provide management of portfolios of investments, including Individual Portfolio Management ('IPM') and Non-Core Services. Baillie Gifford Investment Management (Europe) Limited has been appointed as UCITS management company to the following UCITS umbrella company; Baillie Gifford Worldwide Funds plc. Through passporting it has established Baillie Gifford Investment Management (Europe) Limited (Frankfurt Branch) to market its investment management and advisory services and distribute Baillie Gifford Worldwide Funds plc in Germany. Similarly, it has established Baillie Gifford Investment Management (Europe) Limited (Amsterdam Branch) to market its investment management and advisory services and distribute Baillie Gifford Worldwide Funds plc in The Netherlands. Baillie Gifford Investment Management (Europe) Limited also has a representative office in Zurich, Switzerland pursuant to Art. 58 of the Federal Act on Financial Institutions ('FinIA'). The representative office is authorised by the Swiss Financial Market Supervisory Authority (FINMA). The representative office does not constitute a branch and therefore does not have authority to commit Baillie Gifford Investment Management (Europe) Limited. Baillie Gifford Investment Management (Europe) Limited is a wholly owned subsidiary of Baillie Gifford Overseas Limited, which is wholly owned by Baillie Gifford & Co. Baillie Gifford Overseas Limited and Baillie Gifford & Co are authorised and regulated in the UK by the Financial Conduct Authority.

ARCHIVED

Important Information

China

Baillie Gifford Investment Management (Shanghai) Limited 柏基投资管理(上海)有限公司 ('BGIMS') is wholly owned by Baillie Gifford Overseas Limited and may provide investment research to the Baillie Gifford Group pursuant to applicable laws. BGIMS is incorporated in Shanghai in the People's Republic of China ('PRC') as a wholly foreign-owned limited liability company with a unified social credit code of 91310000MA1FL6KQ30. BGIMS is a registered Private Fund Manager with the Asset Management Association of China ('AMAC') and manages private security investment fund in the PRC, with a registration code of P1071226.

Baillie Gifford Overseas Investment Fund Management (Shanghai) Limited 柏基海外投资基金管理(上海)有限公司 ('BGQS') is a wholly owned subsidiary of BGIMS incorporated in Shanghai as a limited liability company with its unified social credit code of 91310000MA1FL7JFXQ. BGQS is a registered Private Fund Manager with AMAC with a registration code of P1071708. BGQS has been approved by Shanghai Municipal Financial Regulatory Bureau for the Qualified Domestic Limited Partners (QDLP) Pilot Program, under which it may raise funds from PRC investors for making overseas investments.

Important Information

Hong Kong

Baillie Gifford Asia (Hong Kong) Limited 柏基亞洲(香港)有限公司 is wholly owned by Baillie Gifford Overseas Limited and holds a Type 1 and a Type 2 license from the Securities & Futures Commission of Hong Kong to market and distribute Baillie Gifford's range of collective investment schemes to professional investors in Hong Kong. Baillie Gifford Asia (Hong Kong) Limited 柏基亞洲(香港)有限公司 can be contacted at Suites 2713-2715, Two International Finance Centre, 8 Finance Street, Central, Hong Kong. Telephone +852 3756 5700.

Important Information

South Korea

Baillie Gifford Overseas Limited is licensed with the Financial Services Commission in South Korea as a cross border Discretionary Investment Manager and Non-discretionary Investment Adviser.

Important Information

Japan

Mitsubishi UFJ Baillie Gifford Asset Management Limited ('MUBGAM') is a joint venture company between Mitsubishi UFJ Trust & Banking Corporation and Baillie Gifford Overseas Limited. MUBGAM is authorised and regulated by the Financial Conduct Authority.

ARCHIVED

Important Information

Australia

Baillie Gifford Overseas Limited (ARBN 118 567 178) is registered as a foreign company under the Corporations Act 2001 (Cth) and holds Foreign Australian Financial Services Licence No 528911. This material is provided to you on the basis that you are a “wholesale client” within the meaning of section 761G of the Corporations Act 2001 (Cth) (“Corporations Act”). Please advise Baillie Gifford Overseas Limited immediately if you are not a wholesale client. In no circumstances may this material be made available to a “retail client” within the meaning of section 761G of the Corporations Act.

This material contains general information only. It does not take into account any person’s objectives, financial situation or needs.

Important Information

South Africa

Baillie Gifford Overseas Limited is registered as a Foreign Financial Services Provider with the Financial Sector Conduct Authority in South Africa.

Important Information

North America

Baillie Gifford International LLC is wholly owned by Baillie Gifford Overseas Limited; it was formed in Delaware in 2005 and is registered with the SEC. It is the legal entity through which Baillie Gifford Overseas Limited provides client service and marketing functions in North America. Baillie Gifford Overseas Limited is registered with the SEC in the United States of America.

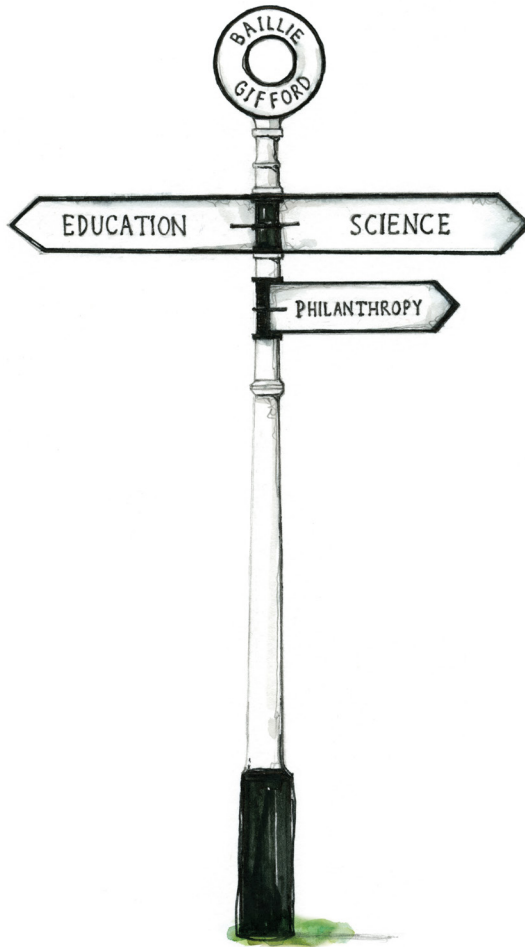
The Manager is not resident in Canada, its head office and principal place of business is in Edinburgh, Scotland. Baillie Gifford Overseas Limited is regulated in Canada as a portfolio manager and exempt market dealer with the Ontario Securities Commission (‘OSC’). Its portfolio manager licence is currently passported into Alberta, Quebec, Saskatchewan, Manitoba and Newfoundland & Labrador whereas the exempt market dealer licence is passported across all Canadian provinces and territories. Baillie Gifford International LLC is regulated by the OSC as an exempt market and its licence is passported across all Canadian provinces and territories. Baillie Gifford Investment Management (Europe) Limited (‘BGE’) relies on the International Investment Fund Manager Exemption in the provinces of Ontario and Quebec.

Important Information

Israel

Baillie Gifford Overseas is not licensed under Israel’s Regulation of Investment Advising, Investment Marketing and Portfolio Management Law, 5755-1995 (the Advice Law) and does not carry insurance pursuant to the Advice Law. This material is only intended for those categories of Israeli residents who are qualified clients listed on the First Addendum to the Advice Law.

ARCHIVED



ARCHIVED

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / www.bailliegifford.com

Copyright © Baillie Gifford & Co 2019.

ARCHIVED