University of Glasgow

Adam Smith Business School

Archangels: Impact evaluation of activities, 1992-2022

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30 YEARS INVESTING in innovation

Key Findings

At the time of publication, Archangels' current portfolio comprises 20 companies, has an estimated current book value of £211.29m, and supports over 755 jobs.

Employment:

- In total, 3,647 jobs have been directly created by Archangels investee firms since 1992
- On average, during the 30 years of investment, we estimate that another 1,500 jobs were created as a result of indirect impacts of Archangels' investment.
- Since 1997, Archangels investee companies have created jobs paying an average 39% higher than the Scottish average annual salary (£33,185 pa compared with £23,842 pa).
- 55% of Archangels investee companies now have female board representation (an increase from 15% prior to 2005).

Commercial Performance:

- Archangels has invested around £161m in 89 Scottish early-stage, high risk companies since 1992.
- Over the period 1992-2022, there have been three Initial Public Offerings (IPO), one Management Buyout (MBO), 21 Trade Sales, and 44 failures.
- Archangels' investee companies' failure rate of 49.44% compares favourably to the angel sector investee company average of 80%.
- Archangels has generated an IRR of 23.6% across its realised investments to date (including failures), returning £144.4m to its investors through successful exits and dividends.

Economic Performance:

- For every £1 invested by Archangels, £7.11-£8.45 is the average estimated economic value generated.
- Between 1992-2022, Archangels investee companies have created between £1.142bn-£1.4bn of Gross Value Added.
- Of the 25 companies exited by Archangels over the period 1992-2022, 16 have retained operations in Scotland, two moved to another part of the UK, four moved abroad, and three were dissolved.
- Post-exit, the companies Archangels invested in generated an additional £776.86m of revenue and created an additional 261 new jobs.
- Archangels portfolio aligns closely to several UN Sustainable Development Goals:
  - Decent Work and Economic Growth
  - Industry, Innovation and Infrastructure
  - Good Health and Wellbeing

In 2015 we were commissioned by Archangels to develop a methodology and report to understand its economic impact. This was a ground-breaking exercise – no analysis of this kind, looking at the private angel investment sector's economic impact, had ever been done before which made it challenging to undertake. We consulted widely with angels, companies, policymakers, and academics on how to create the methodology to accurately assess the impact. This required thinking about impact in different ways beyond just the commercial return on investments and necessitated the development of a novel methodology that captured the economic impact of angel investment activities in a much more holistic fashion than had been done before. We sought to provide an analysis of the Gross Value Added, numbers of jobs created, salaries, and how the commercial performance of the syndicate translated into economic impact. We created both a methodology and actionable outcomes which provided (and still provide) insight into what angel investment means for Scottish companies and the Scottish economy beyond commercial performance.

The report was introduced by the then Finance Secretary in the Scottish Government, John Swinney MSP, who recognised Archangels' contribution to Scotland and its economy, as well as the development and contribution of the angel sector more generally. Economic impact isn't necessarily the first thing an angel thinks of when deciding to invest or not, but by capturing it through our novel methodology we have sought to illustrate its importance more generally in line with the original founding principles of Archangels.

It is important to note that this report is not simply an update of the original findings. Instead, it seeks to build on the original 2015 report in four ways. First, it provides an extended short history of Archangels to the present day; second, it updates the methodology and data from the original report; third, it provides new figures on the economic impact of Archangels; and fourth, it provides a holistic perspective on Archangels' wider impact not just on the Scottish economy, but also on the entrepreneurial ecosystem in which Scotland's companies operate. The original report was a first attempt at understanding the economic impact of Archangels – with this work we have sought to improve upon that where possible with more complete datasets, up-to-date information, and a wider understanding of impact that goes further than the first report in considering for example Environmental, Social and Governance issues, female board representation, and patenting to name just a few. We have conducted numerous interviews with different stakeholders, used Archangels' updated dataset, company reports, and analysed policy documentation to support our analysis. It is by no means comprehensive, and data remains a challenge. Nevertheless, we believe this report provides updated and enhanced insights into Archangels' impact over an extended period.

We are grateful to all who have helped us with the data collection and analysis, with particular thanks to Lindsay Miller of Archangels who has been very generous in tracking down the data we requested and supporting us in compiling the work herein. All errors of course remain our own.

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1 Executive Summary

This report was commissioned by Archangels in the spring of 2022. The draft report was submitted in August and the final version completed early September 2022.

Archangels is the longest continuously operating angel syndicate in the world, being formed in 1992 by entrepreneurs Mike Rutterford and Barry Sealey CBE. Since 1992, the syndicate has invested in pre-revenue and early-stage companies based in Scotland with significant growth potential.

This report considers the commercial performance of the syndicate, the economic impact of its investments, and the non-economic impact it has had to date. This report builds on the original 2015 report by extending and complementing the existing analysis therein. We have updated as many of the original results as possible to bring them to the current day, reflecting the changes in investment behaviour and outcomes over the entirety of the period 1992-2022.

At the time of publication, Archangels' current portfolio comprises 20 companies, has an estimated current book value of £211.29m, and supports over 755 jobs. Over the period 1992-2022, there have been three Initial Public Offerings (IPO), one management buyout (MBO), 21 trade sales, and 44 failures.

2 A Brief History of Archangels, 1992-2022

"We both believed that we had done well out of Scotland and wanted to put something back… We didn't set out to create a business angel movement. In fact, at that time the phrase business angel was unknown." Mike Rutterford, The Scotsman, 27/12/2021

In June 1992, Mike Rutterford and Barry Sealey met in Mackenzie's Restaurant in Edinburgh to explore ways in which they could work together to help Scottish start-up companies. From that first meeting Archangels has since invested in numerous early-stage Scottish companies contributing to the growth of the syndicate to become one of the leading angel investment organisations not just in Scotland, but the world. Both Mike and Barry had long and successful careers in business and wanted to deploy their knowledge, connections, and money to support early-stage business in Scotland to grow. They quickly agreed on four pillars on which to proceed and from its inception Archangels has operated in accordance with them:

i) Build businesses in Scotland
ii) Give something back
iii) Make money
iv) Have fun

In the early 1990s angel investment in Scotland was a largely individual undertaking that tended to be informal. What Mike and Barry had in mind was to give back to young, ambitious Scottish companies and entrepreneurs using their experience and capital. In relatively short order they ended up creating a model of group investing which would pool expertise, capital, and networks of its members to support investee companies in an approach that Archangels still operates successfully to this day and has been mimicked by numerous others. By bringing experts together for a common purpose, Mike and Barry were presaging what we now know as 'smart capital' through access to their resources and advice and combining that with 'patient capital' which is the willingness to support companies for longer periods of time than otherwise might be the case with other capital providers. Individual investing on its own can be successful of course, but likeminded, patient group investing has the potential to harness all the individual benefits and leverage far wider and stronger networks and resources to help early-stage companies thrive and grow.

In 2005, the former Archangels' gatekeeper, Peter Shakeshaft, spoke to the Scottish Parliament's Enterprise and Culture Committee. In his evidence he outlined Archangels' approach to investment thus:

"We take a whole-basket approach to investment. It is very high risk, but we are very hands on. We are all businessmen. We have all been around the block a few times—we have bought a few t-shirts—and we have the bruises and scars to show for it. We bring that experience back into the companies." [1]

Peter's description of working with companies in those earlier days of Archangels still rings true today. Archangels' core operating principles have not significantly changed since Mike and Barry first met in 1992, recognising that smart and patient capital is key to successful angel investment. Angels use their experience of business, the lessons they've learned, and the finance they're willing to provide to support early stage, often high-risk, growth potential companies. Mike and Barry describe this approach as 'getting your arms around the company' – this is in effect the alignment of smart and patient capital in investee companies with the intention of giving them the correct support to help them grow.

Scotland and the UK have developed a supportive ecosystem for angel investment which is highly successful and has been copied around the world. LINC Scotland was established in 1993 as the national association for business angels in Scotland, followed by the creation of the Enterprise Investment Scheme (EIS) as an indirect financial instrument in 1994. LINC Scotland plays an integral role in the functioning and growth of Scotland's angel investment sector which has grown with the support of policymakers, building on the trail Archangels blazed in the 1990s. EIS is now a key plank of almost all angel investment activity in the UK and serves as an effective incentive for investors to support high risk early-stage companies, in turn becoming an effective economic policy tool. In the early 2000s a series of direct financial instruments were created including the Scottish Seed Fund, the Scottish Venture Fund, and the Scottish Co-Investment Fund to support the early-stage risk capital market for supporting Scottish companies. This has helped create what is now known as 'The Scottish Model' of angel investment and support which has been mimicked around the world.[2]

As valuable as the governmental support has been, it is important to remember that at the heart of angel investment activity is that none of the members are under any kind of obligation to invest. Angel investment is a purely discretionary activity that Scotland is a world leader in supporting, facilitating, and growing. Angels choose to invest and under Archangels' model they do so because they want to, in line with the four pillars that Mike and Barry set as their guiding values from the very earliest stage of their collaboration together.

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1 https://archive2021.parliament.scot/parliamentarybusiness/report.aspx?r=771&mode=html

2 LINC Scotland briefing note, 2021. https://lincscot.co.uk/wp-content/uploads/2021/01/LINC-Briefing-Note-2021-1.pdf

2 A Brief History of Archangels, 1992-2022

Consistent within Archangels' operations since 1992 has been an evolution of the syndicate as an organisation itself, recognising its relatively informal beginnings into what is now a highly professionalised investment syndicate comprising over 120 members with certain regulated financial activities. That professionalisation has also led to an evolution in the four pillars towards a vision and mission which is more focused on generating consistent returns to investors. The Archangels vision is ***"to deliver outstanding returns for our investors, harnessing their experience and our network to fuel the success of Scotland's entrepreneurs and innovators"***. Its mission is ***"to provide our members with carefully-curated opportunities to invest in the most innovative companies and to support their early-stage development to fullest potential"***.

Archangels has been highly successful in its investments with a number of high profile exits including for example Optos, Tissue Science Laboratories, Touch Bionics, and Optoscribe, amongst various others. Archangels' performance across its portfolio outstrips the angel sector average with longer investee holding times, fewer failures, and a higher rate of return to investors. Alongside this has been an ongoing commitment to supporting other angels and syndicates with informal advice and co-investing activities. Mike and Barry got together with the intention of helping young Scottish companies grow – neither anticipated that thirty years later they'd have had an impact far exceeding that original intent.

Archangels' investment criteria comprise six main aspects.

1. The company must be based in Scotland.
2. The company must have high growth potential with international sales potential.
3. The company should have defendable technology, whether through IP or know-how.
4. The company should be in a sector which qualifies under the Enterprise Investment Scheme.
5. The funding proposal may cover a range from 'proof of concept' through expansion capital and can include start-up, early stage or series A.
6. The preferred level of investment is £250k to £1m but can cover a range from £500k to £2m.

Archangels Chair of the Board, 1992-2022

1992 - 1998	Mike Rutterford
1998 - 2003	Barry Sealey
2003 - 2008	Sir Gerald Elliot
2008 - 2014	Gavin Gemmell
2014 - 2022	Eric Young
2022 - present	Ian Macleod

Archangels Gatekeeper/Managing Director

1997-2000	Juliet Chapman
2000-2005	Peter Shakeshaft
2005-2015	John Waddell
2015-present	David Ovens and Niki McKenzie

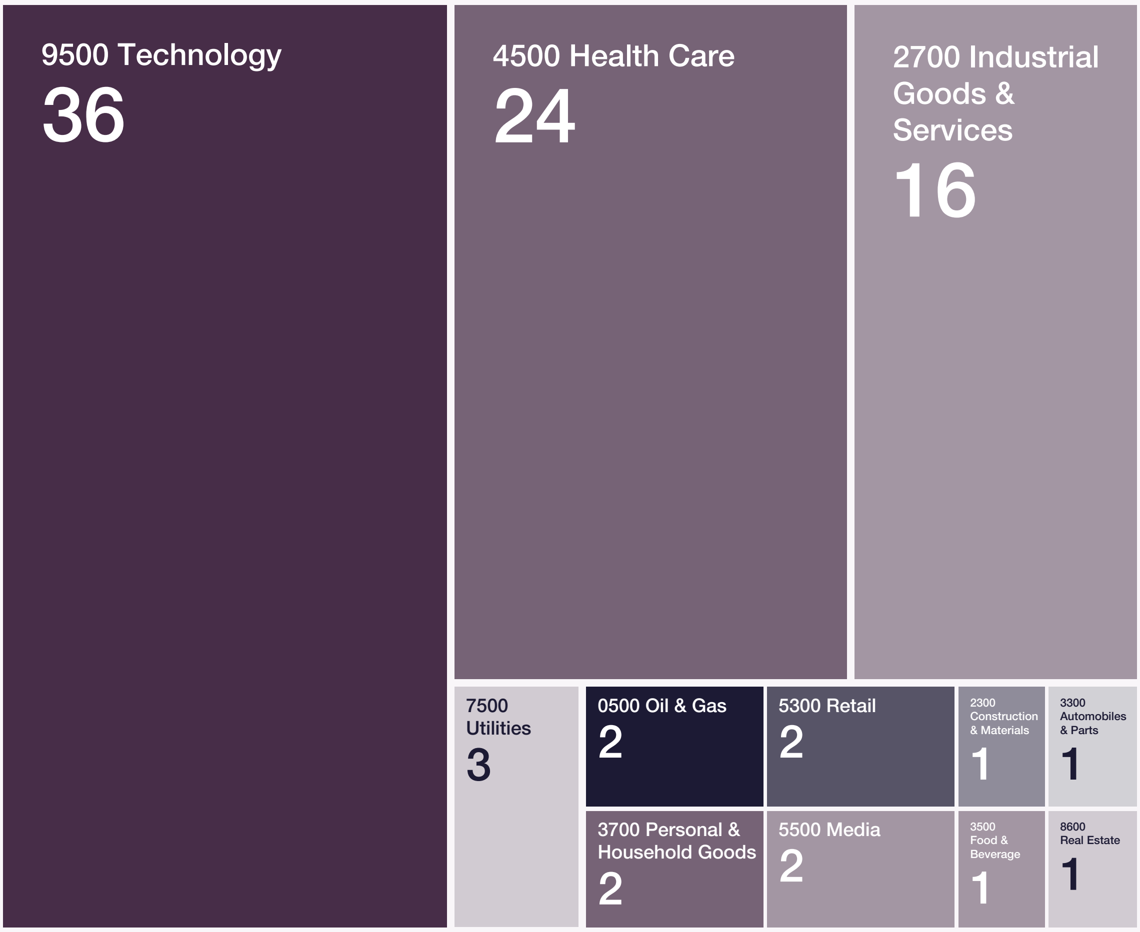
3 Archangels Descriptive Analytics, 1992-2022

In our first report we provided several descriptive analytics for Archangels' portfolio activities up to 2014. In this section we both update and extend the original analyses to bring them to the current day. It is worth noting here that since our original report new data has come to light so some of the analysis may not be directly comparable. We have sought to provide where possible a relevant and comparable analysis with the original report, building on its findings. However, where we have found more accurate data (deal values etc) we decided to use that in the interests of both accuracy and posterity. Due to the nature of the data available there are various challenges in calculating exact figures – what we have done here is provided estimates based on the best available data to us. In some cases, this is a range, in other cases a single figure. All source data is referenced after each figure and table.

Investments by Sectoral Classification, 1992-2022

As one might expect for an organisation that has existed for thirty years, over the period 1992-2022 Archangels invested in a range of different sectors including Technology, Healthcare, Industrial Goods & Services, Utilities, Oil & Gas, Personal & Household Goods, Retail, Media, Construction & Materials, Automobile & Parts, Food & Beverage, and Real Estate. We have grouped these investments together as illustrated in **Figure 1** below to provide a visual representation:

Figure 1: Number of Archangels Investments by Sectoral Classification, 1992-2022

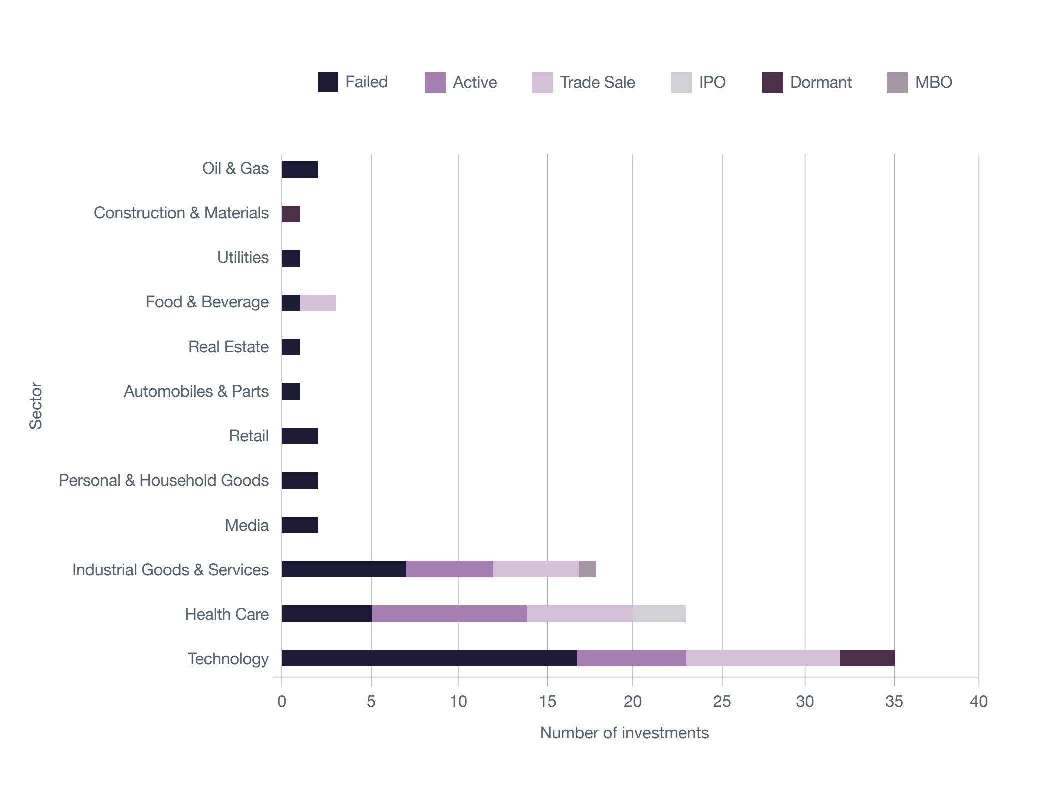


Source: Archangels' Data

3 Archangels Descriptive Analytics, 1992-2022

In recent years Archangels has developed a preference to invest in companies active in the Healthcare, Technology, and Industrial Goods & Services categorisations reflecting its expertise and success in these sectors. **Figure 2** below illustrates the portfolio outcomes in respect of the totality of Archangels' investments over the thirty-year period:

Figure 2: Archangels Total Investment Sectoral Outcomes, 1992-2022



Source: Archangels' Data

In angel investing, success is principally defined in terms of the return from exits in the form of trade sales, management buyouts (MBO) or Initial Public Offerings (IPO). Archangels has mainly invested in companies in the Technology, Healthcare, and Industrial Goods & Services at a much higher rate than in other sectors over the period 1992-2022. Early investments in other sectors were generally not as successful as these three sectors. However, it is worth noting, again, that angel investors expect mixed outcomes from their investments. Archangels is no different in this respect and as the first mover in the Scottish market it is to be expected that early investments were more likely to fail than the later ones where more experienced judgement and expertise comes increasingly to the fore.

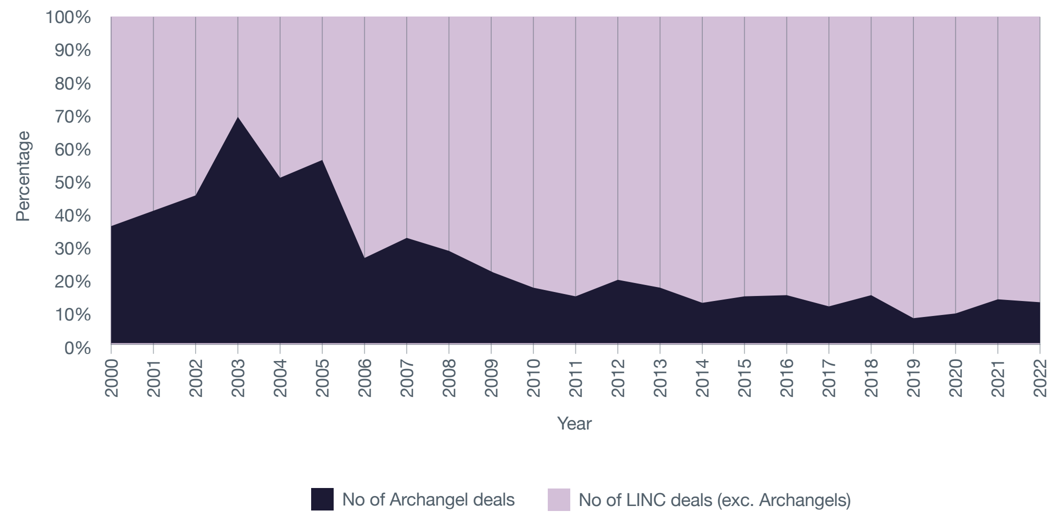
Archangels Annual Deals Data, 1992-2022

By way of context, and in line with the previous report, we have provided an analysis of the average number of deals done by Archangels and LINC Scotland for the period 2000-2022. LINC Scotland kindly provided its data to us, but it captures the period from 2000 only.[1] It is important to note that we are not trying to establish the entirety of the Scottish angel sector here as that would be very difficult to capture – not all angels are members of LINC Scotland for example, and not all will be visible. What we are doing here is trying to show how Archangels fares in comparison with other similar active syndicates and investors in the Scottish market. The comparison is then by no means comprehensive but intended as a guide for context.

The establishment of LINC Scotland in 1993, the year following Archangels' formation, was a critically important juncture in the development of the Scottish business angel sector. As the national association for business angels in Scotland, LINC has collected (and continues to collect) dealflow data since 2000, allowing us to provide an insight into the market in Scotland.

1 We are very grateful to David Grahame from LINC Scotland for sharing his dataset with us.

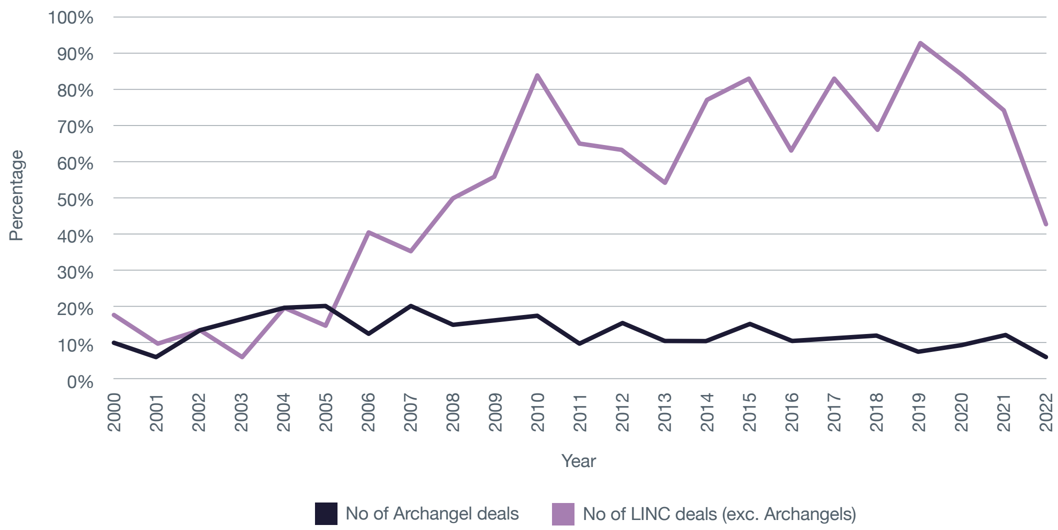
Figure 3: Total no. of Deals Archangels & LINC Scotland, 2000-2022



Source: Archangels' Data & LINC Scotland Data

What we see in **Figure 3** above is the importance of Archangels in the early stages of the Scottish angel investment market – from 2000-2005 it was doing a significant number of deals which comprised the majority of deals done in Scotland for three years. After 2005 the figure dropped in line with a commensurate growth in the percentage share of other LINC members doing deals. It is important to note that the absolute level of investment by Archangels has continued to grow during this period and therefore the relative decline in Archangels market share is directly attributable to the overall growth in the early stage investment market, which in itself is in part due to the success of Archangels' own investment activities.

Figure 4: Average no. of Deals Archangels & LINC Scotland, 2000-2022

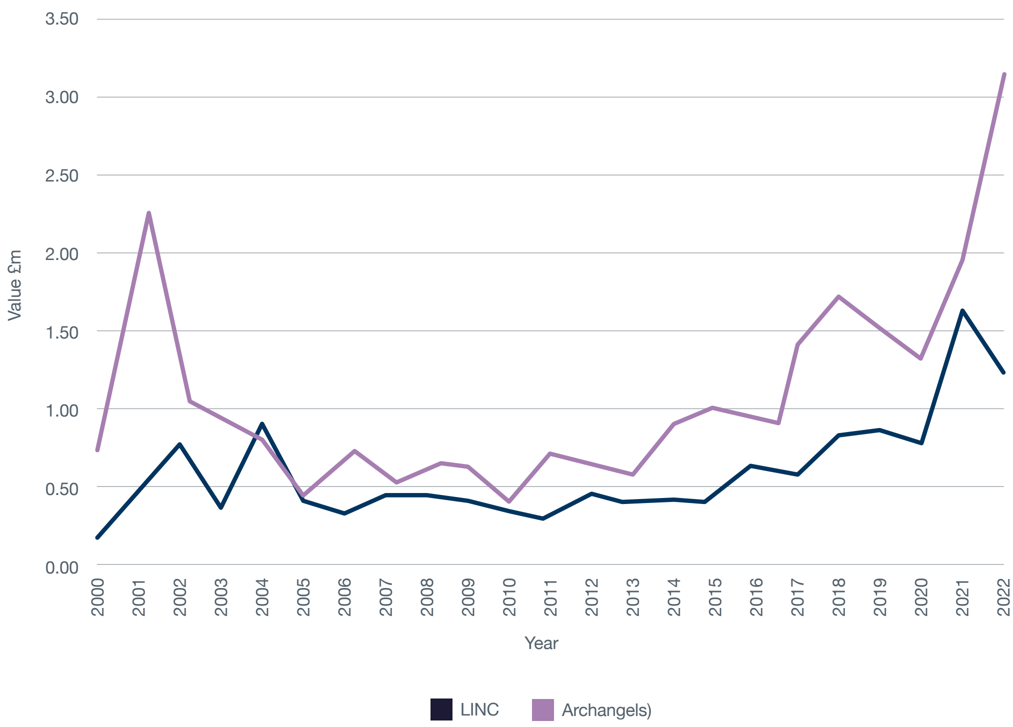


Source: Archangels' Data & LINC Scotland Data

3 Archangels Descriptive Analytics, 1992-2022

Whilst on an annual basis since 2005, Archangels has done fewer deals relative to members of LINC Scotland as a whole, **Figure 5** below demonstrates that during that period Archangels has nonetheless invested at a high level. Since 2015, it is apparent that the appetite for doing larger deals has grown, with Archangels' average deal size in 2022 breaking £2.5m for the first time in its history and Archangels' own contribution approaching £1.5m. This is further demonstration of the maturing Scottish angel investment market, as well as the growth in the desire for larger risk capital deals.

Figure 5: Average annual deal value Archangels and Other LINC members, 2000-2022 (£m)



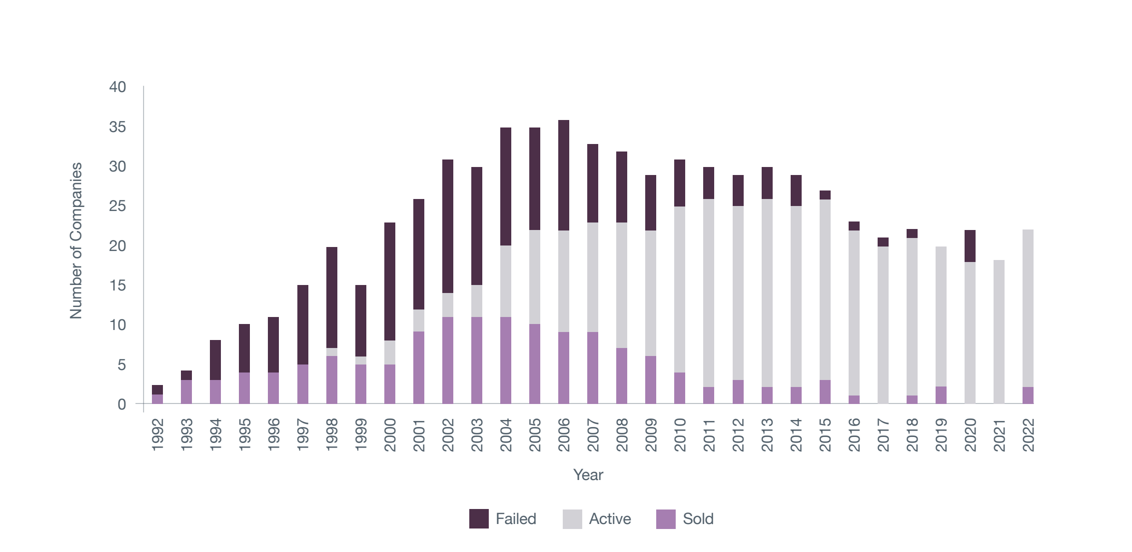
Source: Archangels' Data

The most recent significant uptick in average annual deal value can be attributed to the confidence of Archangels' members to support portfolio company growth ambitions, whilst increasingly bringing in new co-investment partners. This in turn has led to acceleration of growth and there is evidence to suggest it has, in some cases, reduced the time to achieve successful exits e.g. ZoneFox, Optoscribe and Oxy-Gen Combustion which were sold after 6, 5 and 3 years after the initial Archangels' investment. This general upward growth trajectory in the data is apparent from the mid-2000s.

Archangels' Portfolio Outcomes, 1992-2022

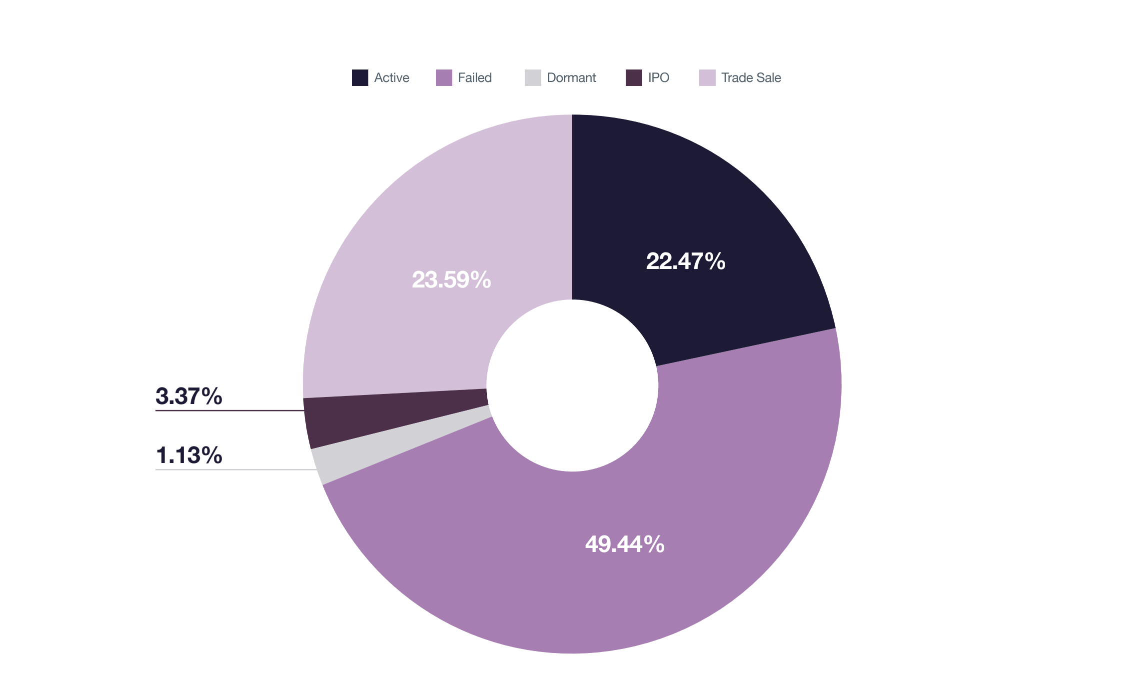
As we established in our first report, Wiltbank (2009) found that investment outcomes in angel investing are highly uncertain and more often than not prone to failure[2]. Mason (2009) also found that only around 20% of businesses backed by angel investors will succeed.[3] In the first report we provided a bar chart with the performance of Archangels' portfolio across a time series 1992-2014. We have updated our original analysis in the chart below and followed it up with an overall analysis of the composition of outcomes in a pie chart format following it.

Figure 6: Archangels' portfolio outcomes, 1992-2022



Source: Archangels' Data

Figure 7: Archangels Portfolio Outcomes, 1992-2022



Source: Archangels' Data

There are a number of interesting findings we can draw from these two charts. First, what they show is that

2 Wiltbank, R. (2009), Siding With the Angels: Business angel investing – promising outcomes and effective strategies. Nesta, London, pg. 5.

3 Mason, C. (2009) 'Venture capital in crisis?' Venture Capital: an international journal of Entrepreneurial Finance, 11 (4), 279-285.

3 Archangels Descriptive Analytics, 1992-2022

Archangels has performed better than both Mason and Wiltbank reported for the performance of angel groups more generally, with a failure rate of around 49.44% (this goes up to 50% if we factor in dormant companies) – contrasting with Wiltbank's assertion that most will fail. It is also apparent from the bar chart in **Figure 6** that Archangels has reduced the number of failures in its investments markedly since 2015 which, given the hugely challenging circumstances of the last few years with Brexit and COVID-19 is quite remarkable. Given this context it is perhaps not surprising that no exits occurred in 2020 and 2021, although we have already seen one significant exit in 2022 just past the halfway point in the year. It is also worth noting that the number of investments in terms of Archangels' active portfolio has held stable despite the challenging situation.

We have already identified the importance of patient capital to angel investment, and Archangels are amongst the most patient of investors. It is important, however, not to conflate patience with a lack of focus on value creation. As can be seen from Archangels' investment track record below, its returns on a time adjusted IRR basis are strong. Archangels has generated an IRR of 23.6% across its realised investments to date (including failures), returning £144.4m to its investors through successful exits and dividends. Below is a comparison of the portfolio averages of length of investment and company age at first investment, which shows Archangels' patience has actually increased since our original report, as evidenced in the table below:

Table 8: Portfolio Average holding period – 2015 & 2022 Comparison

	2015 Figures		2022 Figures	
	Length of Investment (yrs)	Age of company when first invested	Years of Investment	Age of company when first invested
Active	8.11	2.22	9.23	4.12
Failed	3.66	2.26	4.77	2.19
IPO	7.84	0.58	7.84	0.58
Trade Sale	8.17	2.31	9.42	2.32
Portfolio Avg.	6.07	2.15	7.81	2.30

Source: Archangels' Data
NB We have removed any dormant companies from this analysis.

In our first report we referenced an interview with John Waddell, former CEO of Archangels, with Business Insider where he remarked on how long it typically takes to make money out of angel investments. He maintained it was around eight to nine years, which the comparison provided in the above table indicates is correct. The patient approach Archangels take to companies is even more pronounced from our updated analysis than in the 2015 report. There is a clear change in the age profile of Archangels' active portfolio companies, with an increase from 2.22 years old to 4.12 years old, which is complemented by a similar increase in the holding time for active, failed, trade sale and the overall portfolio average. There is little difference in the average age of investee companies that resulted in a trade sale and or that failed between the analyses. No IPOs took place in the intervening period from the first report.

Exits and Impact

Since our first report, Archangels has exited a further seven companies in the form of Trade Sales, outlined in **Table 9** below:

Table 9: Archangel Exits since 2014:

Company Name	Date of Incorporation	Month of First Archangel Investment	Exit Year	Years of Investment	Age of Co at first investment
Optoscribe	1-Jun-10	25-Apr-16	2022	5.76	5.90
Document Outsourcing Group	22-Aug-03	1-Jun-05	2019	14.56	1.78
Oregon Timber Frame	12-Dec-97	1-Feb-98	2019	21.41	0.14
ZoneFox	6-Nov-08	19-Sep-13	2018	5.10	4.87
Touch Bionics	7-Jun-02	1-Feb-04	2016	12.20	1.65
Bloxx	10-Dec-99	1-Jun-04	2015	11.45	4.48
CXR Biosciences	9-Oct-00	1-Dec-01	2015	13.76	1.15
Oxy-Gen Combustion	3-Oct-05	1 Jan 2012	2014	1.75	6.3

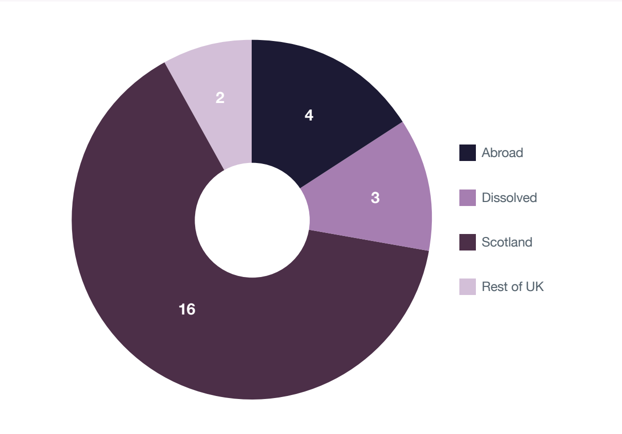
Source: Archangels Data

This brings the total number of successful exits via trade sale, IPO, and MBO from its portfolio for the period 1992-2022 to 25. Out of those successful exits only five failed to make a profit.

Considering the EIS benefits, Archangels has generated an IRR of 23.6% across its realised investments to date (including failures), which demonstrates that it is possible to generate excellent returns notwithstanding the high-risk nature of the investee companies.

Of the 25 firms that Archangels has exited, we searched the individual company websites and Companies House to determine if they retained operations in Scotland or not. From there we broke down the results into companies that retained operations in Scotland, moved abroad, moved to the rest of the UK, or dissolved. We then updated the registered location of former Archangels investee companies as per **Figure 10** below:

Figure 10: Registered location of Archangels Invested Companies After Exit, 1992-2022.



Source: Company websites, Companies House

What we see from these updated figures is that concern regarding exits of Scottish companies invested in by angel syndicates to new owners and the risk of losing these companies to Scotland remains largely unfounded. Of the seven companies exited since the last report, one has seen its registered office moved overseas, one was dissolved, and the rest remain in Scotland. One of the high-profile sales, Touch Bionics, was purchased by the Icelandic prosthetics firm Ossur in 2015 who subsequently announced a £5.3m investment in the Livingston plant in 2018.[4] Another trade sale, Oregon Timber Frame, was purchased by one of the largest house builders in the UK, Barratt Developments, and recently announced plans to double its workforce in Selkirk from 30 to 60.[5] Of the 25 companies sold by Archangels over the period 1992-2022, 16 have retained operations in Scotland, two moved to another part of the UK, four moved abroad, and three were dissolved. Our analysis suggests that the companies sold by Archangels have gone some way to allaying fears over Scotland losing their presence, and in fact they have been enhanced and developed further post-sale.

In our first report, we assessed the continued economic impact of companies that Archangels had exited, by analysing published company accounts (where available). We found that these 18 companies had generated revenues of £587.45m and created a net sum of 240 jobs in Scotland after Archangels involvement with them had ceased. In line with our previous approach, we also researched Companies House returns to establish the exited companies' turnover and how many jobs they support.[6] We found that since 2015, Archangels exited companies have contributed a combined turnover of £189.41m and support a total of 375 jobs in Scotland, with the number of net new jobs created being 21.

Table 11: Archangels Exit Economic Impact

Period	Total Revenue Generated Post-Exit (£m)	Net jobs created
1992-2015	587.45	240
2015-2022	189.41	21
Total	776.86	261

Source: Archangels Data & Companies House

Archangels – a story in three parts

1992-2001:

Archangels' first decade was noteworthy in many ways. It saw the creation of the syndicate in 1992 and growth in its membership and investment amounts. In 1992 seven Archangel investors participated in investing in two companies having levered additional funds from four outsiders. There was participation by government funds in that year. By 2001, 50 Archangel members had invested in 36 companies to the tune of over £23m and had levered an additional £28m mostly from other private sources. Public investment was available during that decade through some regional funds and Scottish Equity Partners prior to its privatisation, however the total amount invested by those external entities was less than £1.0m. By 2001 eight of those companies had failed and the investors had experienced three exits.

A key event during this decade was the dot com bubble bursting which occurred between 2000 and 2002, with a few frothy investment years before which saw the NASDAQ stock market rise by 730%. Archangels were participants in both the upside and downside of this event as private equity valuations and prices follow those of public markets which reflect general economic conditions. Archangels added nine new companies to its portfolio in 2000 bringing the total to 31. Only one of those companies created an exit for its investors with the other eight failing after an average holding period of just over four years. Another five were added in 2001 and of those three were successful investment stories and one is still in the portfolio. Perhaps as values had already started to decline this is a sign that buying at the right price is a key metric to success.

4 https://www.med-technews.com/news/Ossur-invests-5-3m-in-scotland-to-develop-new-prosthetics/

5 https://www.thesouthernreporter.co.uk/business/company-expansion-set-to-create-30-new-office-jobs-in-selkirk-3513373

6 NB Of the seven companies exited, we were not able to establish figures for two – Bloxx Limited and ZoneFox.

3 Archangels Descriptive Analytics, 1992-2022

2002-2011:

The second decade of Archangels' life saw the Scottish Investment Bank, a subsidiary of Scottish Enterprise launch the Scottish Co-investment, Scottish Seed, Ventures and Portfolio Funds, which were partly funded by the European Regional Development Fund. These funds added significant capacity to the early-stage risk capital market in Scotland and allowed a greater diversification of the Archangels' investments and the establishment of many other syndicates. The early years of this decade saw many of the venture capital players leave the Scottish market and with the privatisation of Scottish Equity Partners, the void was filled by these public funds and the increased angel investing capacity. Indeed during that decade eight new business angel groups were formed as shown in **Table 20:** Scottish Business Angel Groups and Launch Year.

Archangels themselves grew exponentially during the decade and helped many other syndicates get established and flourish. By the end of the decade investments had been undertaken by more than 175 Archangel members who had invested £46.4m and levered £18.5m from the Scottish Government Funds and £32.1m from other private investors, evidencing the increased volume of capital that came into the market this decade and the importance of angel investors in filling the void created by the exit of the VCs. During this decade Archangel's members invested in 33 new companies, experienced 10 exits, and 24 failures.

2012-2022:

The last decade in Archangels 30-year history has been somewhat different from the preceding two. Activity was reduced at the new investment level with ten new additional investments and three exits and an increasing focus on supporting the existing portfolio companies. However, failures too were less numerous, with only nine occurring. This lower rate of portfolio activity did not result in less being invested however – during this decade Archangels invested over £90m and levered an additional £39.7m from government funds and £42.8m from private investors. During this decade almost 270 Archangel members participated in investments.

This decade also saw Archangels further formalise its syndicate. Niki McKenzie, a Chartered Accountant with a strong background in Corporate Finance, joined the Archangels' team in 2011 and is now Joint Managing Director alongside David Ovens, an experienced investor and corporate financier, who joined in 2014. Dr Sarah Hardy joined the management team in 2016. Sarah brought with her many years of experience of financing early-stage opportunities in the life science and healthcare sectors having worked for over 15 years with The Wellcome Trust. In 2017, Shaolei McKie, a Chartered Accountant who specialised in leveraged finance and fund investments, joined the team to provide support such as management of share cap tables and due diligence..

The current team is focused on the types of investments it makes, having recognised through time which businesses would be more likely to have favourable outcomes. There is now a clear focus on technology and life sciences sectors reflecting the expertise of the organisation and its track record to date.

4 Economic Impact of the Archangels, 1992-2022

In our first report we developed a novel methodology to assess and understand Archangels' economic impact until 2014. In this section we update those figures to reflect their economic impact from 1992-2022. Where data was unavailable from early years, we have used it from years where it is consistently available.

Both the UK and Scottish governments have long seen the creation and growth of small innovative businesses as critical to employment growth. Nesta wrote a report in 2009 which outlined that just 6% of high growth companies created half of the UK's employment growth between 2002 and 2008[7]. Job creation is important as the salaries of those jobs are spent on other goods and services which create demand growth for the goods and services of other companies, which in turn stimulates increase demand for the inputs of production and thus impacting the economy at many levels and increasing the overall level of economic activity and citizens' wellbeing. The knock-on effect of such activities by private investors was not well-understood until our 2015 report. Here we update these figures to provide a whole picture of Archangels' economic impact since 1992.

Job Creation

Job growth in Scotland in the last five years has been affected by both Brexit and the Covid-19 pandemic, which occurred towards the end of Q1 2020. Policies to restrict movement resulted in aggregate demand falling sharply and bottlenecks occurring in supply chains as whole factories closed and transportation was curtailed, resulting in costs rising or supply being limited. Longer delivery times and severe shortages caused many nations to reconsider their domestic manufacturing facilities and areas where domestic production may be beneficial, causing the beginning of a reversal of the long-standing globalisation trend. As many businesses suffered from lower demand, higher costs and challenges in securing supply, the level of jobs created within Scotland was dampened, resulting in a greater level of inactivity amongst the workforce. After a fall of 10.6% in Scottish economic activity in 2020[8] there has been a gradual recovery in both the economy and job creation since the end of that year and over the last five-year period, total employment in Scotland has increased by 1.6% with a dip and recovery over the Covid-19 period[9].

This 30th anniversary analysis illustrates the contribution Archangels has made to job creation in Scotland. Previous reports outlined that in 2015 the syndicate's investee companies had been responsible for the creation of 2855 jobs, which increased by a further 645 jobs by their 25th anniversary in 2017. On its 30th anniversary our updated analysis shows that number has increased by another 147 jobs, bringing the total to 3647 jobs created by Archangels investee firms since 1992. Although the 147 new jobs created since Archangel's 25th anniversary suggests lower momentum in job creation than historically has been the case, considering the context of Brexit and the pandemic in the intervening period as well as the job growth of the Scottish economy as a whole, the number of new jobs is indeed noteworthy. With a total growth figure of 4.2% over that period, the number of jobs created in Archangels investee companies is in fact more than double that of the economy at large with the 1.6% total growth previously mentioned[10].

Types of jobs

The total number of jobs created by Archangels' investee companies is only part of the story. The 2015 impact report highlighted the development of the average salary of Archangel investee companies over a 10-year period. The point was made that the patient capital investment approach adopted by Archangels resulted in higher value jobs being created in the long run. This indeed can be seen from the figure below which tracks the average salary paid by Archangel companies to their staff compared to the Scottish average from 1997-2021.

7 Nesta, (2009). The vital 6 per cent: How high-growth innovative businesses generate prosperity and jobs. (London).

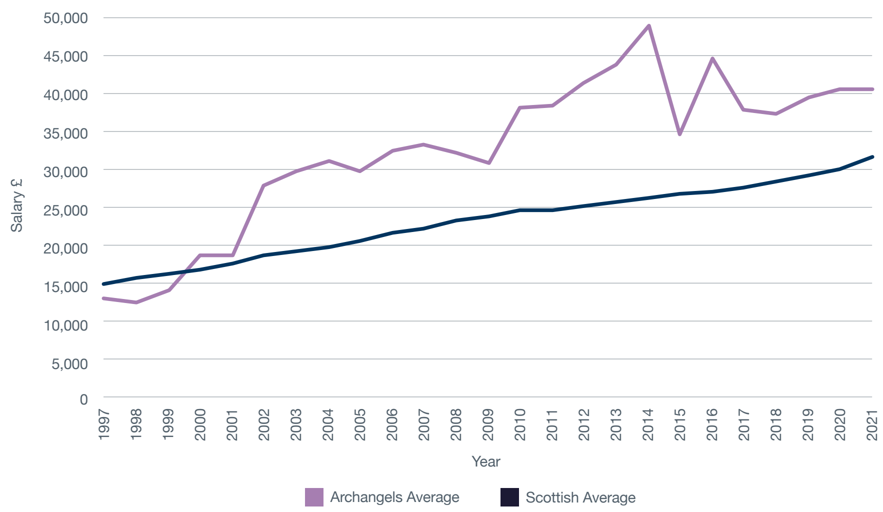
8 Scottish Government, (2021). Labour Productivity Statistics: 2021 Quarter 4. Available from https://www.gov.scot/publications/labour-productivity-statistics-2021-q4/

9 Office for National Statistics, Labour Force Survey, In Employment ScotlandLFS: In employment: Scotland: All: Thousands: SA - Office for National Statistics (ons.gov.uk)

10 Archangels' Data and Scottish Government, (2021). Labour Productivity Statistics: 2021 Quarter 4. Available from https://www.gov.scot/publications/labour-productivity-statistics-2021-q4/

4 Economic Impact of the Archangels, 1992-2022

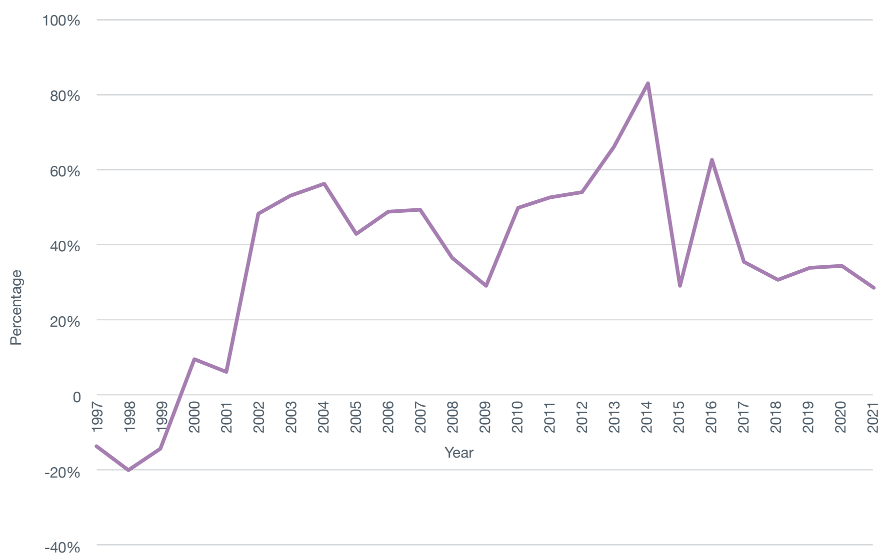
Figure 12: Archangels Portfolio Outcomes, 1992-2022



Sources: Archangels' Data, Scottish Government Annual Survey of hours and earnings: 2021. Available from https://www.gov.scot/publications/annual-survey-of-hours-and-earnings-2021/

This chart shows that, excluding the early years of the time period covered (which may well reflect cash flow and wage pressures during the tech bubble), the average salary paid by Archangel companies has been consistently higher than the Scottish average since 2000. Since 1997, the average salary per job created by Archangels was £33,185 compared with a Scottish average of £23,842.

Figure 13: percentage difference in average salary per job Archangels average vs Scottish average



Sources: Archangels' Data, Scottish Government Annual Survey of hours and earnings: 2021. Available from https://www.gov.scot/publications/annual-survey-of-hours-and-earnings-2021/

Over the period 1997-2022, **Figure 13** shows that Archangels investee companies have created jobs paying an average 39% higher than the Scottish average annual salary. The early years show the Scottish average as being higher, but from 2000 Archangels investee companies paid salaries ranging from 6% to 84% higher than the Scottish average depending on the year. It is important to note here that the figures change depending on the success or failure of investments as the portfolio changes over time.

Thus, there will be periods of feast or famine so taking an average over the whole life of the investments by Archangels is the most appropriate figure to use. By creating jobs that pay on average 39% more than the Scottish annual average salary it is clear Archangels is helping to generate and sustain well-paying jobs that create economic value.

Cost per job created

It is one thing to identify that Archangels have created higher paid jobs compared with the Scottish average, but at what cost in doing so? If we consider the £160.6m invested by Archangels' members and the 3647 jobs that have been created by companies whilst in their portfolio over the period 1992-2022, we can conclude that each job cost £44,000 to create which is essentially a sunk cost. When we consider that each Archangels investee company job pays on average £33,185 per year (covering the period 1997-2022), after 16 months of employment the average Archangels job breaks even on this cost and then becomes net positive. This shows that Archangels is efficient and effective in creating well-paying jobs.

The cost per job calculation above is relatively simplistic and misses a degree of nuance in how the monies are matched, provided, and deployed. Such a measure neglects the continued growth of companies after their divestment and the jobs that are created thereafter. It should also be noted that the Enterprise Investment Scheme (EIS), which often benefits the members of Archangels as they invest in these high-risk businesses, will mean that one third of that job cost or investment value is actually paid by the tax man which results in subsidised early-stage investment activity being a very economical job creation policy. Therefore the figures above, as impressive as they are, are almost certainly only a starting point for understanding the economic impact these investments have.

Indirect Job Creation

In the previous section the job growth created directly by Archangels' companies was discussed. As the increased jobs stimulate additional economic activity, further jobs are created by those companies as they expand their economic activity. This multiplier effect is measured by the Government's statisticians at the sector level[11]. On average, during the 30 years of investment, we estimate that another 1,500 jobs were created as a result of these indirect impacts. This estimate was based on the application of Formula A below to the year 2015 and then aggregated for the total number of jobs created by the portfolio companies.

Formula A:

Total Indirect Jobs Created = ((FTES$_{c2015}$) * (Type II Employment multiplier$_{c2015}$)) + (((FTES$_{c2015}$) * (Type II Employment multiplier$_{c2015}$)) * ((Total FTES in Archangels' Portfolio – Total FTES$_{2015}$)/ Total FTES$_{2015}$)

GVA Calculation

As in the first report, we used official Scottish Government multipliers to calculate the GVA arising from Archangels' investments 1992-2022. The Scottish Government's statistics department collate and produce data which enabled us to calculate the estimated economic impact from these increased jobs. The economic activity data considers the different sectors in the economy and for each on an annual basis a series of multipliers are published which estimate the downstream impact of that sector's activity. Applying this data to Archangels' portfolio companies gives an estimation of the value of increased economic activity created by its investments in these companies.

Our analysis deploys Formula B below to show the Gross Value Add at a Scottish macroeconomic level. Our analysis shows that for every £1 invested by Archangels £7.11- £8.45 is the average estimated economic value generated. To give this number some perspective, this suggests that since inception Archangels companies have created between £1.14bn - £1.36bn of economic activity which represents 0.7% of the annual onshore estimate of GDP for 2021 at £167.6bn calculated by the application of Formula C.

Formula B:

Total GVA$_{ct}$ = (GVA range per £ invested$_{2015}$) + ((({[(GVA$_{ti}$/Total Output$_{ti}$) *Turnover$_{tc}$] - leakage percentage$_{c}$ – displacement percentage$_{c}$ – substitution percentage$_{c}$} * Type II multiplier$_{ct}$)/ (Archangels Invested Amount$_{t}$))

where:

- **t** = the calendar year 2016-2022
- **c** = the company
- **I** = the industry of the company

Formula C:

((Total Value Invested by Archangel members) * (Average of £7.11+ £8.45)) / Annual Onshore Estimate for Scottish GDP 2021

Figure 14 below shows how Archangels' GVA metrics have changed over time referencing the numbers provided in this 30th anniversary report alongside the numbers of our previous work. Two sets of numbers are shown, one is the GVA range per £1.00 of Archangel money invested and the other is the cumulative range of Total GVA at the macroeconomic level.

Figure 14: The Contribution of one Pound Invested by Archangels to the Scottish Economy

	Report Year		
	2015	2017	2022
GVA per Archangel £1.00 invested	£7.08-£8.94	£7.61-£9.51	£7.11-£8.45
Total Invested by Archangels	£91.5m	£103.5m	£160.6m
Total GVA created	£648m -£818m	£788m -£984m	£1142m -£1357m

11 Scottish Government, Supply, Use and Input-Output Tables 1998-2018. Available from Supply, Use and Input-Output Tables: 1998-2018 - gov.scot (www.gov.scot)

4 Economic Impact of the Archangels, 1992-2022

The per £1.00 invested number is a ratio which varies over time due to the nature of its inputs. Key inputs into the calculation are the annual turnovers of the companies in the portfolio for the time frame considered, the amount Archangel invests in each of the companies in that time frame year by year and the GVA ratio calculated by the Government statisticians for the industries to which each of the portfolio companies belong (which to some degree reflects the profitability of the company) and lastly the GVA Type ii multiplier that again the Government statisticians calculate for each company's industry which reflects the direct and indirect impacts on the economy.

As we know, industries' profitability varies over the business cycle and as they mature; likewise positive changes in their productivity may well lessen the indirect effect that it is having on the economy as less inputs are required. At any point in time this number may be affected by the R&D supportive investments Archangels are making such that incidence of pre-revenue companies may be higher and hence there is no turnover to include. Suffice to say this ratio will vary over time and does not reflect any cumulative effects.

Cumulative GVA contributions, in contrast, can be considered by considering the Total GVA created at any point in time by applying the amount invested to the per pound ratios. It is thus noteworthy although the per pound ratio in this report is slightly lower than previous numbers obtained, the total contribution is significantly higher.

Current Portfolio Companies

Archangels' current portfolio of investments reflects its preference for high-technology businesses, with rich IP, and scalability. Over half of the investee companies in the current portfolio are in the health sector, but there is a clear diversity present in their investments with industrial goods and services and technology also well-represented.

Company name	Month of first Archangels' investment	Sector Sic-Code
Administrate	1-Dec-10	9500 Technology
Arrayjet	1-Feb-01	4500 Healthcare
Bio Images Drug Delivery (BDD Pharma)	20-Mar-18	4500 Healthcare
BioCaptiva	6-Apr-21	4500 Healthcare
Blackford Analysis	1-Sep-12	9500 Technology
Calcivis	1-Aug-12	4500 Healthcare
Cytomos	1-Dec-14	4500 Healthcare
Fios Genomics	1-Jul-11	4500 Healthcare
Hearing Diagnostics	20-Oct-20	4500 Healthcare
Indigo Lighthouse Group	1-Jun-04	2700 Industrial Goods & Services
MGB Biopharma	1-Feb-10	4500 Healthcare
NCTech	1-Oct-11	2700 Industrial Goods & Services
PhysioMedics	6-Dec-17	4500 Healthcare
Powerphotonic	1-Nov-07	2700 Industrial Goods & Services
Queryclick	21-Aug-19	9500 Technology
Quosient (Earth Blox)	13-Jun-22	9500 Technology
RD Group (Integrated Graphene)	9-Nov-20	9500 Technology
Reactec	1-Apr-04	2700 Industrial Goods & Services
Speech Graphics	10-Oct-18	9500 Technology
Trig Avionics	1-Jun-06	2700 Industrial Goods & Services

In its current portfolio, Archangels supports over 755 jobs, with its investee companies ranging from 5 to 187 employees reflecting the willingness of the syndicate to support both very early stage and maturing businesses. Below are averages for age, length of investment, and number of employees within the current portfolio.

Averages:

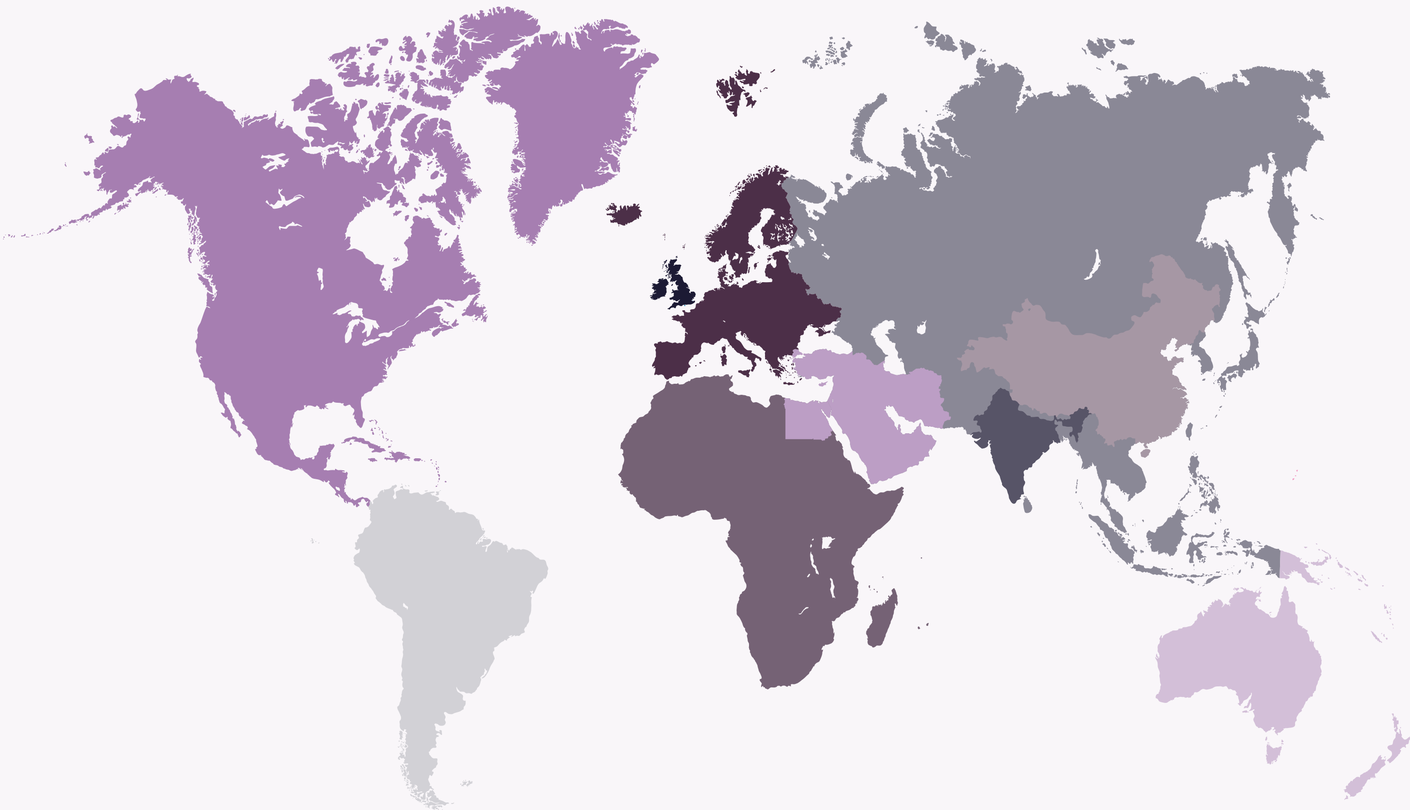
- Age at investment – 4.21 years
- Length of investment – 9.17 years
- Number of employees – 35.2 full time equivalents

Global Activities

Archangels' current portfolio comprises companies active in global markets, recognising the importance of Scottish companies internationalising and growing their operations accordingly. Although focused on Scottish-based companies for investment, Archangels' investment strategy focuses on companies whose products and technologies address global markets. In terms of overseas market penetration, Archangels' investee companies are selling to every major world territory, with over half of the portfolio (12 companies) currently serving overseas markets and plans for the others to follow suit. Building globally successful businesses takes patience, time, and money. Archangels' investee companies benefit from all three of these in their quest to become successful.

4 Economic Impact of the Archangels, 1992-2022

Figure 15 Current portfolio companies with overseas market penetration



	UK	Europe	Africa	Asia	Australia	Middle East	S America	North America
Administrate	●					●		●
Arrayjet	●	●	●	●	●			●
Bio-Images Drug Delivery (BDD Pharma)	●	●		●				●
Blackford Analysis		●			●			●
Fios Genomics	●	●		●				●
Indigo Lighthouse Group	●	●						
NCTech		●		●				●
PhysioMedics	●	●		●				
Powerphotonic	●	●		●				●
RD Group Co (Integrated Graphene)	●	●						
Speech Graphics	●			●				●
Trig Avionics	●	●						●

5 Beyond Economic Impact

Our original report explored the economic impact of Archangels' investments from 1992-2015. Whilst we have updated those figures for this report, we have also sought to better understand the non-economic impact of Archangels, in recognition of the changed context of both Scotland and the wider world. There has been significant change since the first report of course with the emergence of the climate emergency, and significant global upheaval caused by the COVID-19 pandemic and the concomitant effects on society, the economy, and everything therein. As a result of these, there is growing recognition of the importance of social aspects of business and that it should be more than just an afterthought. Companies and investors are therefore beginning to pay closer attention to issues such as female representation on company boards, good jobs, and sustainable development. This section considers other aspects of Archangels' investment activities beyond the commercial and economic impact, namely broader social impacts.

Environmental, Social, and Governance:

Environmental, Social, and Governance (ESG) perspectives have grown in importance in recent years through recognition of climate concerns and the need for business to meet societal challenges[12]. Whilst creating social impact is not a direct investment focus for Archangels, Archangels investment portfolio nevertheless aligns closely to several UN Sustainable Development goals that set out a blueprint for a sustainable future. The UN Sustainable Development Goals were implemented in 2015, comprising 17 goals to meet global challenges including poverty, inequality, climate change, environmental degradation, peace and justice.

12 https://www.london.edu/news/esg-is-not-a-distraction-against-climate-action-2056

5 Beyond Economic Impact

	Administrate	Arrayjet	BDD Pharma	BioCaptiva	Blackford Analysis	Calcivis	Cytomos	Fios Genomics	Hearing Diagnostics	Indigo Lighthouse Group	MGB Biopharma	NCTech	PhysioMedics	Powerphotonic	Queryclick	Quosient (Earth Blox)	RD Group (Integrated Graphene)	Reactec	Speech Graphics	Trig Avionics
1 NO POVERTY																				
2 ZERO HUNGER																				
3 GOOD HEALTH AND WELL-BEING		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓					✓		
4 QUALITY EDUCATION																				
5 GENDER EQUALITY																				
6 CLEAN WATER AND SANITATION																				
7 AFFORDABLE AND CLEAN ENERGY																				
8 DECENT WORK AND ECONOMIC GROWTH	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10 REDUCED INEQUALITIES																				
11 SUSTAINABLE CITIES AND COMMUNITIES																				
12 RESPONSIBLE CONSUMPTION AND PRODUCTION																				
13 CLIMATE ACTION																✓				
14 LIFE BELOW WATER																				
15 LIFE ON LAND																				
16 PEACE, JUSTICE AND STRONG INSTITUTIONS																				
17 PARTNERSHIPS FOR THE GOALS																				

Of its current portfolio investees, all 20 companies align with SDGs 8 (Decent Work and Economic Growth) and 9 (Industry, Innovation and Infrastructure), and over half (11) of them align with SDG 3 (Good Health and Wellbeing) reflecting Archangels' strength in healthcare investments. Since 1992, several of the investee companies have also aligned with other goals including SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action) and SDG 15 (Life on the Land).

Sustainable Development Goal 3 – Good Health and Wellbeing

The UN Sustainable Development Goal 3: Good Health and Wellbeing seeks to "ensure healthy lives and promote well-being for all at all ages".[13] The UN identifies several ways to achieve this goal, of which the key ones relevant to this work are in supporting research and development, universal access to affordable vaccines and medicines, and increasing health financing. In its current portfolio, Archangels has invested in several companies and their technologies which align to SDG 3 including:

These companies work across a range of technologies in the healthcare sector, covering diagnostics, testing, drug delivery, hearing aids, medical imaging and logistics. These are technologies and businesses at the cutting edge of innovation in healthcare and related industries which are breaking new ground with their research, intellectual property, and market penetration, including overseas. It is not difficult to envisage these technologies being applied in both emerging and developed markets accordingly.

Health and well-being technology is an area of historic strength for Archangels, with successful exits from investments in Optos, Touch Bionics, CXR Biosciences, Tissue Sciences Laboratories, Mpathy, and Vitrology, and several others. These companies were/are all successful in developing health and well-being technologies and penetrating overseas markets, making them attractive to larger businesses looking to enhance their own capabilities through acquisitions. Beyond the commercial return arising from these exits, Archangels has supported the development of the healthcare sector in Scotland by demonstrating the ability of Scottish companies in developing new capabilities, technologies, and innovations which support innovation. Below are some short case studies of Archangels' investee companies in this important sector.

13 United Nations (2015) Resolution adopted by the General Assembly on 25 September 2015, Transforming our world: the 2030 Agenda for Sustainable Development (A/RES/70/1).

5 Beyond Economic Impact

Optos was Archangels' second investment and has arguably been one of its most successful and important in showing how patient capital and the commitment of investors can help build a global business from scratch in Scotland.

The initial investment in Optos was in 1992 in the founder Douglas Anderson who wanted to develop a non-invasive digital widefield image capture of the retina to help save people's sight after his son lost sight in one eye due to an undiagnosed detached retina. After 31 rounds of investment by Archangels' members, Optos went to an Initial Public Offering in 2006, and was then taken private by the Japanese company Nikon in 2015 in a £259m deal. It has remained in Fife since its creation, where it employs 256 people. Since its inception 30 years ago, Optos has sold over 12,000 devices and served over 70m patients around the world.

"I'm amazed we've managed to get so far. We make the product today that I hoped for 25 years ago. It means there are many parents out there who won't have to go through what we did all those years ago."

Douglas Anderson, founder of Optos, interview, Daily Express, 2017.[14]

In 2004 Archangels first invested in Touch Bionics, a spin out from the NHS, where prosthetic specialist David Gow came up with the idea of a bionic hand. Touch Bionics was sold to the Icelandic prosthetics firm Ossur in April 2016 for £27.5m, illustrating both the smart and patient aspects of Archangels' investment strategy. Since the sale of Touch Bionics to Ossur, the Icelandic parent firm committed to investing over £5m in the Livingston plant in 2018 where it employs 45 people. At the time of its sale to Ossur, Touch Bionics had provided over 5000 patients with new myoelectric prosthetic hands (the i-Limbs and i-Digits quantum hand models), making a significant improvement to their everyday lives.

"I have seen hundreds of people... I have seen the father that says 'thank you' on behalf of his son," Gow says, wiping a tear from his eye. "That means an awful lot because you don't, as an engineer, get many moments where you articulate human emotions about these things."

David Gow, inventor, Touch Bionics, interview with CNN, 2013.[15]

14 https://www.express.co.uk/life-style/health/767046/douglas-anderson-optos-eyesight-invention)

15 https://edition.cnn.com/2013/02/01/tech/bionic-hand-ilimb-prosthetic/index.html)

The nature of Archangels' investment strategy and focus is on creating high value Scottish companies that create well-paying jobs in high-technology industries. Consistent within this focus is a clear alignment with Sustainable Development Goals 8 and 9 which focus on "Decent Work and Economic Growth" and "Industry, Innovation and Infrastructure". Taken together the entirety of Archangels' current portfolio are representative of these two SDGs. As broad as they are, these SDGs are nevertheless important in illustrating the societal value placed on creating good jobs and developing industry and innovation. Archangels' investee companies are designed to provide good jobs and contribute to economic development by virtue of their focus on R&D and cutting-edge technology.

Reactec

8 DECENT WORK AND ECONOMIC GROWTH

Reactec is a current investee company whose core focus is on workplace health and safety technology sector. Archangels first invested in the company in 2004, supporting the development of Reactec into its current position, where it now provides integrated workplace wearables and data analytical services to over 12,000 subscribers, comprising 38m employee risk data records. The company's principal focus is preventative engineering and software that provides organisations and employees with specialised technology to ensure a safer work environment. Reactec is currently focused on the construction, facility management, heavy manufacturing, and local authority sectors. The focus on prevention and monitoring in jobs that are often dangerous, challenging, and infrastructural in nature, speaks directly to SDGs 8 and 9. Reactec currently employs 36 people at its premises in Edinburgh.

"The support of Archangels is what has allowed us to stay focused on expanding our technology roadmap through all of the challenges of 2020. It believes strongly in the value that our technology offers and has never wavered in backing the plans that took us to leadership in Hand Arm Vibration. Now it is equally supportive in helping us to grow the business into new areas of health risk in the workplace."

Interview with Jacqui McLaughlin, Chief Executive of Reactec, The Scotsman, 2020.[16]

OPTOSCRIBE
Pioneering 3D photonic integrated circuits

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Archangels first invested in Optoscribe, a spin out from Heriot Watt University, in 2016. As lead investor, but working closely with fellow investors Par Equity, Maven Capital Partners, Scottish Investment Bank, and Optoscribe's management, they exited the company in January 2022 with a sale, yielding a significant multiple to their investment, to a large American multinational. Optoscribe is an advanced photonics company that manufactures wafer 3D glass based integrated optical components for data centres. Located in Livingston, it opened a state-of-the-art 7,400 square feet manufacturing facility in March 2017, then in May 2018 it was certified to "the most updated standard of its kind" by the International Organisation for Standardisation.[17] Optoscribe held a number of strategic partnerships with big players in the electronics market including the Japanese multinational electronics manufacturer Sumitomo Electric, Cisco, Jenoptik, and Corning. Optoscribe's technology supports the electronic infrastructure for everyday life with its products featuring cloud-based computing and data centres around the world. Optoscribe continues to operate from its base in Livingston where it employs 32 people.

"One of the biggest challenges has been building an understanding of the market intelligence to give Optoscribe the independence to be able to take the technology to market… Equally important is having the right investors, and finding investors that are willing to support a particular type of business; in our case, innovative hardware technology. We had to find investors that are keen to support a high-tech manufacturing business that involves some level of capital investment in a manufacturing facility and capital expenditure."

Nick Psaila, PC Magazine, 2017.[18]

16 https://www.scotsman.com/business/big-interview-reactec-chief-executive-jacqui-mclaughlin-3034218)

17 https://www.scotsman.com/sport/football/livingstons-optoscribe-seals-japanese-alliance-105121

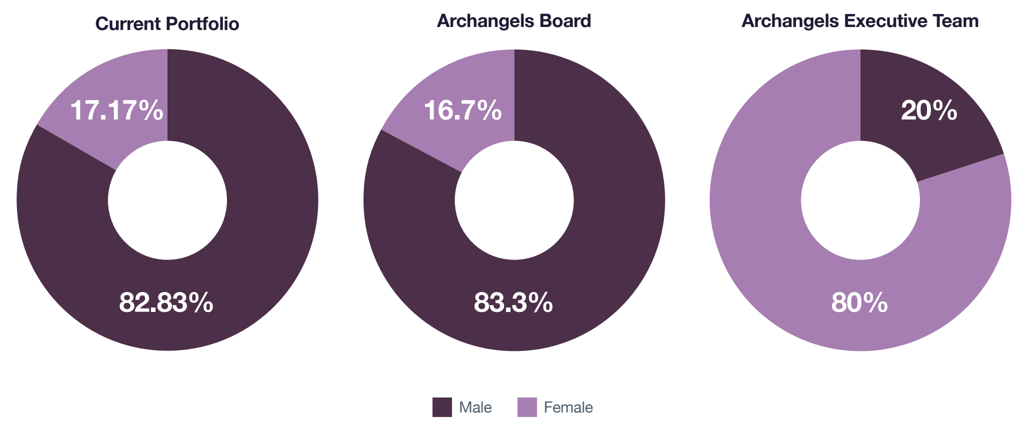
18 https://picmagazine.net/article/102585/PIC_manufacturing_solutions_for_optical_communicationsÂ%C2%A0/feature

5 Beyond Economic Impact

Female Representation

Archangels typically holds a portfolio of around 20 companies at any one time. In the figures below, we analysed the male/female split in board composition of current investee companies, the Archangels' Board, and the Archangels' management team:

Figure 16: Board Compositions



Source: Archangels' Data, Companies House, company websites

Interestingly the current portfolio of investee companies nearly matches Archangels' Board's own percentage split of males and females. On the one hand this is not entirely surprising as start-up companies often mimic their investors in the gender composition of their management teams.[19] However, on the other hand Archangels' own executive team shows the opposite with females significantly outnumbering males in its composition.

When we analyse the entire portfolio of investments stretching back to 1992, a very different picture emerges. In this analysis we found a significant change in female representation on investee company boards. Prior to 2005 (when Archangels was more informally run) only 15% of its investee companies had female board representation, but post-2005 the number has jumped to 55%.

Table 17: Archangels pre-2005 and post-2005 investee board representation

	No of companies with female representation on board	Percentage of companies with female representation on board
Pre-2005	3	15%
Post-2005	11	55%

Source: Archangels' Data.

Whilst there is still space to improve on this figure it is important to recognise the contextual issues that affect these figures. In the UK only 25% of STEM graduates are female compared with 52% for males.[20] However, the number of females entering full-time undergraduate courses in STEM subjects has increased from 33% to 41%, and an increase of 50% in females being accepted onto full-time STEM undergraduate courses in the UK between 2011-2020.[21] More recently, in 2019/20 females accounted for 11.4% of STEM start-ups, an increase from 8.8% in 2017/18.[22] Furthermore we know the recent COVID-19 pandemic has negatively affected females disproportionately to males[23], so the current portfolio analysis is not entirely surprising. Nevertheless, the figures representing the wider context suggest that there will be an increased talent pool in the future of female founders and directors in the types of research-intensive businesses that Archangels typically invests in. It is apparent then that things are moving in the right direction.

19 Campero, S., & Kacperczyk, A. O. (2020). Asymmetric gender homophily in the startup labor market. In Employee Inter-and Intra-Firm Mobility. Emerald Publishing Limited.

20 https://www.womenintech.co.uk/small-amount-of-women-in-stem

21 https://www.twinkl.co.uk/news/do-teachers-need-to-encourage-more-girls-to-study-stem-subjects

22 https://educationhub.blog.gov.uk/2021/02/11/women-in-stem-week-2021-how-were-empowering-the-next-generation/

23 https://www.womenintech.co.uk/mums-in-tech-balancing-working-from-home-with-homeschooling-during-the-pandemic

Investing in Innovation

Scotland has a relatively low rate of Business Expenditure on Research and Development (BERD) compared with the UK average[24], although it has been growing in recent years and was identified by the Fraser of Allander Institute as being the principal driver of the growth in Gross Expenditure on Research and Development (GERD) overall.[25] BERD is widely regarded as the most important form of research and development for productivity growth in developed economies.[26] Archangels has been a consistent supporter of BERD through its focus on cutting edge technology companies. It is worth highlighting here that around a quarter of Archangels portfolio any given time is pre-revenue which means these investee companies are almost solely focused on research and development. As we have established, it can take many years for angel investments to make money so Archangels' patience in supporting cutting edge BERD is an important point to consider when we look at how they support innovation in the Scottish economy.

Archangels' strapline is 'Investing in Innovation', and it identifies its preference for IP-rich technology and life sciences businesses in its investments. Consequently, many of its investee companies have registered their IP with the appropriate authorities to protect their innovations. We searched ESPACENET the European Patent Office's website for every Archangels investee company and founders (cross-referencing with Archangels' data and Companies House filings), identifying 174 patents registered. The range was 0 patents to 16 patents registered across the portfolio by investee companies and their founders. In searching for these patents, we only counted patents registered during Archangels' investment period with the companies, or immediately before the investment started. On average over a thirty-year period, Archangels companies registered 1.93 patents each which doesn't seem much. However, it often only takes one patent (and sometimes none) for a company to become successful. More importantly, in recognising, registering, and protecting innovations created in Scotland with the European Patent Office, Archangels' companies are demonstrating the cutting-edge technology that they are developing to a global audience.

Public Sector Co-Investment Activity

The investment funds run by the public sector have often been hailed as an explanatory variable for the success of the angel sector in Scotland. Prior to the launch of the Scottish Seed Fund in 2006[27] and the Scottish Co-Investment Fund in 2003[28], government investment activity occurred through regional funds, such as Fife Enterprise, West Lothian Venture Fund, Lothian Investment Fund for Enterprise, or city entities such as the Glasgow Development Agency. Another important investor in the Scottish market, prior to its privatisation in 2000, was Scottish Equity Partners. Scottish Equity Partners was the first entity to create a co-investment fund in Scotland, which happened when it received an equity guarantee from the European Investment Bank in 1994 for a £25m fund.

Since its formation in 1992, Archangels has engaged in co-investment activities with several different public funds. We collated information from Archangels' data into the chart below to show how often and to what extent Archangels engage with public co-investment in their deals. It is apparent, from the early 2000s onwards, that they started to use public co-investment more regularly to the extent that, by 2009, almost all deals did have some form of public involvement, occasionally dropping but not below 70%.

24 ONS (2021). Business Enterprise Research and Development Scotland 2020. Available from: https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2021/12/business-enterprise-research-and-development-2020/documents/business-enterprise-research-and-development-2020-report/business-enterprise-research-and-development-2020-report/govscot%3Adocument/BERD%2B2020%2Bpublication.pdf

25 https://fraserofallander.org/back-to-basics-research-and-development-in-scotland/

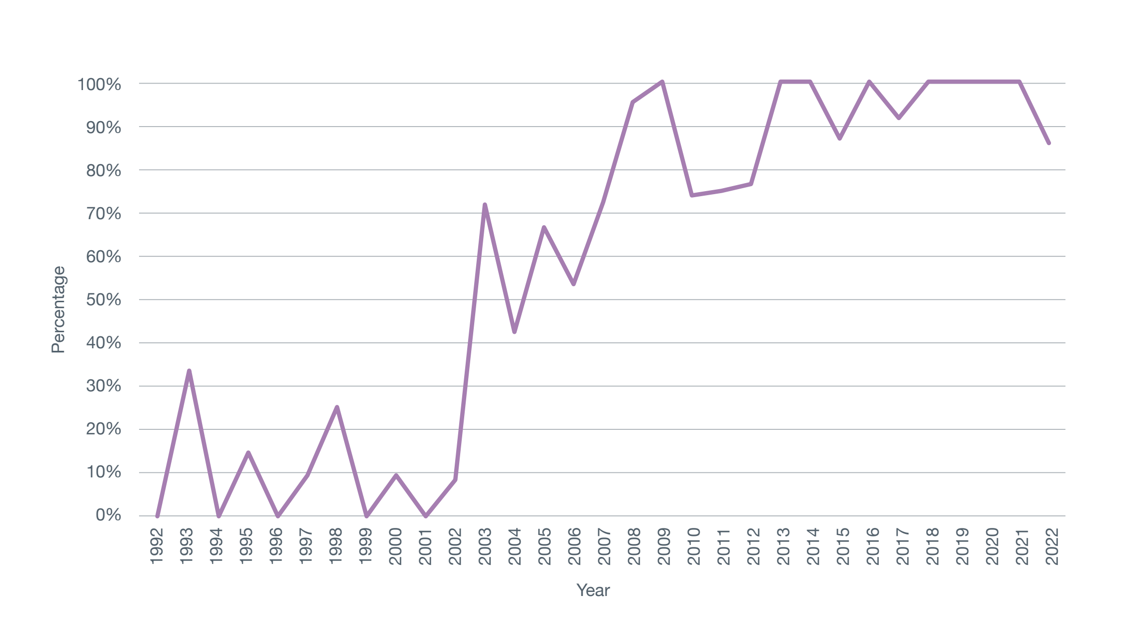
26 Sveikauskas, L. (2007). R&D and productivity growth: A review of the literature. Bureau of Labor Statistics Working Paper, 408.

27 PACEC, (2014). Economic Impact of the Scottish Seed Fund; Final Report. Cambridge.

28 Harrison, RT, (2009). Public Policy and Regional Risk Capital Markets. A Case Analysis of the Scottish Co-investment Fund. Nesta. London.

5 Beyond Economic Impact

Figure 18: Percentage of Archangels' deals with public Co-Investment, 1992-2022

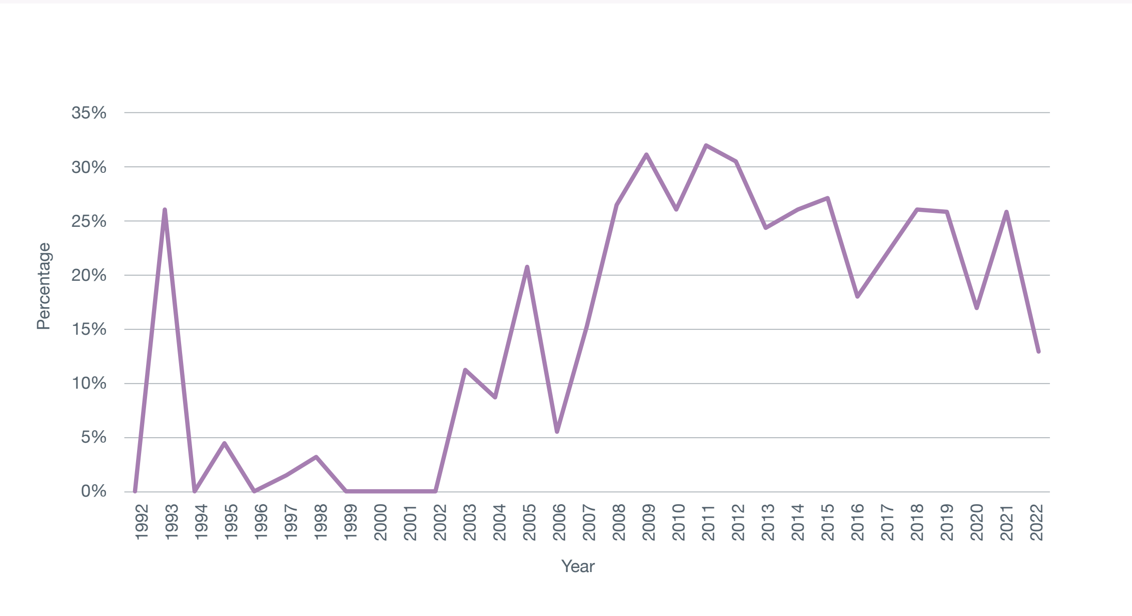


Source: Archangels' Data

We know that public co-investment in Scotland has been designed with private angel investment in mind and it is important to recognise the nature of it – it is not typically prescriptive and has generally been of a relatively 'silent' disposition. This is a highly successful feature of the Scottish model which has been copied elsewhere and a key component of the success of the Scottish business angel sector.

Although the figure above demonstrates that public investment is involved in the majority of deals that Archangels have done since the early 2000s, it is important to quantify what this means in value terms. **Figure 19** below shows that aside from 1992 and 1993, participation of public money in Archangels deals was actually quite limited. After the launch of the Scottish Co-investment Fund the value increased to its peak of around 30% of total deal value in the early 2010s, but has now declined to less than 15%. The public sector interventions were designed to provide "gap filling" capital to early-stage growth companies, supporting private sector investors. The fact that Archangels has taken relatively limited capital from public funds demonstrates the strength of its own investors' financial capacity as well as the increasing availability of private co-investment capital, which is indicative of a maturing market.

Figure 19: Value of Co-Investment by Public Funds



Source: Archangels Data

Despite the varying participation of the public and private sector over Archangels' history, any participation has always needed to be within the operating practices of Archangels who lead on every deal they invest in. Thus, it is important to recognise that public monies have played an important but not dominant role in their investment activities. The public investment vehicles created in Scotland typically recognise the sophisticated nature of Scottish angel investors by providing models that allow for them to lead on investment decisions and has had no little success in this approach.

Wider Scottish Angel Community

One of Archangels' conditions for investment is that companies must be located in Scotland. This has two outcomes – first it sends a signal that Archangels is Scottish focused, and second it demonstrates to others that Scottish companies are investable and operating at the cutting edge of technology and industry. This has the effect of building confidence in Scottish business internally and externally. The Scottish angel investment sector is regarded as one of the most sophisticated in Europe[29], based on its collaborative model of angels supporting businesses and each other. In our first report we identified active angel groups in Scotland that emerged after Archangels' initial establishment. Below is an updated table of currently active Scottish angel groups, their year of founding, and their location.

Table 20: Scottish Business Angel Groups and Launch Year

	Name	Launch Year	Location
1	Archangels	1992	Edinburgh
2	Aurora Private Equity	2003	Aberdeen
3	Tri Capital	2004	Melrose
4	Discovery Investment Fund	2006	Dundee
5	Highland Venture Capital	2006	Dundee
6	Par Equity	2008	Edinburgh
7	Kelvin Capital	2009	Glasgow
8	Innova Partnerships	2009	St Fillans
9	Equity Gap	2010	Edinburgh
10	ESM Investments	2011	Stirling
11	Gabriel Investments	2012	Glasgow
12	London & Scottish Investment Partners	2012	Edinburgh
13	Apollo Informal Investment	2013	Edinburgh
14	Galvanise	2013	Edinburgh
15	Investing Women	2013	Edinburgh
16	EOS Advisory	2014	St Andrews
17	Lancaster Capital	2014	Glasgow
18	Alba Equity	2019	Aberdeen
19	Mint Ventures	2020	Edinburgh

Source: Young Company Finance, Crunchbase, and Group websites.

29 LINC Scotland briefing note, 2021.
https://lincscot.co.uk/wp-content/uploads/2021/01/LINC-Briefing-Note-2021-1.pdf

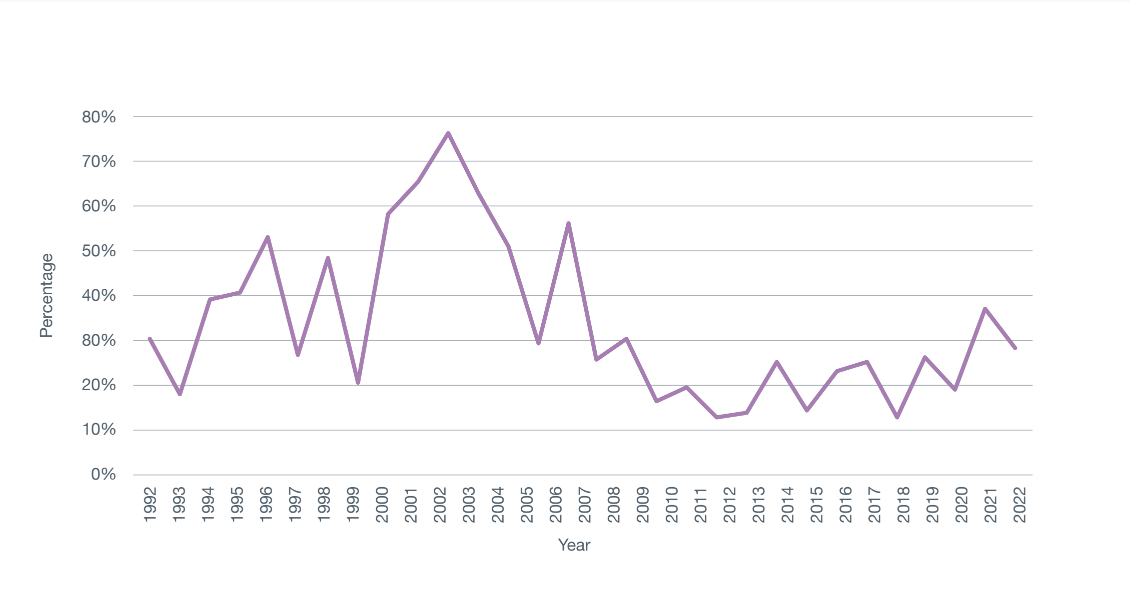
5 Beyond Economic Impact

There are three things this table indicates that are important to recognise – the first is the number of active angel groups is at its highest ever, the second is the coverage their locations provide across Scotland, and the third is that there is a clear maturing of the sector with more than half of the groups having been in operation for over ten years. Angel investment is, as we've established, a long-term play so the fact that that there are so many groups currently in operation serving almost the entirety of Scotland for so long is significant. We now have a maturing sector that harnesses significant experience, expertise, and capital to grow early-stage companies in Scotland. Archangels were undoubtedly the first here and helped chart a course for others to follow.

Archangels – Supporting the Angel Ecosystem

In this section we provide an analysis of the extent of Archangels' engagement in syndication over the period 1992-2022. As we can see, there was a high point in the early 2000s where over 70% of deals done by Archangels had syndication partners involved. There has been a downward trend since then until around 2011 where we can see a slow upward trend of syndication occurring.

Figure 21: Extent of Archangels Syndication by Year



Source: Archangels' Data

In line with the sector, Archangels have had increased participation by number of deals from external private co-investors. As a percentage of total value invested this participation has almost doubled from the low teens of the early 2010s to almost 40% early 2020s. Increased syndication has also been seen in previous market cycles when external investors represented well over 50% of the annual total deal size in 2000, 2001 and 2002. A recent Young Company Finance Report observed that since 2019, 189 new investors from outside Scotland have participated in funding rounds for Scottish companies.[30] This suggests that there is a healthy Scottish angel market maturing that is attractive to UK and overseas investors.

In line with our first report, this time round we again spoke to a number of active private equity investors in Scotland to better understand Archangels' position in the sector and its contribution to its development. The interviewees we spoke with were consistently positive about Archangels. The discussions centred around Archangels' role within the wider Scottish Business Angel community, dealings that they had with the respondents, and their overall impression of them. What we found were reports of Archangels being active, visible, and engaged in the community, both in terms of scouting deals and potential investee companies, as well as supporting both formally (through syndication of deals) and informally (through advice) other angel groups and companies.

30 Young Company Finance, (2022). New records reached Angel investment and the risk capital market in Scotland 2019 to 2021. Glasgow. Available from: https://lincscot.co.uk/wp-content/uploads/2022/05/New-records-reached-the-risk-capital-market-in-Scotland-2019-to-2021-1.pdf

Below is a selection of quotes from the respondents:

Archangels are hugely experienced, founder friendly, and very patient. They've undoubtedly helped the sector develop."

David Milroy, Maven Capital Partners

If you go back that far they really were forerunners and were head and shoulders above any other syndicate to work with… Informally, they've always been there or thereabouts. They are always at events and always busy. People want to talk to them. For the sector they have set standards."

Alec Mackie, Barwell

If Archangels didn't exist, we wouldn't have the angel sector we have now in Scotland. They've had a huge impact."

Aidan MacMillan, Par Equity

Together with LINC (Scotland) they played a fundamental role in the development of Scotland's informal investment market."

Pat McHugh, Scottish Government

At the very earliest stages of Gabriel forming, the original Gatekeeper Peter Shakeshaft, and Chairman, Barry Sealey, were extremely generous with their time in giving their views, and experience of investing in early-stage technology companies. These insights were invaluable to Gabriel and helped us to form a syndicate that is complementary to the Scottish Syndicate market rather than competing with them."

Gill MacAuley, Gabriel Investments

High quality, highly respected team of angel investors, investing in early-stage businesses across Scotland."

Aaron Lawson Clark, Mercia

Archangels are a really important and active investment group in Scotland. They, along with other investment companies, play a big part in helping businesses take the next steps in growth."

Steven Hamill, Scottish Edge

What we can see from the data and the respondents is that Archangels occupies an important place within the Scottish angel ecosystem. It can be gleaned from the respondent interviews that Archangels engagement with the ecosystem extends beyond its syndication of deals into a more informal role of mentoring and supporting other angels through advice, knowledge sharing, and engagement. Given its position as the longest running and biggest of the angel syndicates operating in Scotland, it would be easy to rest on its laurels, but our respondents were very clear that Archangels maintains a visible presence socially as well as a willingness to continue to invest in early stage, high-risk opportunities.

6 Conclusion

In this report we have sought to build on the 2015 analysis of Archangels' activities, to both update and enhance our understanding of their impact over the period 1992-2022. At thirty years old Archangels is now a mature angel investment syndicate with a sophisticated Board and management team, experienced members, and a demonstrable track record of impact across a range of measures.

From the relatively informal early stages to what is now a formalised and professional organisation, Archangels' economic impact over the period has been both deep and wide – it can point to positive developments such as returns to investors, the growth of the Scottish angel sector, the creation of numerous world-class Scottish companies, investment in and creation of cutting edge technologies that have made and continue to make a real difference to people's lives, and the growing recognition of Scotland as a place where technology and innovation are an integral part of the industrial base. Scotland in 1992 was a significantly different environment than the Scotland of today. Archangels has played an important role in helping create a supportive environment for new businesses in Scotland through leading from the front and showing investment in early-stage companies is both important economically and rewarding commercially..

Archangels

30 YEARS INVESTING *in innovation*

Current portfolio:

20 companies

Employing

755 people in Scotland

23.6% post tax realised IRR.

£144.4m returned to Archangels investors through successful exits and dividends.

The companies in which Archangels has invested, have created over

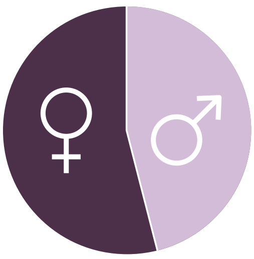
5,200

direct and indirect jobs since 1992

Up to £1.4bn GVA

£ = £ £ £ £ £ £ £ £

For every £1 invested by Archangels, its portfolio companies have **contributed an estimated £7.11-£8.45 of GVA* to the Scottish economy**



55% of portfolio Boards have **female representation.**

Average salary per job created by Archangels,

39%

higher than the Scottish average.

All 20 of Archangels' portfolio companies align with UN SDGs 8 and 9.

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

And over half (11) align with SDG 3, reflecting our strength in healthcare investments.

3 GOOD HEALTH AND WELL-BEING

* GVA is a monetary value for final goods and services produced minus all the attributable costs of production.

Archangels

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