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Financial performance studies of University Spin-Off Companies (USOs) in the West Midlands

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Abstract

Doubts remain over the true impact of university spin-offs (USOs), particularly those created outside elite research universities. This paper examines the financial performance of USOs from a single UK post-industrial region, the West Midlands within the framework of signalling theory. It adds to the existing literature on USO performance at company level, a currently under-represented topic, despite the attention and funding devoted to USOs by UK policymakers. By considering a single region, it brings new insight into the regional context of USOs. Key results of the study are a correlation between research strength of a university and ability of its USOs to attract external finance, but a lack of successful exits across the whole region.

1. Introduction

University spin-offs (USOs) have become a significant feature of the UK's higher education landscape since the late 1990s. During the 1980s, in line with the pioneering US Bayh-Dole Act of 1980¹, legislation was enacted allowing UK universities to retain the intellectual property rights (IPR) arising from publicly funded research (Richards, 2009). The UK government released significant public funds - University Challenge Funds (UCFs) - from 1999, to help universities create USOs. Numbers of USOs formed each year in the UK increased from fewer than 10 in 1994 to over 100 by 2001 (Mueller, 2010). Some were able to attract private investment sector funding, implying that commercialisable technologies were being discovered and developed. These patterns were also observed elsewhere following the US lead (Wennberg et al., 2010).

However, once initial UK USO creation rates slowed, some commentators, e.g. Lambert (2003) called for reviews of the USOs' financial performance. Critics of the USO agenda have focused on whether it generated quantity rather than quality (Fini et al., 2017), and whether it ignored more challenging performance measures such as third party finance attracted (Guthrie, 2004). A picture was painted of many small USOs not justifying the

¹ <https://autm.net/about-tech-transfer/advocacy/legislation/bayh-dole-act> accessed May 7 2020

investments and hype surrounding them, as noted in other countries (Iacobucci et al., 2011; Civera et al., 2020). Harrison and Leitch (2010) described the phenomenon of USOs as a ‘voodoo institution’ where evidence for claims of success was lacking.

A complication in assessing performance is that there is no universally accepted definition of a USO in the academic literature. Most follow the principles of Djokovic and Souitaris (2008) that the definition USO should specify three key elements, namely: the ‘outcome’ of the spinout process, the essential ‘parties’ involved and the ‘core elements’ that are transferred (spun-out). In this study a USO is a company formed with some university equity ownership, based on technology developed at that university.

This study adds to knowledge of the conditions under which USOs perform because only a few studies have investigated the financial performance of USOs at company level (see Wennberg et al., 2011; Colombo et al., 2011; Clarysse et al. 2011; Civera et al., 2020). At first glance this may be surprising as there are a large number of USOs, created over a significant period, providing a potentially suitable dataset. In addition, many countries spend significant sums of money targeting university-based entrepreneurship (Wright et al., 2008). This only makes sense if such entrepreneurship is an effective way of establishing companies with high growth potential. However, attempts to conduct studies meet a number of practical difficulties, which have led to the repeated observation of a lack of a sufficiently high standard financial data relevant to USOs (Zhang, 2009). Rasmussen et al. (2012) note that most studies on the impact of USOs have used simple measures often driven by data availability.

It is therefore important, from a public policy as well as an academic perspective, to study the financial performance of USOs, not least because significant public money has been invested in support programmes (Wright et al., 2008). In addition, such studies are needed to evaluate the policy that USO creation is appropriate for a significant number of universities across many regions, to deliver regional financial benefits, rather than just for elite universities with strong scientific and technological research pedigrees.

Moreover, the regional perspective has not yet been explored in sufficient depth at company level. Two points are worth noting. First, no studies of a single UK region are known. This paper presents evidence from a ‘post-industrial’ region, the UK West Midlands. Second, the UK university sector has a research hierarchy ranging from elite intensive universities to less research intensive ones (Trippel et al., 2015). Previous studies have often focussed on elite

research institutions such as Oxford (Lawton Smith and Ho, 2006), Cambridge (Garnsey and Heffernan, 2005), London Universities (Holi et al., 2007; Lawton Smith et al., 2014). These have strong, well-funded science and engineering departments, whence the majority of USOs traditionally originate.

The West Midlands region contains a range of universities from research-intensive “Russell Group” universities² to newer universities with less research pedigree. Previous USO performance studies have tended to focus on a single university e.g. ETH Zurich (Oskarsson and Schlöpfer, 2008) or a single country e.g. Mueller (2010). Here overall USO regional performance is disaggregated by university, challenging assumptions that elite universities’ USOs generate positive regional economic outcomes. We suggest that a policy expectation that successful USOs play an important role in creating and commercialising new technologies, thereby halting regional decline through employment creation and protection, may be over-optimistic.

This study is UK-based but the context of policies to regenerate post-industrial regions, and the role of USOs, are of wider significance. Moreover, explanation is needed for observed patterns. In this paper, signalling theory is used to explore the interconnections between investment decisions, the financial performance of USOs, their survival, and the regional context.

There are five further sections. The first reviews what is known from the literature about performance metrics and external investment; the regional context; and the relevance of signalling theory in explaining possible links to USOs’ performance. In the second, the West Midlands context is introduced and in the third the methodology is explained. Data analysis is in the fourth and in the last conclusions are drawn.

2. Understanding financial performance of USOs, signalling theory and the regional context

Measurement of both quality and quantity of technology transfer from universities is complex (Library House, 2008). Hence there is general agreement about the need for consensus about metrics used for determining performance in order for effective analysis. Standard indicators of financial and growth performance of USOs as well as survival are necessary to develop a complete picture (Siegel and Wright 2015). Some gaps are being filled by small but growing

² <https://russellgroup.ac.uk/about/our-universities/> (accessed May 15 2020)

academic literature assessing the financial performance of USOs at company level. For example, Rasmussen et al. (2012) undertook an extensive literature review in this area on entrepreneurial firms including USOs. Missing from many studies is the regional context which is needed as there is the possibility of strong regional signals which may influence investment, performance and survival.

2.1 Performance metrics, external investment and survival

Performance metrics may conveniently be grouped by nature of performance measure investigated as well as key measures (Jelfs, 2016). There are descriptive performance measures, growth-based performance measures, survival measurements and external investment measurements. These are summarised in Table 1. Each has limitations.

Measures	Indicators	Examples
Descriptive absolute performance measures	Company turnover Employees Patents Net cash flow	Lawton Smith and Ho 2006 Harrison and Leitch 2010 Lindholm Dahlstrand 1997 Ensley and Hmielski 2005
Growth-based performance measures	Turnover Employees	Wennberg et al. 2011 Zahra et al. 2007 Clarysse et al. 2011 Lindholm Dahlstrand, 1997 Clarysse et al. 2007
Survival	Length of survival	Wennberg et al., 2011 Oskarsson and Schläpfer, 2008 Zhang 2009 Criaco et al. 2013.
External investment measurements	Obtaining venture capital Venture capital acquisition and IPO value	Soetanto and van Geenhuizen, 2015 Shane and Stuart 2002

Table 1 Metrics used in assessing USO performance

Amongst measures of absolute performance used in studies of USOs, employment or job creation is popular especially with policy makers in regional or national government. While these measures indicate the scale of activity of the USO, and are easy to collect, they only provide a snapshot of performance (Lawton Smith and Ho, 2006). They do not address whether USOs are performing effectively in relation to other start-up companies (Zahra et al., 2007) or to the level of investment made.

Growth-based performance measures are popular because growth is the most appropriate measure of performance for new ventures, (which are often loss-making) (Clarysse et al., 2011). Turnover and employment are the two most popular measures of performance having the advantage over absolute performance measures of providing a more dynamic picture of the company over time and allowing for useful comparisons between USOs. These measures have limitations (Tietz, 2013) and inconsistencies.

Firstly, they say nothing about the true financial value of the company; a company may have developed very valuable technology but not yet achieved any sales. Employment data can be misleading or difficult to gather as many USOs initially use self-employed consultants rather

than employees to avoid employment expenses and give flexibility to hire only when required. In addition, data can be distorted given that the USO will typically be starting from a very low base value on the growth measure. There is also a problem, in the UK and elsewhere, of limited publically available data.

On first principles a company that does not survive is one that is unsuccessful: most companies, including USOs, fail within their first few years. Survival, which is a simple measure with easily available data (Rasmussen et al., 2012) may be a more appropriate measure than metrics based on profitability (Criaco et al., 2013).

However, a general finding in different countries and universities is that USOs tend to survive for longer than other start-ups (Shane, 2004; Tietz, 2013). Three possible explanations are that academic entrepreneurs have higher opportunity costs than non-academics (more to lose if the USO fails), a tacit technology advantage arising from the USO's university origins given the high quality of research at the institution, and finally the benefits of incubatory services provided by the university (Zhang, 2009). Other, less positive reasons are that some USOs may be kept artificially alive by subsidies (de Cleyn, 2011) and that a number of other factors may be at stake. These include sector, university resources, ownership structure, academic commitment, academic movement, and the relevant TTO's attitude to survival (Curran et al., 2016).

Moreover, growth of surviving USOs may stall leading to limited impacts (Rasumssen et al., 2012). Indeed most studies derive from data relating to successful companies and suffer from survival biases. Few studies have data that can separate USOs that fail from those bought or merged.

Studies of external investment measurements include estimations of the amounts of investment a USO raises from third party venture capitalists and the percentage who made an IPO of shares (Zhang, 2009). Lambert (2003) considered amounts of investment as a good measure of quality, given the stringent due diligence performed by private equity firms before investment. Lambert noted that UK USO creation had been driven largely by government-funded UCFs with only one third of new USOs in 2002 securing capital from private equity. Rasmussen et al. (2012) note that most USO performance studies rely on proxy rather than direct performance measures; USOs often need significant development financing so obtaining external financing is considered a useful measure, given that external financiers will independently assess the USO's potential and establish a value for their investment.

Wright et al. (2006) argued that while VCs are reluctant to fund USOs at seed/start-up stage due principally to concerns over lack of management experience, nevertheless USOs are significantly more likely to obtain venture backing than the average small business, but at a later stage.

Two performance metrics stand out as providing good evidence for the financial performance of a USO at company level, and can be evaluated given the current UK publicly available data. These are (i) survival and (ii) attraction of external investment. Both metrics are identified as important in the Library House (2008) study, and in the wider literature evaluation by Rasmussen et al. (2012). These two metrics form the core of this study in terms of performance data collection and analysis. The ability or otherwise of USOs to reach an IPO or an exit for investors is a complementary metric, representing a specific scenario in obtaining external investment. Attracting external investment by a USO, while a key financial performance metric in its own right, may also a priori impact the survival or completion of an IPO or exit by reflecting the strength of the company and its attractiveness to investors. A new company with more resources might be expected to survive for longer.

2.2 Signalling theory and USOs' performance

While metrics indicate patterns of USOs' performance, to better understand the reasons signalling theory is a useful analytical tool in analysing all four strands in Table 1. It has been used in a variety of strands of academic literature including entrepreneurship (Ahlers et al., 2015). It is concerned with the reduction in information asymmetry between two parties (Spence, 2002). Information asymmetry has been described as occurring when 'different people know different things' (Stiglitz, 2002), and arises where imperfect information exists.

Stiglitz identifies two broad categories of information where asymmetry is important. These are information about quality, important where one party is not fully aware of the other's characteristics, and information about intent, important where one party is concerned about the other's behaviour (Connelly et al., 2011).

Three key actors are the signaller, signal and receiver. The signaller is an insider who has information, positive or negative, not available to outsiders (Spence 1973). In the USO context this could include details of the company's underlying technology. Entrepreneurship studies often focus on signallers as leaders of start-up or Initial Public Offering (IPO) firms e.g. Zimmerman (2008). Studies using signalling theory generally focus on deliberate communication of positive information to convey positive attributes (Connelly et al., 2011).

To be effective, a signal must be observable to outsiders and costly to produce (Bird and Smith, 2005), so signallers are viewed as well placed to absorb the cost. Effectiveness also means that an uninformed agent can distinguish between superior and inferior endowed firms (Ndofor and Levitas. 2004).

A wide range of signals of quality have been considered. One important approach considers signalling theory alongside institutional theory where firms strive for legitimacy to survive, with typical signals being the quality of their directors, management or shareholders. For start-ups, founder share ownership can be a costly signal of quality given the need for them to invest their own resources. Arthurs et al. (2009) note, in the IPO context, that signals of quality include scientific capabilities (Deeds et al., 1997), venture capital backing (Megginson and Weiss, 1991), prestigious underwriting (Carter and Manaster, 1990) and length of lockup agreement, to reduce current and potential investors' doubts of going to IPO.

Receivers are outsiders who lack but desire information about an organisation. For signalling to occur, the signaller should benefit by some action from the receiver that the receiver would not otherwise have done, often involving selection of the signaller from other alternatives (Connelly et al., 2011). In entrepreneurship literature, applicable to USOs, this often includes a decision over whether to invest (Busenitz et al., 2005), including at IPO stage (Arthurs et al., 2009).

The relevance of signalling theory here is that USOs as signallers, along with other start-up companies created to exploit new technology, are obvious cases where potential investors lack information (Gompers and Lerner, 1999). They have limited operating history available for good external investment decisions. Audretsch et al. (2012) find that new ventures are particularly prone to financial constraints and that innovative new ventures usually rely on external finance. Information asymmetry is a particular problem given the lack of any company track record and uncertainty about the value of the new technologies. Similarly Cao and Hsu (2010) suggest that start-up firms are characterised by large intangible assets, negative cash flow, great technological uncertainty and low liquidation value. They rely on venture capital for finance which might mitigate information asymmetry through financing strategies.

Signalling theory has been used in previous USO performance studies e.g. Mueller (2010) where USOs, along with other start-up companies created to exploit new technology, are

signallers. Attracting external investment is a key performance metric here. The theory has been identified by Mathisen and Rasmussen (2019) as one with potential in future studies.

Signalling theory may have value when considering financial performance data from USOs from a specific university through its TTO. Williamson (1996) identifies three mechanisms reducing uncertainty surrounding any transaction, namely trust built up through multiple transactions, greater information disclosure, and bonding. There may be a link between the number of USOs formed by a TTO and the level of external funding obtained, both of which may be relevant performance metrics. Bonding may include reputational capital of the TTO which would only seek to commercialise high quality technologies, or the ownership of an equity stake in the USO. Arthurs et al. (2009) consider such a bond as a stronger form of signal than the above elements, since if the information provided is incorrect, the TTO itself will suffer financial or reputational loss.

Signalling theory may be able to provide a framework against which to gauge consistency when considering the survival of USOs. Hsu and Ziedonis (2008) note that prior studies identify two mechanisms where quality is signalled, namely entrepreneurial experience of management teams and knowledge and capability transfer from a parent (Agarwal et al., 2004) which affects new ventures' probability of survival.

Finally, USOs, like other technology-based firms, require external capital investment in order to deliver products and services to market. Thus they or their agents (usually TTOs) need to signal that their firms are 'investor ready' - a form of marketing signal (Giones and Miralles, 2015). Information asymmetry (Spence, 1973; Papaionnou and Karagozoglou 2017) whereby investors cannot distinguish between high quality and low quality firms, requires proxies for USO quality. For technology entrepreneurs (Giones and Miralles, 2015) they need to signal quality. New technology-based ventures with no track record and untested technology might have to rely on symbolic elements to signal to their customers/investors.

Signalling theory predicts that universities of greater research strength should generate more technologies with commercial potential. This leads to more USOs and more external funding being attracted given the strong signal of the university's research reputation (Meoli et al., 2013; Munari and Toschi, 2010; Soetanto and van Geenhuizen, 2015). As a result, the USOs from such universities should survive longer (Conceição and Faria, 2014) and have more successful exits.

2.3 The regional context

The application of signalling theory at regional level is threefold. First, there might be strong regional signals at work due to local knowledge held by investors about the strengths of the universities' USOs' potential. Second, there might be a collective regional effect of a density of universities and commercialisation activity. Third, signalling theory can be applied to the possibility of these attributes interacting with the evolving attributes of a region.

Four factors influence the level of USO activity in a location and may imply signalling (Shane 2004). These are access to capital to develop proof of concept and prototypes to attract private sector investors; property rights that reside with the university to minimise creating an anti-entrepreneurial culture, giving university expertise in company formation, spreading risk across the USOs associated with university and technologies; less rigid labour markets to give inventors the ability to generate resources and take leave to start companies; and increased mobility between universities and industry allowing flows of commercial knowledge. The last is predicated on the existence of managers, customers and suppliers. Thus both the financial performance of USOs and consequently economic value to the region are impacted (Sternberg, 2014; Civera et al., 2020).

Harrison and Leitch (2010) propose that the important position of universities in regions in the entrepreneurial system model (Spilling 1996) provides symbolic signals which may attract investors. These include as an enhancer of human capital and as a source of knowledge capital which can stimulate entrepreneurial development through licensing, consulting, education and training, joint ventures and USOs. Breznitz (2011) notes that regional interactions between universities and other institutions influence the entrepreneurial nature of both the university and its USOs, thus increasing reputation. DiGregorio and Shane (2003) claimed that the geographic location of universities influences USO activity because some economic, legal and cultural environments are more supportive of USOs than others. The networking capability of a USO (the signaller) has been shown to impact upon its performance (Walter et al., 2006). When taken into account by investors (receivers) these factors may further influence decisions on investment.

It is noticeable that certain regions in the UK e.g. the 'Golden Triangle' of Oxford, Cambridge and London universities appear to have achieved financial success from technology commercialisation. From a signalling theory perspective some of this may be attributed to the profile or branding of the region; 'a Matthew effect' of reputation for quality

which signals the presence of desirable investment opportunities. There is also likely to be existing infrastructure providing a high quality business environment (Holi et al., 2007; Lawton Smith et al., 2014).

In sum, signalling theory can be applied to explain why there is a regional dimension to levels of external investments in USOs, and why it can be used to understand how performance and survival relates to external investment. However, a drawback is the limited amount of data available to thoroughly test for associational effects.

3. The West Midlands Context

The West Midlands region is a typical example of a ‘post-industrial’ region in which traditional industries which employed significant numbers of local people have radically changed in the face of lower-cost international manufacturing and the globalisation of supply chains. Its heritage is largely represented by different forms of heavy industry such as ceramics in the Stoke region; metalwork and manufacturing in the Birmingham region; and automotive and supporting industries, which attract significant amounts of research from academia and industry in the Coventry and Warwickshire areas (Amison and Bailey, 2014).

Universities within the region provide a range of research intensities, have grown significantly over the last two decades and generate increasing wealth and employment for the region. In certain cases they have become key actors in undertaking basic research and development (R&D), developing new technologies while the proportion of R&D undertaken on a national level by industry has declined. Such universities are prime candidates for generating USOs as they seek to commercialise their technologies and add to the overall economic growth of the region, an effect encouraged by UK national and regional government.

These characteristics make this good for applying signalling theory to explore performance of USOs. It might be expected that if there is a match of research in the universities and region, there would be significant numbers of USOs in those sectors. Such industries are still very much present in these traditional areas, but now employ far fewer people than previously with work largely undertaken in smaller industrial units employing more highly skilled workers. There are many similar regions in other developed nations and so the findings will have wider applicability. A study of this type of region also complements the current focus on the world’s elite research universities and their USOs.

4. Hypotheses and methodology

In this study while the unit of analysis is the USO, the relevant university and region are closely associated with the USO in the analysis. Three performance metrics investigated are i) the attraction of external investment, ii) survival and iii) successful exit/IPO. In line with signalling theory, the following hypotheses were developed which link the quality of the university to the pattern of performance.

The premise is that universities with greater research strength create more and broader technologies (Clarysse et al., 2011) potentially capable of commercialisation. Significant amounts of high-quality underlying technology encourages TTOs to set up USOs and attract internal and external investment (DiGregorio and Shane, 2003).

H1: Universities with greater research strength create more USOs.

Further, the university's research strength is a positive signal for potential investors to support USOs since technologies created and developed are more likely to be of high quality and successfully commercialised (Colombo et al., 2019).

Signalling theory postulates that the possession of resources such as attractive technology will send strong positive signals to the potential investor (Mueller, 2010). The work required to obtain investment often requires the construction of a university-led infrastructure of significant scale, including a TTO and associated functions. Signalling theory would support the observation that such research-focussed universities would attract funding for significant numbers of their USOs, which in turn attract other investors, forming a virtuous circle.

H2: USOs from universities with greater research strength will attract more external finance

H3: Such USOs will attract a wider range of investors

H4: Such USOs will be more likely to achieve a successful exit for the parent university

Following from H2, such USOs are likely to attract more external investment and obtain the necessary resources further to develop their underlying technology. USOs with more financial resources will be able to meet their expenses incurred in commercialisation for longer, and survive for longer in line with findings of earlier studies e.g. Shane and Stuart (2002), Nerkar and Shane (2003).

H5: USOs from stronger research universities will survive for longer

H6: USOs attracting more external finance will survive for longer

While the financial performance of USOs at company level is increasingly studied, there remain methodological difficulties, and as a result significant gaps in the literature. Key difficulties in conducting studies on USO financial performance include lack of publicly available data from sources independent of the company or university (Lawton Smith and Ho, 2006), lack of clarity in the definition of a USO (Zahra et al., 2007) and the difficulty in obtaining a complete population of USOs over a long period of time to avoid survivor bias (Shane and Stuart, 2002). This study seeks to address these concerns by analysing a number of independent objective sources, using a focussed definition of a USO, to create a very accurate data set of USOs formed over a significant period. It then extracts a range of accounting information, building a narrative of the history of the company over time even after effective existence ends. Such a methodology overcomes the difficulties noted by Shane and Stuart (2002) that many studies suffer from significant survivor bias as USOs that fail are often omitted. This study also avoids the problem of under-recording company histories as companies are traced from incorporation to grave.

Once an accurate data set of USOs is created from this time-intensive process, it is easier to make comparisons of performance between companies and universities and be confident that trends observed can be fairly compared and contrasted. In this study, the data collected are mainly secondary in nature i.e. obtained from existing data sources. The universities in the region were identified and an initial case study performed on the University of Birmingham to confirm that the proposed methodology and data sources were viable (Jelfs, 2016). The case study was then undertaken for all other universities within the region. Data was collected between March 2014 and March 2015.

Throughout the financial data collection, informal conversations were held with TTO staff at Warwick and Birmingham universities, and a number of founders, directors and employees of still trading USOs across the universities. These discussions served to inform subsequent analysis and provided potential justifications for trends in data, ensuring that such analysis was not solely the authors' value judgements. USOs for each university were identified by combining data from four separate independent sources, chosen for the accessibility and quality of data.

The first is the university's published accounts. Most UK universities are constituted as charities, thus required by law to prepare and file detailed financial accounts available in the

public domain, prepared under relevant accounting standards and statements of practice, with the Charity Commission. A requirement is that the accounts give full details of companies wherein the university has an equity investment stake. This disclosure captures all USOs generated by the parent university and is available over a number of years. It also includes companies that are not USOs such as property management companies, and so other sources are needed to avoid non-USOs inclusion.

It is not known whether this source of data has ever been previously explicitly used, but it is a particularly useful source as it tracks annually USOs as they are created and subsequently dissolved. The university's statutory accounts are also prepared by a finance team completely independent from the TTO, and are audited by an independent firm of chartered accountants with no connection to the university's knowledge commercialisation activities. Thus the source is therefore extensive, independent and objective, especially when accessed through the Charity Commission's website.

The second is the university's TTO, primarily responsible for overseeing and facilitating the process of forming USOs and transferring technology derived into the USO. It will need to maintain records of all USOs created and so is an obvious and potentially easiest place whence to obtain data on the financial performance of USOs. This is reflected in many studies to date in this field of academic literature, e.g. Oskarsson and Schläpfer (2008).

There are some difficulties in thus obtaining the data particularly if not cross-checked against other sources. TTOs rarely maintain historic data on failed USOs, giving rise to the danger of survivor bias (Shane and Stuart, 2002). Furthermore, detailed financial records in a consistent format over time are not always kept due to resource constraints. Changes of TTO personnel can lead to difficulties with loss of expertise and knowledge relating to USOs (Lawton Smith and Ho, 2006). There may also be legal constraints on sharing USO financial data with external third parties.

Accordingly data from this source was treated with caution and cross-checked thoroughly against other sources. The TTO website and other published material were used as well as other relevant public domain data to provide a further list of potential USOs.

The third is commercial databases. Although there are issues with the quality and accessibility of company data from Companies' House this remains the major source of publicly-available UK company financial performance data. All UK companies are obliged by law to file accounts with Companies' House and the data contained therein is collected by

a number of commercial databases, often for the purpose of providing a credit score for a company.

During the course of this work two such databases were used: Experian Corpfin UK and Market IQ. As well as providing the basic balance sheet accounting data from filed company accounts, other documents such as annual returns and liquidation documents may be accessed which help build up a picture of the activity of the company over time. Changes in ownership and details of third party external investment can be obtained from such documents.

The accessing and use of these supplementary documents to create a long term picture of the company has not previously been used in USO performance studies, particularly in obtaining details of third party external investment. Such data has been difficult to obtain as previous studies have usually resorted to asking the company itself. Both commercial databases used have a search function that allows searches by shareholder name. This is a useful tool for identifying potential USOs as the name of the relevant university can be used as a search term to identify companies where it held an equity stake. While not all such companies are USOs, it provides another independent source of companies for cross checking.

The last is a specialist database, Spinouts UK, maintained by Young Company Finance, which attempts to list all UK USOs. It uses a variety of data sources (not publicly disclosed) although much of the data is thought to be derived directly from the universities/TTOs. Again, this provides one more data source for cross-checking.

Once a population of potential USOs for a university had been collected from each source, they were correlated between sources and anomalies resolved through detailed analysis of all available sources and other public sources of information, including the company's website. Where potential USOs did not meet the chosen definition of a USO, they were discarded from the database and a reason for exclusion noted.

Basic classification data for each confirmed USO was then collected, usually from the commercial databases, and in line with the three key performance metrics:

- Survival data was collected mainly from the commercial database to determine dates of incorporation and dissolution.
- External investment data was collected from all the sources although the company accounting information from sets of annual accounts held on the commercial databases was the key source. The share premium account in the USO's balance sheet

was the key source for investment received. Investment data collected included investor's identity, amount of investment and date of investment.

- Where USOs achieved a successful exit for the university, a brief case study of their lifecycle was collected from a variety of sources, including news websites.

5. Results and Analysis

The results are divided into two sections. The first is the USO performance (number and survival) and thence their contribution to regional economic development. The second is investment attracted into the spin-offs.

Population of USOs

In the region as a whole, only two universities, both research intensive (Russell Group) (Warwick and Birmingham) generated a significant number of USOs (43 and 29 respectively), and attracted external investment. Half of the region's universities did not create any USOs, in line with Pressman (2002) who reports that 36% of US academic institutions did not generate any USOs, and Benneworth and Charles (2005) who identified uneven distribution amongst UK universities. The non active universities are all Post-92s and rarely have significant research in those academic areas which historically leading to most UK USOs. Other universities that created USOs were Aston (7), Coventry (11), Keele (6) and Staffordshire (6). The data therefore support Hypothesis 1.

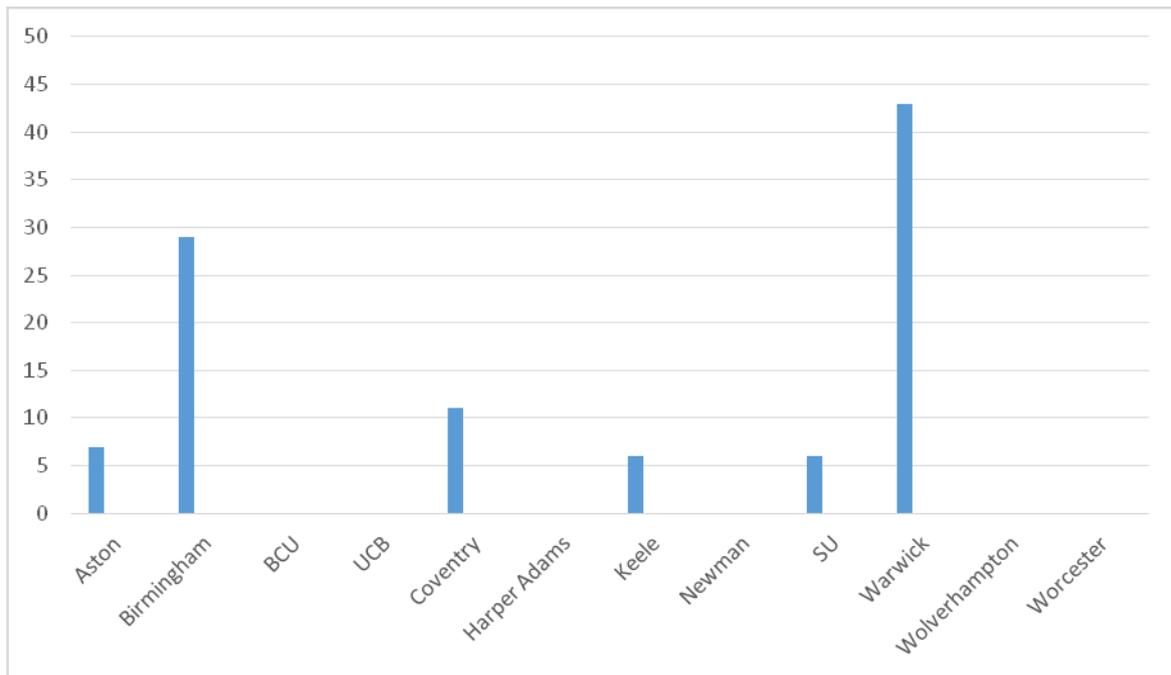


Figure 1: USO numbers by university

The results suggest that the relationship between the nature, quality and heritage of research performed at a university and the quantity of USOs generated is not necessarily simple; a range of factors may be needed for determining a convincing explanation of trends (Rasmussen and Borch, 2010; RSC, 2005). Some non-Russell Group universities in the region have traditions of scientific-related disciplines. Aston was founded as a College of Advanced Technology (CAT) has significant research in science and technology and an early history of commercialisation. However, the number of USOs it generated is low and fewer than some newer universities. This may illustrate that some universities remain unconvinced that USOs are the best way to achieve commercialisation.

External Investment into USOs

Figure 2 shows the percentage of USOs at each university able to attract external third party funding.

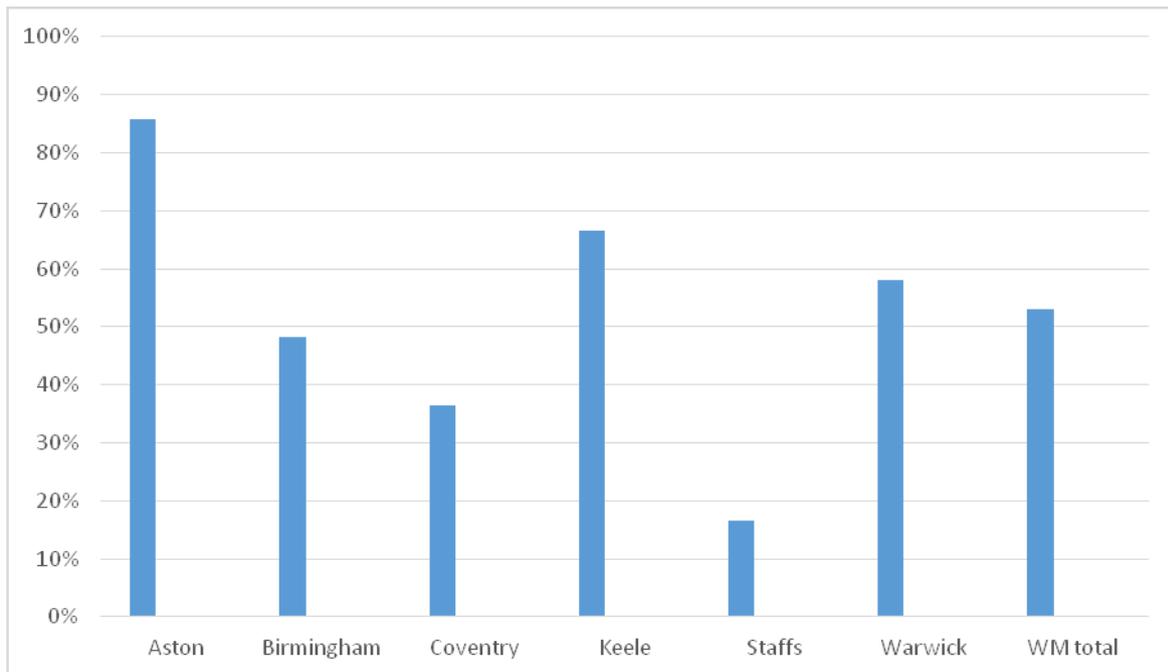


Figure 2: USOs gaining 3rd party financing (%)

There is wide variation between universities in their USOs attracting external funding, in line with prior studies e.g. Wright et al. (2006). This is a different result from the survival metric where results are more consistent across the region. This may therefore be a more accurate reflection of success of the USO or university.

Birmingham and Warwick are responsible for about 70% of the region's USOs and show levels of attracting finance close to the region's mean of 53%. However, their rate of attracting funding is lower than of Aston's, suggesting that some of their larger number of USOs were not attractive to investors, and highlighting that the signalling relationship between university research strength and USO funding is not straightforward.

Aston shows a particularly high rate (86%) which ties in with its observed behaviour of forming relatively few USOs that own commercialisable technology and hence are attractive to potential investors. Keele, a 1960s university, also has a high rate of attracting finance (67%) but less relevant research strength. Amongst the Post-92 universities, Coventry has a lower rate of attracting finance (36%) and Staffordshire significantly lower (17%).

Hypothesis 2 is therefore only partially supported on this measure.

Figure 3 shows the total amount of third party external USO funding received by each university. USOs attracted funding from a number of third parties including the regional UCF

(Mercia Fund), other private equity or venture capitalists, limited companies and individual investors.

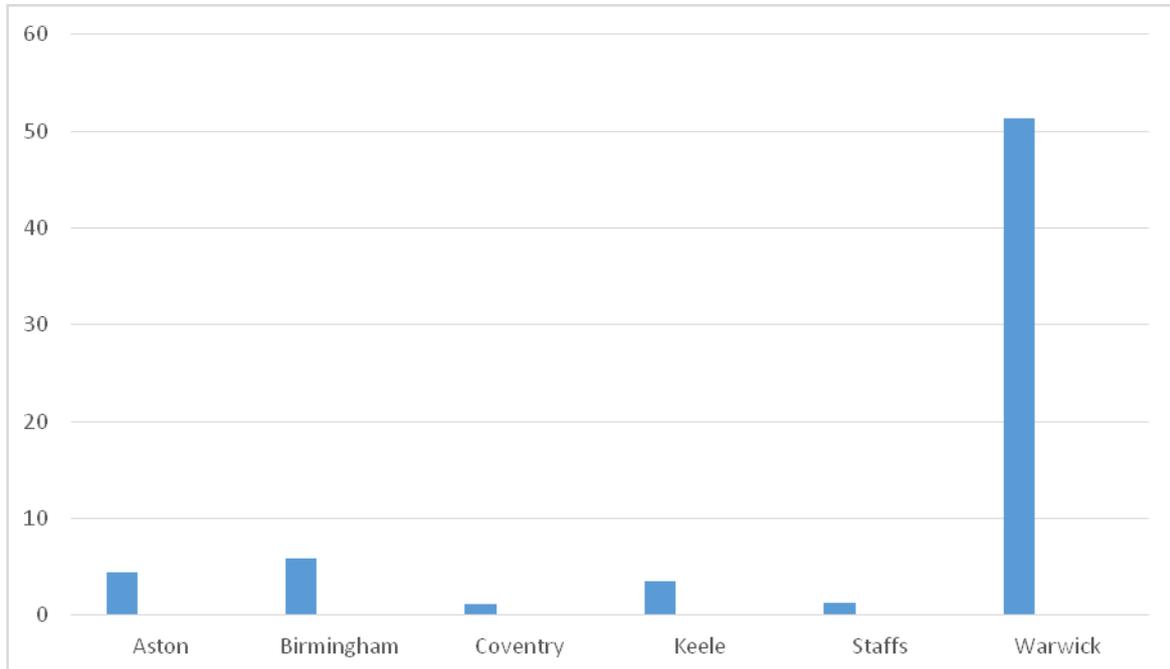


Figure 3: Total 3rd party funding in USOs (£m)

Warwick has attracted significantly more external third-party funding than all other universities combined. The difference cannot be explained simply by the number of USOs (43 out of 102). Possible explanations are that Warwick USOs have more underlying technologies e.g. in engineering, which are more attractive to potential investors, or alternatively that Warwick has a vastly superior infrastructure. There is likely to be a cumulative effect, in line with the predictions of signalling theory in relation to signallers and signalling.

Clearly Warwick has significant resource in place to attract funding including wide networks with potential investors especially in specialised areas. However, the low amounts of funding obtained by other research-intensive universities, particularly Birmingham, casts some doubt on this interpretation; if the number of USOs generated by a university be a valid proxy for its enthusiasm and desire to obtain funding for its underlying research, such significant discrepancy would not be expected. It is likely that other factors are at play, possibly including pre-entry experience of the USO (Curran et al., 2016), area of the underlying technology, TTO performance and the identity and risk appetite of investors.

Hypothesis 2 is again only partially supported. While the amount of funding obtained does follow the university's research strength in terms of ranking i.e. the Russell Group obtain more funding than 1960s universities which in turn outperform Post-92, Warwick's performance demonstrates that other factors are involved. Figure 4 shows for each university the amount of external third party funding obtained per USO generated.

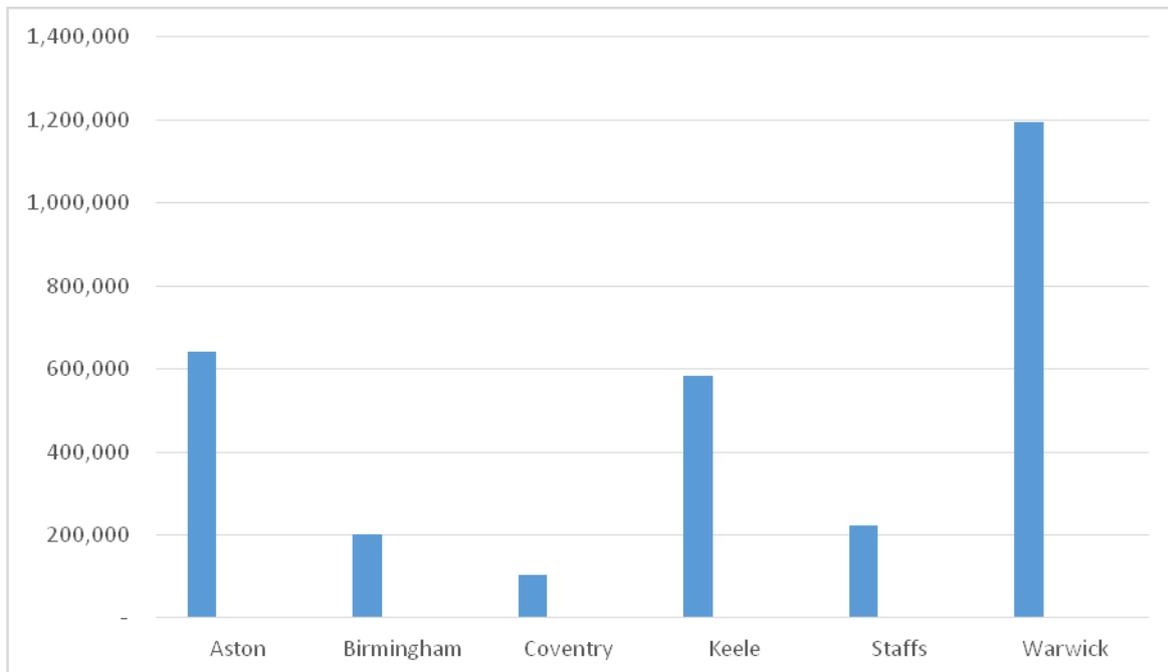


Figure 4: Total 3rd party funding per USO (£)

Warwick is still significantly ahead although the difference is less pronounced. An interesting feature is the relatively low amount of funding secured per USO by Birmingham. This suggests USO quantity was more important than quality, a key accusation levelled by Lambert (2003) and others, assuming that external third party funding is a good proxy for USO success. Again, signalling theory would not predict such a low result but this finding may relate to subject mix.

Of the 1960s universities, Aston and Keele score highly, suggesting that they pursue a small number of potentially high quality USOs with underlying technologies of interest to potential investors. Hypothesis 2 is therefore again partly supported.

Figure 5 shows the types of investors. It was not possible to obtain further details of the investments such as the amount invested by each party or the number of funding rounds because consistent data was not available. Some funding rounds predated public domain information.

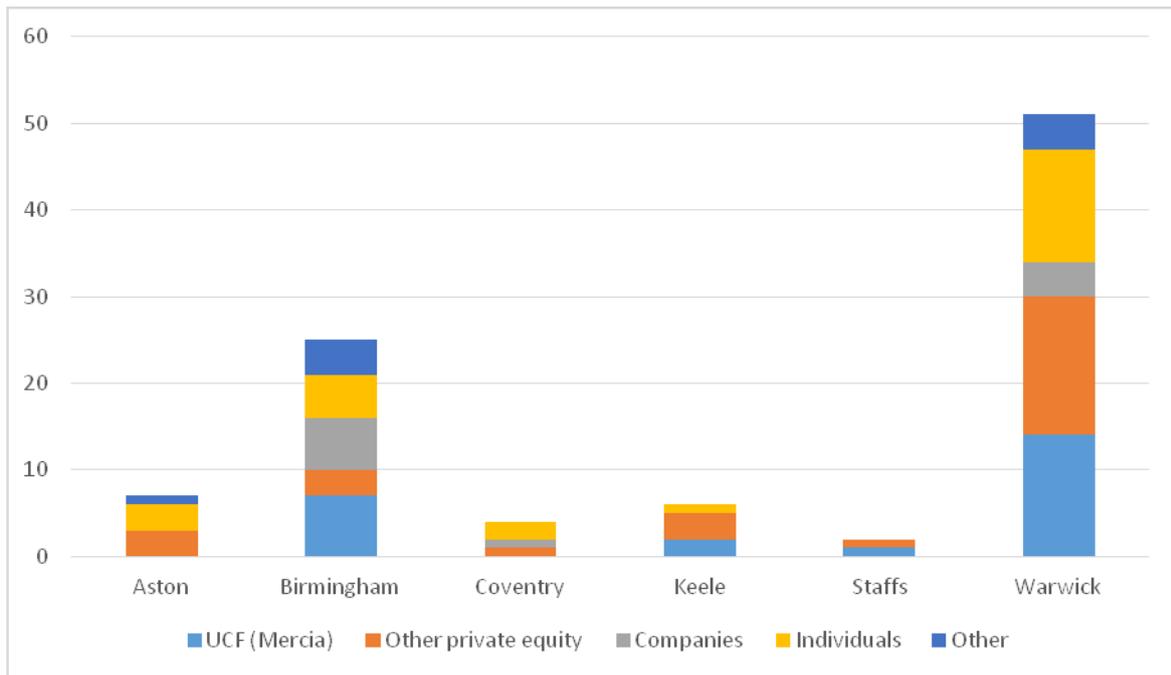


Figure 5: Types of investor

Each university obtained external USO funding from a range of sources in line with earlier studies (Shane and Stuart, 2002). In terms of government UCF funding, Aston and Coventry did not receive any whereas the Russell Group universities took full advantage. However, it is noticeable that no university relied solely on UCF money. Warwick was particularly active in securing significant private investments. Warwick also had a wide range of different private equity funders, suggesting strong social networks with the private equity community. In line with signalling theory, the existence of other investors (Diamond, 1991) and many USOs sends strong signals to investors. Hypothesis 3 is therefore supported.

The final investment metric is successful exits from a USO by its parent university. An important financial metric is the amount of money which a university realises in a controlled exit such as a placement of shares, merger or trade sale (Bonardo et al., 2011).

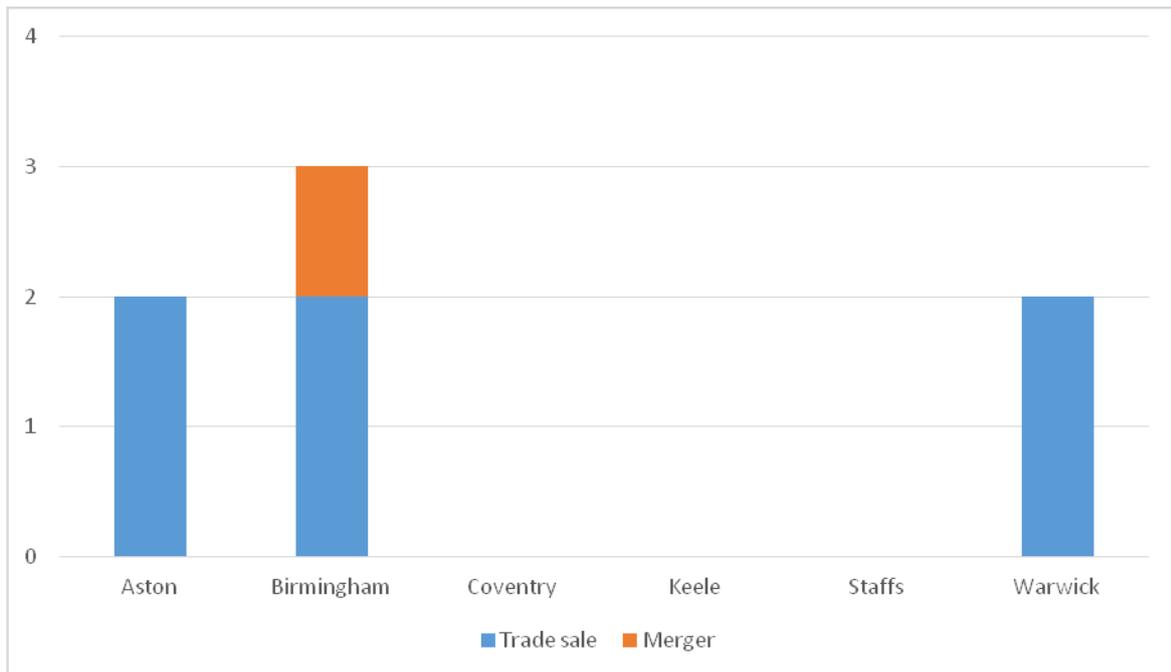


Figure 6: Number of USO successful exits

The data show that the financial impact for the sponsoring universities has not been positive. Figure 6 demonstrates that the number of successful exits is extremely low. No USO from the West Midlands achieved a stock market listing in any form, a particularly unfavourable comparison with the US (Zhang, 2009), and with other UK universities such as Oxford and Cambridge (Holi et al., 2007).

Only the three more established universities ((Aston, Birmingham and Warwick) have had any success. Aston continues to reinforce the theme that a few USOs contain commercialisable technologies which ultimately lead to successful exits. Warwick, despite creating many USOs and achieving significant external investment into them, has fared no better than Aston in achieving successful exit. Birmingham's record falls between Aston and Warwick.

Signalling theory has limitations. For example, an exit is essentially a special form of external investment, so it would be expected that Warwick would have significantly more exits than other the universities given its attraction of external investment. This is not the case. The conclusion is that information asymmetry remains a significant factor for investors, even where a university has a strong research pedigree. While the three strongest research universities were the only ones to obtain any exits this does not explain the lack of exits seen

across the region. Hypothesis 4 is therefore not supported: no clear link between external investment attracted and exit is found.

Figure 7 shows the actual cash received on exit by the universities through disposal of their equity stakes. The most successful university is Birmingham (Jelfs, 2016) largely based on the sale of its stake in one USO, Entice Technology Limited. This USO did not secure external financing: the underlying technology was the key resource behind financial success. This company was effectively the only financially successful USO in the whole region during the observed 30 year period.

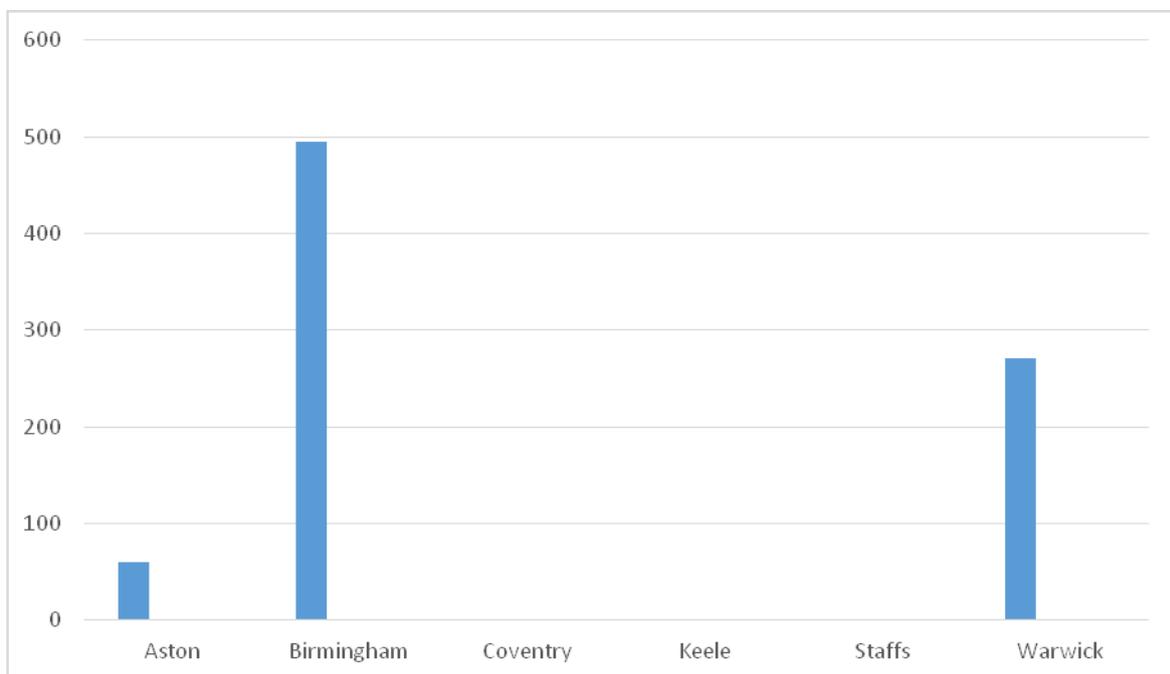


Figure 7: Cash returned to university on sale of USO stakes (£'000)

While there are other programme success factors, the failure to match the significant sums raised by US and other USOs is a major disappointment. It supports previous studies sceptical of return from USOs e.g. Harrison and Leitch (2010). It is unlikely that the sums shown above even covered the running costs of the various university TTO operations, supporting previous findings e.g. Siegel and Wright (2015).

Survival rates

Figure 8 shows the aggregate failure rate for each university obtained by dividing the number of USOs that failed for each university (defined as formally dissolved) by the total number of

USOs founded. It makes no allowance for time profile effects - newer USOs are less likely to have had time to fail. However, it does have value as previous studies have highlighted the relatively long survival times of USOs without attempting to control in this manner e.g. Shane (2004).

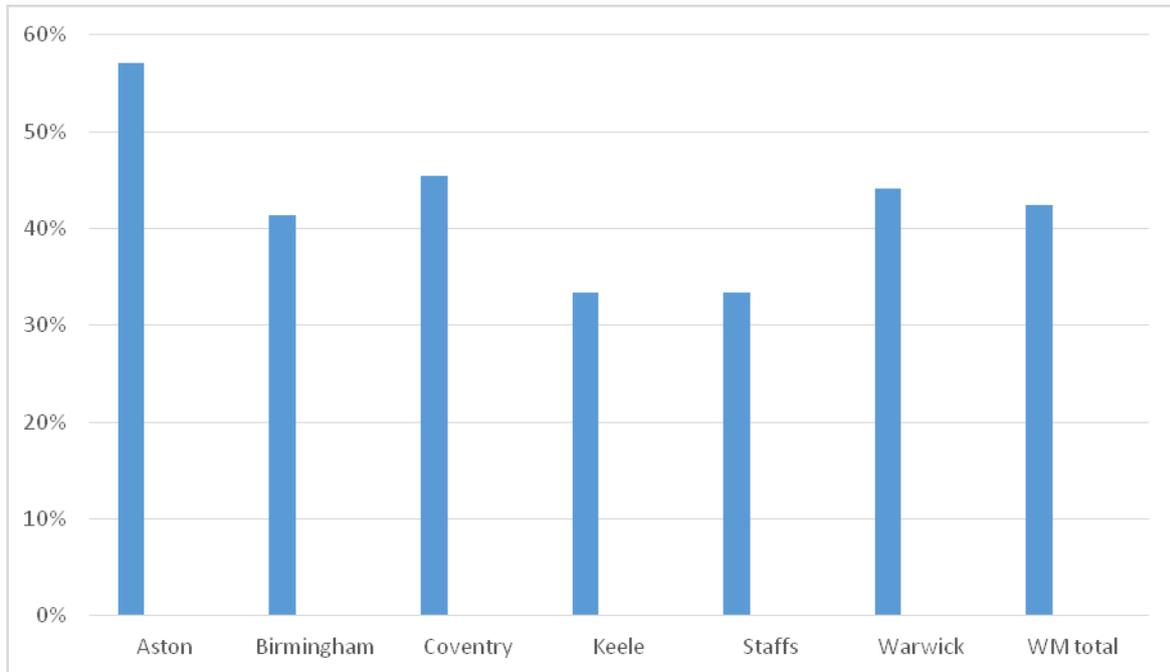


Figure 8: Aggregate failure rate (%)

The aggregate failure rate is relatively consistent between universities. Aston appears to show a high failure rate but two USOs were over twenty years old before being removed. By contrast, USOs of Keele and Staffordshire are relatively recent and have had less time to fail.

However, given that USO formation was extremely low in the region before 2000, meaningful comparisons can be made. The uniformity of failure rates is notable. This may imply that the universities' TTOs have taken a consistent view in allowing USOs to fail across a wide range of timescales and population sizes. Given that the financial resources of USOs vary considerably by university, this would go against previous findings that more financial resource increases the likelihood of survival (Shane and Stuart, 2002).

The data also show that the universities (with the exception of Aston) show a very tight band for the average time it takes a USO to fail (78 months to 87 months) although these quantities mask significant variations at company-level at each university). This finding would not

necessarily be anticipated given the wide range of factors impacting survival. Hypothesis 5 is therefore not supported.

The mean lifetime of a USO is significantly longer than for a start-up company in the private sector. Cressy (2006) finds that several start-up studies show that about half fail within the first two and a half years. Survival gives only a partial picture of how invested funds are deployed.

There is a category of USO designated ‘twilight USOs’ - USOs that are not dissolved but have effectively ceased any significant level of activity. These have been described elsewhere as the ‘living dead’ (Ruhnka et al., 1992). Where the USO has received external funding, a significant gap is needed between last funding and twilight designation. While some judgment was necessary to designate a USO as such, careful analysis of financial records gave a reasonable level of assurance that the twilight designation is correct. Figure 9 gives the aggregate twilight USO rate by university.

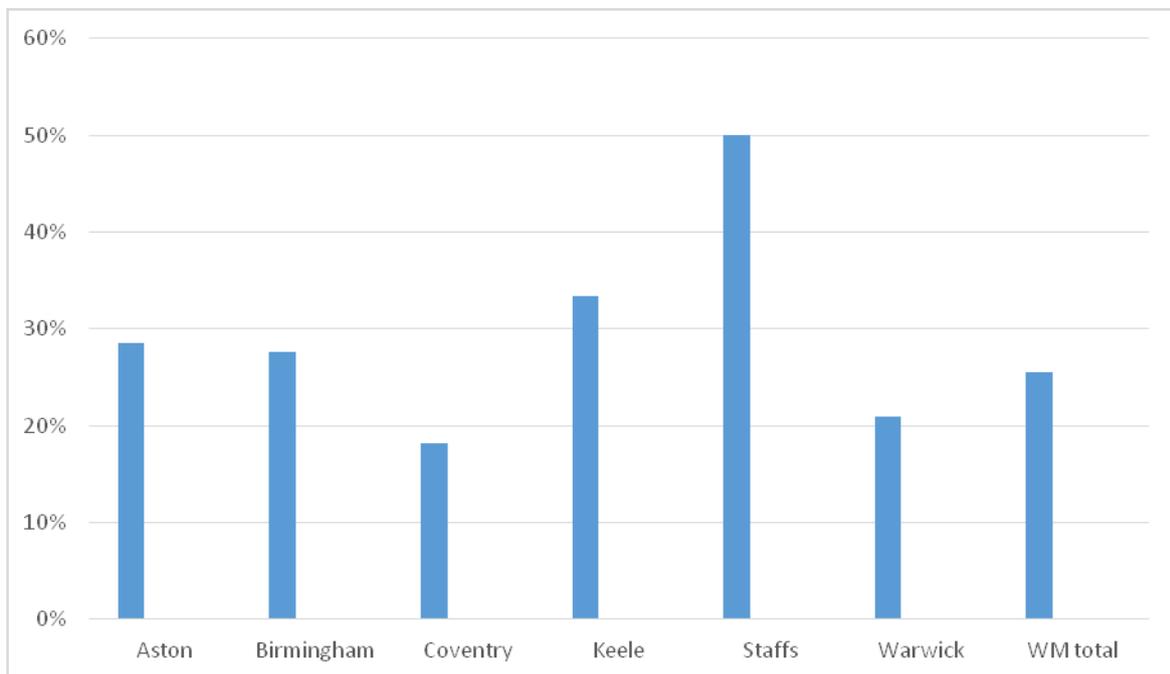


Figure 9: Twilight USOs – aggregate rate (%)

The data show a rate consistently between 20% and 30%. This consistency is of interest as no allowance is made for the age of the USOs. In addition, the policy of universities towards USO formation has already been noted to be diverse, so the same is likely so for the identification and management of twilight USOs.

Staffordshire is an outlier with a rate of twilight formation of 50%, although there are only 6 USOs. A high rate may be indicative of a desire not to dissolve companies for fear of 'losing face' (de Cleyn, 2011). This significant level of twilight USOs may lead to the conclusion that survival is a poor performance metric. A higher rate of twilight USOs may also be observed when a university secures little external funding, as such third parties may on first principles be less concerned about striking a company off where it is clear that the underlying technology will not be commercialisable.

Twilight USOs contribute towards providing a fuller and more accurate picture of true survival rates of USOs. By combining the aggregate failure rates of twilight and dissolved USOs, a clearer picture is obtained. The data show a reasonably consistent range of twilight and dissolved USOs for the universities across the region of between 60% and 70%.

Hypothesis 5 is therefore not supported. This consistency is of interest because no allowance is made for the USO age or quality, which signalling theory would predict to be linked, in that stronger research universities should produce longer-living USOs (Ziedonis, 2007).

These numbers are significantly higher than those obtained in previous studies and provide an explanation of the long-held view that USOs survive longer than other start-up companies.

Significantly in relation to signalling theory and firm performance, the data show a relationship between the lifetime of each USO that failed, and the external funding that it obtained. In general, companies with more funding survive longer. However, the majority of USOs obtained very little external funding. Several USOs with little funding survived for a long time, presumably because their technology could be commercialised at an early stage and generated sufficient income to enable the company to survive. The above sample is a small one, so observations must be made with care, and the relationship is unlikely to be straightforward, in line with Manigart et al. (2002). Hypothesis 6 is therefore partially supported.

6. Conclusion and discussion

The results and analyses provide insight into the ability of signalling theory to rationalise and explain the financial performance data of a region's USOs. While some results are in line with expectations, others are not and demonstrate the complexity in attempting to explain the data, and the need to consider wider data sets and more explanatory factors, as well as extending the timescale of the study to catch subsequent exits e.g. Beauhurst (2019).

Universities with a strong research pedigree generated the most USOs in line with theory; the Russell Group universities' USOs had at first glance the dominant influence on the economy of the region, although this finding is not in line with some earlier studies e.g. Tornatzky and Bauman (1997). Universities have different policies with regard to USO formation, for instance Aston, with good research credentials, creating a low number of USOs. The formation of USOs in the period under observation is heavily dependent upon the availability of UCF funding provided by the UK government.

The data relating to USO survival are more difficult to rationalise and lead to a tentative conclusion that this is not a useful performance metric, despite previous use. In line with previous studies, USOs survive for longer than other start-up companies e.g. Zhang (2009). This study highlights the existence of 'twilight USOs', backing up the findings of de Cleyn (2011), who identified that many European universities adopted policies to keep underperforming USOs alive; this therefore indicates that survival times say little about underlying USO quality (Agarwal et al., 2004). Findings on 'twilight USOs' from this study are important as they explain why USOs appear to survive for longer than other start-ups, and further study as to whether they received proportionately more funding would be interesting. In addition, a number of the survival measures show a degree of consistency between universities, which would not be expected under the theoretical framework, as USOs from stronger research universities would be expected to survive for longer (Conceição and Faria, 2014). In line with previous studies e.g. Shane and Stuart (2002), and theoretical expectations, USOs with external funding tend to survive longer, although some USOs with little or no funding survive a long time.

Data on external funding appear to be partially in line with prior studies e.g. Shane (2004), Colombo et al. (2019) and the theoretical framework in that total funding obtained by a university is positively correlated to its research strength. However, at a more granular level, by reviewing the amount obtained per USO, the picture is more mixed, with both the 1960s universities of Aston and Keele outperforming Russell Group Birmingham, implying a more focussed approach in creating USOs, and showing clearly that other factors than the research strength of the parent university are in play. This finding is an interesting addition to the literature.

Finally, the data on exits demonstrates consistent inability to generate financially successful exits. This is not in line previous studies e.g. Shane and Stuart (2002). From a regional

perspective, it is clear that the strategy of creating and funding USOs had little material effect upon the prosperity of the region or impact upon the reduction in traditional industries, despite the significant sector-specific knowledge remaining within the West Midlands. This is an important finding for policymakers in that incentivising the creation of USOs does not lead to financial success for all types of region. The region explored, as a post-industrial one, is more typical worldwide than those which contain elite research universities and the results here will be relevant internationally..

At a theoretical level, the study confirms that signalling theory is of value as a framework within which to conduct research on USO financial performance. It is clear that not all of its predictions are reflected in the data, and this is maybe to be expected, given the complexity and range of potential factors that influence a newly-formed company's subsequent financial performance. However, it offers a reasonable framework within which to discuss and analyse the results obtained, which backs up its use in prior studies of USOs e.g. Mueller (2010), where new companies and their signals are analysed by external parties to overcome information asymmetry and uncertainty.

This study is therefore able to add to the literature by the granularity of data collected clearly illustrating the different behaviours of universities with respect to USO programmes, a feature that has not previously been given prominence. Through consideration of a range of performance metrics, this study builds up a detailed picture of how different universities within the same geographical region have approached their "third mission" of developing academic entrepreneurship. The West Midlands region contains a range of universities and behaviours. An important example is the contrast between two universities: Aston appears to have focussed on creating a small number of high quality USOs while Warwick has instead maximised its use of government UCF funding to create a large number of USOs and attract a considerable external third party funding, yet in terms of exits and financial benefits the results are very similar. This is an important finding for regional policymakers about how best to target support for USO programmes.

This study also adds to the literature with its methodology involving obtaining the accuracy and completeness of the USO population. The creation of the USO database is significant and replicable internationally. It appears likely that the impact of this can be seen in the difference in some of the performance results obtained when compared with those from previous studies, particularly with the metric of survival of USOs which appears previously

to have been consistently overstated, as USOs that failed some years before any study have often been omitted from the population.

Finally, the study provides a useful assessment of the value of different performance metrics in assessing USO financial performance. Of the metrics selected, the number of USOs generated is a poor proxy for their financial success. Survival also proves to be a poor metric, given the surprising consistency across companies. External investment attraction is of some value, but there is little correlation in the West Midlands region with successful exits, which may be said on the current work to be the best metric in assessing the true success of a USO from a financial perspective.

The study contains a number of limitations and provides opportunities for further work. The data only covers a single UK region, and the study's conclusions should be tested against larger USO samples, both in the UK and internationally. Additional qualitative data might provide deeper insights into issues such as the actions of different universities in promoting USOs, and unpicking the motives for creating 'twilight' USOs. While the timeframe across which data were collected is significant, it would also be interesting to repeat the work for the region considering subsequent years, to see in particular whether any USOs of more recent creation gave successful exits and whether those responsible for USO creation and development have learned any lessons³.

7. Acknowledgement

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³ Warwick is known to have had a trade sale and IPO accredited to two of its USOs some time after the data collection finished in this paper, although it is not known to what extent the university benefited financially (Beahurst, 2019)

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