

What Makes University Inventions Appropriate for Spin-offs?

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EXECUTIVE SUMMARY

University spin-offs – new companies founded to exploit the intellectual property assigned to universities by virtue of invention by faculty, staff, and students who made material use of university resources – are valuable entities. They are 108 times more likely than the average new firm to go public, create more jobs than the average new business, induce more investment in technology development than established company licensees, enhance local economic development, license inventions that large, established firms do not license, and offer the potential for high returns to universities from equity holdings. As a result, policy makers, university officials and other stakeholders are interested in learning what makes some university inventions more appropriate for spin-off companies than others.

This study sought to explain what makes some university inventions more appropriate for spin-offs than others by interviewing the directors of technology licensing offices at U.S. universities. I approached a randomly selected list of 107 directors of technology licensing offices at U.S. universities listed in the 2003 Association of University Technology Managers (AUTM) survey. Of the 107 directors contacted, 55 agreed to participate in the study.

The study involved semi-structured telephone interviews with directors. The interviews lasted an average of 35 minutes and were tape recorded and transcribed. The analysis was conducted from the transcripts, using standard qualitative methods.

The study indicated that four categories of factors make some university inventions more appropriate for spin-offs than others: characteristics of the inventors, characteristics of the inventions, characteristics of the intellectual property position that can be obtained on the inventions, and characteristics of the industry in which the technologies would be exploited.

Eight characteristics of the inventors increase the appropriateness of a spin-off as a vehicle to commercialize a university invention:

1. *With the exception of inventions for which knowledge is well-codified, the willingness of the inventor to be involved in the further development of the technology*
2. *Inventor commitment to the concept of a start-up company*
3. *Inventor personal attributes of low need for control, ability to work with others, good communication skills, and willingness to seek complementary skills in others*
4. *Inventor prior start-up experience*
5. *Inventor prior industry experience*
6. *Inventor prior product development experience*
7. *Inventor prior social ties with investors in start-ups*
8. *Inventor prestige*

Three characteristics of the invention increase the appropriateness of a spin-off as a vehicle to commercialize a university invention:

1. *With the exception of biotechnology, a platform technology*

2. *A disruptive technology*
3. *A stand alone invention*

Five characteristics of the intellectual property position that can be obtained on the invention increase the appropriateness of a spin-off as a vehicle to commercialize a university invention:

1. *With the exception of inventions for which further development within the university is not appropriate, patentability*
2. *The ability to get composition of matter patents*
3. *With the exception of technical fields in which patents are not effective, the scope of patent claims*
4. *Un-crowded intellectual property space around the invention*
5. *Clear title to intellectual property held by the university*

Three characteristics of the industry in which the technology would be applied increase the appropriateness of a spin-off as a vehicle to commercialize a university invention:

1. *With the exception for early stage development companies, lack of capital intensity*
2. *With the exception for early stage development companies, industry fragmentation*
3. *With the exception of biomedical technologies, industry youth*

INTRODUCTION

Although university spin-offs are relatively uncommon entities – the number founded since the passage of the Bayh-Dole Act in 1980 is less than 5000 – these companies are extremely important economic entities. Among them are several billion dollar public corporations, including Cirrus Logic, Google, Genetech, and Chiron. Moreover, these companies are 108 times more likely than the average new firm to go public and create more jobs than the average new business (Shane 2004). The induced investment in technology development by spin-off companies is greater than that by established company licensees (Pressman et al, 1995). Furthermore, spin-off companies tend to be founded near the universities that spawn them, enhancing local economic development (Shane, 2004). Spin-offs also tend to license inventions that large, established firms do not license, making spin-offs useful mechanisms to increase the amount of technology licensed from universities (Thursby et al, 2001). Lastly, at many universities, the financial returns from equity holdings in spin-off companies exceeds that from licensing to established companies (Shane, 2004).

Approximately 15 percent of licensed university inventions result in the formation of spin-off companies (Shane, 2004). However, to date, we have relatively little information about what makes spin-off companies appropriate vehicles to commercialize university inventions. This study examines the attributes of the inventors who have developed the technology, the new technologies that they have invented, the intellectual property protection that can be obtained on those inventions and the industries in which those inventions would be applied that increase the appropriateness of spin-off companies as the entities to commercialize university inventions.'

METHODOLOGY

This study sought to explain what makes some university inventions more appropriate for spin-offs than others by interviewing the directors of technology licensing offices at U.S. universities. The study defines as a university spin-off a company that was founded to exploit intellectual property assigned to a university by virtue of invention by faculty, staff or students that made material use of the university's resources.

To gather the necessary data, I approached 107 directors of technology licensing offices at US universities randomly selected from those listed in the 2003 Association of University Technology Managers (AUTM) survey. Of the 107 directors contacted, 55 agreed to participate in the study. I interviewed the 55 TLO directors between November 2004 and January 2005.

The study involved semi-structured telephone interviews with directors. The interviews lasted an average of 35 minutes and were tape recorded and transcribed. The analysis was conducted from the transcripts.

In qualitative research, it is important to establish a reliable methodology for analyzing the data. Reliability was established using table shells to record the data (Miles and Huberman, 1984). Direct quotations on each of the topics explored in the study from each case were separately entered into tables. The tables were then explored to determine

whether or not there was a common pattern of response among the participants. The use of table shells ensures that data analysis is focused on the key interview topics for all respondents, and that common analytic techniques are used for all cases.

For answers in which a common response was made, that response was summarized and representative quotations were used to illustrate it. The quotations were also compared to rival, mutually exclusive propositions derived from the literature to determine the degree to which they were consistent with one or the other explanation. This approach is consistent with the pattern matching logic that is recommended for qualitative research (Miles and Huberman, 1984). In qualitative research, evidence is considered to exist in those situations where common responses are found for respondents and those responses support a particular proposition and not its alternative (Yin, 1984).

FINDINGS

The study indicated that four categories of factors make some university inventions more appropriate for spin-offs than others: characteristics of the inventors, characteristics of the inventions, characteristics of the intellectual property position that can be obtained on the inventions, and characteristics of the industry in which the technologies would be exploited.

Characteristics of the Inventor(s)

Eight characteristics of the inventors increase the appropriateness of a spin-off: (1) With the exception of inventions for which knowledge is well-codified, the willingness of the inventor to be involved in the further development of the technology; (2) inventor commitment to the concept of a start-up company; (3) inventor personal attributes of low need for control, ability to work with others, good communication skills, and willingness to seek complementary skills in others; (4) inventor prior start-up experience, (5) inventor prior industry experience, (6) inventor prior product development experience (7) inventor prior social ties with investors in start-ups, and (8) inventor prestige.

1. The Willingness of the Inventor to be Involved in the Further Development of the Technology Increases the Appropriateness of a Spin-off.

The preponderance of TLO office directors interviewed believe that the willingness of the inventor to be involved in the further development of the technology increases the appropriateness of founding a spin-off company to commercialize a university invention. The TLO directors generally believe that inventor involvement is more important if the licensee of the university invention is a spin-off company than it is if the licensee is an existing company. As the director of the TLO at University O explained,

As a rule of thumb, I would say that it would require more involvement from the inventor to transfer the technology to a start-up company. It may be the most appropriate technology and a great start-up opportunity but if the inventors just flat out say 'I'm not interested. I want to do research,' then we have to go out and license it to existing companies."

Similarly, the director of the TLO at University BBB explained,

“If you don’t need the investigator anymore that suggests that this is the technology that ought just to be put in the hands of an established company and let them go forward on their own.”

In particular, the TLO directors believe that inventors need to spend more time with the licensee of the invention over a longer period if the licensee is a spin-off than if the licensee is an existing company. The Director of the TLO at University R explained,

“I think it’s a requirement that the inventor is going to have to be prepared to be involved longer with a start-up than with an existing company.”

As a result, many of the TLO directors expressed the view that they would discourage spin-off company formation if the inventor did not want to be involved with the further development of the invention. As the Director of the TLO at University EE explained,

“I’m not sure I would encourage a start-up where the inventor was not involved. I’d probably encourage them to go the licensing route.”

Similarly, the director of the TLO at University Q explained,

“They have to be able to devote some time to further develop the technology. If they’re not willing to help with the technology, what’s the point in starting this company?”

Reasons Why Inventor Involvement Makes Spin-Off Companies More Appropriate

The TLO directors offered a variety of reasons why inventor involvement increases the appropriateness of spin-off companies as vehicles to commercialize university inventions. One reason is that spin-offs require the inventor to take on the role of technology developer. With a license to an established company there might be other people who could fill the role of further developing the invention, but a start-up is not going to have such personnel. Therefore, inventor involvement makes technology development by spin-offs possible, and so increases the appropriateness of a spin-off. As the director of the TLO at University OO explained,

“Pretty much the inventor is going to have to stay involved in further development if you’re licensing to a start-up because they’re not going to have their own lab space and you need the professor involved to fund additional research in their lab. For a start-up, you need at least willingness to do further sponsored research at the university on that technology. For an established company, it’s still very beneficial to have the inventor involved but they often have their own scientists that can take it and run with it in the direction that they want once they take it in house.”

Similarly, the director of the TLO at University SS explained,

“Especially coming out of the university where technologies are very early stage and often require a significant amount of development, you need to have the inventors involved one way or another. The start-up company is going to need to rely on the inventors. When we do a license, it’s the patent that the company needs. They have the expertise to develop it themselves where the start-up would not have that. The start-up relies on the inventor.”

Furthermore, as the director of the TLO at University YY explained,

We need to have their involvement regardless, but an established company would generally have some technical staff of their own. A start-up company most likely would not so the extent of involvement is greater with the start-up.

A second reason why inventor involvement increases the appropriateness of spin-off companies as the vehicles to commercialize university inventions is that university inventions are tacit and often cannot be developed by anyone other than the inventor. Licensing an invention to a third party is most effective when the information about how the technology can be codified and written down in the form of blue prints, plans, and procedures (Arrow, 1962). When knowledge is tacit and lies mostly in the heads of inventors, inventor involvement becomes very important to move the technology from invention to product (Jensen and Thursby, 2001). Tacit knowledge makes it problematic for other parties to see how to further develop the invention into something commercializable the early stage and tacit nature of the university inventions at the time that they are disclosed makes it very difficult for people not involved in inventing the technology to have the foresight to see its value. As the Director of the TLO at University N explained,

One of my inventors “formed a start-up because they could not license to an existing company. Despite his strong efforts he could not get anyone to catch the vision. It was just something that he thought could be played out. The industry didn’t share that vision and that didn’t let him move on licensing opportunities.”

Therefore, few people, other than the inventors are willing to bear the risk of the future development of the technology. The director of the TLO at University Q explained,

“Who’s going to take the risk and move the technology forward? There aren’t many people willing to do that. We start if an inventor says I want to start a company.”

A third reason why inventor involvement increases the appropriateness of a spin-off companies as the vehicles to commercialize university inventions is the inventor’s involvement increases the value of a start-up to potential investors. Investors in spin-off companies exploiting early stage university inventions recognize the tacit nature of the knowledge developed at universities and the importance of inventor involvement for its further development. Inventor involvement means that more than just the invention is being transferred to the new company and makes a spin-off more valuable. For instance, the director of the TLO at University MM explains,

“Without the inventor’s participation, early stage intellectual property isn’t very valuable.”

Similarly, the director of the TLO at University PP explains,

“Prospective investors are not just in the technology, but the know how that’s represented in the person’s brain. So helping to formulate the business plan once you start talking about a specific company and defining the scientific agenda in

some way are important. Again, this is very different that you would have an inventor do in a license to an existing company.”

Furthermore, the director of the TLO at University BBB explained,

“Because everybody is trying to understand that there if it’s a fundable opportunity in order to understand that they’re going have to they’re going to have to be sold. They’re going to have to be pitched to and it’s going to have to be done in a way that they’re convinced that they pass the early test that there is a pathway to the market then that kind of inventor has a lot of experience to bring to the equation and also has an ongoing value to the company.”

Because of the tacit nature of university inventions, inventors are a good source to explain the technology and its applications. Therefore, their involvement facilitates the ability to explain the new technology to key stakeholders. As the Director of the TLO at University Z explained,

“At the end of the day, [members of the] faculty are good folks to stand up and explain the technology. They bring credibility to the table and to the venture. So there needs to be some level of involvement. If they want to be totally disengaged, it’s probably not going to go anywhere regardless of how hard we would try to push them.”

Similarly, the Director of the TLO at University Z explained,

“If the inventors go into a meeting with a venture capitalists and say we just want to give you the technology and we want you to do good things with it; we want to stay in our lab and do our science, you might as well end the meeting right there. That’s not a good sign of their willingness to engage. I think from any investor’s standpoint, they want to see that the researchers continue to be engaged.”

Exception for Codified Knowledge

The effect of inventor involvement on the appropriateness of a spin-off company just described is influenced by the nature of the invention. Some inventions are more easily codified than others and therefore do not require inventor involvement to be commercialized. When the invention is well codified and the technology is largely developed already, the willingness of the inventor to be involved does not influence the appropriateness of a spin-off company. As the Director of the TLO at University Y explained,

“It would depend on whether it’s a technology that’s well defined by the patent or there is some kind of secret sauce that you need to know. I think you really have to look at the technology and say how complicated or straightforward it is.”

Similarly, the director of the TLO at University FF explained d,

“Does the inventor want to be part of the start-up? That is certainly a factor. But if the technology is pretty much developed and our faculty inventor has made his or her contribution, they really don’t have to participate any further. Their continued participation is not much of a factor. We’ve had other technologies where it’s essential that the inventor continue to participate, continue to develop,

and continue to innovate. In those situations, we'd certainly want to know whether or not the faculty member had an interest in participating either as a member of the company or to receive research support from the company and to continue to work at the university."

Furthermore, the director of the TLO at University AAA explained,

"It depends upon is how much input is even going to be required from the inventor. Not all start-ups require that the inventor be intimately involved. Sometimes he's got a piece of technology and the specifications on how to develop the technology are fairly clear or well understood. So his input is not necessarily required. The concept has been proven. In that instance it's not going to really make too much difference to me. But a lot of our technologies are so embryonic and you couldn't do anything with it without the professor's lab to do a lot of the additional development. In that case if the professor is someone that people are going to have a hard time working with because next week he's going to get a grant in another area and drop his research, It's going to be hard for us to start a company around it. He's got to be committed to what the vision of the spin out is if his participation is required."

2. *Inventor Commitment to the Concept of Start-up Companies Increases the Appropriateness of a Spin-off.*

Most of the TLO directors believe that inventor commitment to the concept of a start-up company increases the appropriateness of a spin-off as the vehicle to commercialize a university invention. Inventors are more likely to do the work necessary to make the spin-off company successful if they are committed to the concept of a spin-off company. As a result, inventor commitment leads TLO directors to be more favorably inclined to the concept of a spin-off. The director of the TLO at University TT explained,

"If there is strong desire on their part to start-up a business to commercialize the technology that has been created, then we want to take that into account."

Similarly, the director of the TLO at University F explained,

"Intense inventor interest [in a start-up] would tend to lean me towards a start-up."

In contrast, if the inventors express no interest in the concept of a start-up, the TLO directors believe that spin-offs are less appropriate. As the director of the TLO at University RR explains,

"If the inventor isn't interested then it doesn't make a lot of sense to move forward in establishing a start-up."

Reasons Why Inventor Commitment Matters

The TLO office directors offered several reasons why inventor commitment to the concept of a start-up company increases the appropriateness of a spin-off company as the vehicle to commercialize a university invention. One reason is that the process of creating a successful university spin-off takes more work than licensing to an established company. Therefore, the inventor needs to be willing to be committed to the concept of a

spin-off to justify the greater work load that spin-offs entail. As the director of the TLO at University PP explained,

“We look for an interested faculty inventor who is willing to invest in much heavier amount of work on his or her part in a start-up that with a traditional license. They need to help us to understand the technology and the many different applications and really do the due diligence early on in the technology opportunity itself.”

Similarly, the director of the TLO at University Z explained,

“You have to look at what the inventor wants to do. Are they interested in seeing a start-up? Do they want to be engaged and involved? Are they willing to make time commitments related to that?”

A second reason why inventor commitment increases the appropriateness of a spin-off as the vehicle to commercialize a university invention is that it increases the likelihood that the inventor will persist with technology development when faced with obstacles along the way. As the director of the TLO at University DD explained,

“One of the biggest factors influencing whether we pursue a start-up is whether or not the inventor is really going to be committed emotionally to the process. And when it gets difficult that they’ll persist.”

Similarly, the director of the TLO at University OO explained,

“You want people who understand that it’s a lot of work. It’s not their God-given right to start a company and have the university pay for everything at that company. They have a desire to start a company and really want to work at it not that they were talked into it by someone else or because they think it might be fun. It’s mainly drive and whether or not they seem to understand what they’re going to have to do.”

A third reason why inventor commitment increases the appropriateness of a spin-off as a vehicle to commercialize a university invention is that someone needs to champion the development of the technology and the creation of a company. Because TLO offices do not often have the time to do that, inventors fill an important void in making spin-offs an appropriate option. As the Director of the TLO at University S explained,

“I think that a start-up with a faculty inventor in the game is a good thing. Any time there’s an inventor who wants to take the time to drive a start-up, and who help to identify credible people to make the company happen, is a good thing.”

Similarly, the Director of the TLO at University W explained,

“I think you have to have an inventor that’s willing to invest the time and effort in working to create a start-up. It’s pretty hard to do a start-up without the enthusiasm of the lead inventor. At least that’s what I’ve experienced over the years. Even if he or she doesn’t end up being the entrepreneur, somebody has to sit around and make the presentations.”

Moreover, inventors are often very effective champions of their own technologies because of their intimate knowledge of the technologies and their belief in their value. As the Director of the TLO at University D explained,

“You have to have a champion who is going to sell it to the folks who have the money to fund the company. In general, the only way that’s going to happen is to have one of the inventors interested enough to do that. If you don’t have an entrepreneurial inventor, it’s extremely difficult to have a start-up formed.”

3. *Inventor Personal Attributes Of Low Need For Control, Ability To Work With Others, Good Communication Skills, And Willingness To Seek Complementary Skills In Others Increase The Appropriateness Of A Spin-Off.*

Inventor personality also influences the appropriateness of a start-up as the vehicle to commercialize the technology. Specifically, inventor personal attributes of low need for control, ability to work with others, good communication skills, and willingness to seek complementary skills in others all increase the appropriateness of a spin-off as the vehicle to commercialize a university invention.

Reasons Why Inventor Personal Attributes Matter

The TLO directors offered several reasons why inventor personal attributes of low need for control, ability to work with others, good communication skills, and willingness to seek complementary skills in others increase the appropriateness of a spin-off. First, the appropriateness of a spin-off company as a commercialization vehicle increases with the willingness of inventors to include people with business skills increases because performance of spin-off companies is higher if they have founding team members with business experience (Shane, 2004). As the Director of the TLO at University J explained,

“One of the things that we look for are folks that know what they don’t know. And people that are willing to surround themselves with people that are experts in other areas and have the intellectual curiosity to surround themselves with people that can help them grow their business.”

Similarly, the director of the TLO at University J explained,

“They are folks that know their strengths and weaknesses and know that most days of the week that they are scientists and don’t want to own a company. They want to get the best expertise they can from a business management perspective and help the science go forward while somebody else runs the company. That would be my perfect person.”

Second, the appropriateness of a spin-off company as a commercialization vehicle increases with the ability of university inventors to work with others. Creating a company requires the contributions of multiple people and cannot be done alone. Therefore, inventors who are unwilling to work well with others tend to be inappropriate sources of spin-off company inventions. As the director of the TLO at University NN explained,

“The inventors need to be cooperative and some people are easy to work with and some people are not. They need to be cooperative to go the start-up route because the start-up is going to need more of their time.”

Similarly, the Director of the TLO at University Q explained,

“They have to be friendly people. They have to be able to get along with other people. If you can’t even get along with this office what makes you think you’re going to be able to get along with a venture capitalist.”

Furthermore, the director of the TLO at University SS explained,

“They need to be cooperative. They need to be able to work well with others in a business environment. If you have an inventor who you know doesn’t get along well with others, doesn’t play with others and you think that it would be very challenging for business folks to work with our faculty member that may deter you from pursuing a start-up.”

The ability to work with others is particularly important because of the difficulty raising money for university spin-offs. In general, venture capitalists and angel investors are reluctant to invest in university spin-offs because of the high levels of technical, market, management, and competitive uncertainty involved with these ventures. Therefore, they look for reasons not to finance university spin-offs rather than reasons to finance them. Difficult inventors often provide a justification not to finance the spin-offs. As the Director of the TLO at University V explained,

“Some people can work cooperatively with the world and others can’t. You can’t start a company if the inventor is not the kind that will get out in front and be able to woo the investors. There are just some people who are so prickly that nobody will get into a deal with them because they’re just a difficult personality. VCs invest in anywhere from 1 in 100 to 1 in 300 things they see. They see a lot of things that will make money. So they have all sort of walk out points where they can walk out without a second thought and without a bit of concern. If they’ve got somebody that’s difficult to work with, they’ll just walk away.”

Third, the appropriateness of a spin-off as a commercialization vehicle decreases with the inventor’s need for control because the success of spin-off companies is predicated on the willingness of the inventor to let others gain control of their technology as it moves toward commercialization. As the Director of the TLO at University H explained,

“We had a situation where a very strong willed guy who wanted to be chairman, president, CEO, secretary. It was his ball and his game and he wanted to do everything. So in this particular scenario we weren’t really very excited about a start-up.”

Similarly, the director of the TLO at University RR explained,

“If they cannot tolerate losing control and have to control both the science side and the business side, they’re not well suited to understanding what it takes to take an early technology and transform that into a product for the market place and they are not a good candidate for a start-up.”

Furthermore, the director of the TLO at University BBB explained,

“We may have situations where inventors are perfectly willing to participate in the start-up but we think that participation would be a negative as opposed to a positive. And for that reason we feel like this may be a more we could feel like this would be a more appropriate licensing opportunity. Over controlling faculty is probably the biggest concern. If they’re not willing to share, if they’re not willing to face reality, if they’re not willing to listen and be influenced, then those are not good business partners.”

Fourth, inventor communication skills increases the appropriateness of a spin-off company as a commercialization vehicle because creating a company requires the inventors to be involved in talking to business people and potential investors, especially in the early stages of the business when few other people are involved. If the inventor cannot communicate well with the outside world, they cannot attract investors or business people, making spin-off companies inappropriate commercialization vehicles. As the Director of the TLO at University K explained,

“We use a phrase ‘that you can’t dress them up and take them out.’ If it is someone who is very argumentative or very pompous or doesn’t present their science well – I mean we’ve got brilliant people who cannot stand in front of a group and present their science such that it could be understood – I think that would be a serious handicap. And we always consider what the individual is like before going further.”

4. *Inventor Prior Start-up Experience Increases the Appropriateness of a Spin-off*

Most of the TLO directors believe that a spin-off company is a more appropriate commercialization vehicle if the inventor has past experience licensing his or her inventions to start-up companies. Prior experience increases the appropriateness of a spin-off even if the prior start-up was not a success. As the director of the TLO at University EE explained,

“If they had experience working with start-ups that would be a positive. It wouldn’t have to be something that was successful. So many start-ups fail. It would be better if it was successful experience, but just the fact that they had experience would be a positive.”

Similarly, the director of the TLO at University OO explained,

“If they’ve done it before then they have a better understanding so obviously that’s a plus. I would say doing it before – they actually tried and worked at it the right way not whether or not the company failed. You can’t control the market and you can’t control what your technology is and everything else. Just because your technology wasn’t what the market wanted didn’t mean you didn’t do a good job trying to get there.”

In fact, some of the TLO directors even believe that having an experience with a failed start-up might make a spin-off a more appropriate commercialization vehicle than

experience with a successful start-up. As the Director of the TLO at University A explained,

“The prior start-up can be a success or a failure. In fact some say that if you failed a couple of times you’re much more valuable to help start a business than if you’d been successful.”

Similarly, the director of the TLO at University TT explained,

“I actually place more emphasis on failure than on success. The reason is because a lot of people are successful just because they are able to get to market at the right time and right place and get a lot of money and then dump the thing fast. Those who have failed have failed for lots of different reasons and those reasons then become hard learning lessons that can be turned into other things. People that I’ve met that are serial entrepreneurs that have become successful have failed at least one business if not more than 50 percent of their businesses. So just the experience alone is very valuable to those people.”

In particular, the TLO directors that believe that failure provides important learning about how to create companies, which makes a spin-off company a more appropriate commercialization vehicle. As the director of the TLO at University J explained,

“Experience is helpful. A failure is a badge of courage. If it didn’t work out it is not a negative but shows you’ve been through one series of experiences and hopefully you’ve learned from those experiences.”

Similarly, the director of the TLO at University KK explained,

“I would rather have somebody who has had a couple or even more unsuccessful experiences in start-ups than somebody who has been successful. When you’ve been unsuccessful you have learned a significant number of lessons of what not to do and, in many cases, what to do. Sometimes, going the successful route can be a matter of luck, good fortune, and a dynamite technology that kind of pulls its way through. So if I had my choice, I’d take somebody who has had the hard lumps and now knows they don’t want to repeat it.”

Furthermore, the director of the TLO at University SS explained,

“Any experience with a start-up is good even if you’ve failed. At least you’ve been involved and know a little bit about what to expect. If you had somebody who was involved with a start up for a number of years and got a lot of experience and for whatever reason the company fails, that would be very beneficial.”

However, many TLO directors explained that they view the inventions of those inventors who were successful with spin-offs in the past as particularly appropriate for spin-offs. As the director of the TLO at University P explained,

“Successful investigators that have been involved in other ventures where significant venture money has been raised and technology has been developed are better than the first timer.”

In particular, inventors' prior success makes a spin-off a more appropriate commercialization vehicle because it reduces the need to understand the causal mechanisms behind performance of the past venture. If the venture was unsuccessful then the TLO must determine whether the same factors will make the spin-off unsuccessful his time around. As the Director of the TLO at University V explained,

"If they were, successful, yes. If they were not, it depends upon whether the reason they were unsuccessful was because the inventor was a bust or just other uncontrollable forces."

Similarly, the director of the TLO at University GG explained,

If the person has had a bad experience and we know for a fact that the person is a bad manager, or the person wouldn't be involved with a business person, or they had to do it all themselves, then the business failure would be something that we would worry about. If, on the other hand, it was because they were a pure Internet play or they were tied to the Internet and the dot com crash hit them and there was absolutely nothing they could do about it –financing dried up and they couldn't weather the storm, that's okay."

Furthermore, the director of the TLO at University PP explained,

"I think the best indicator is successful experience. We've had some faculty who had gone through it, and the first company has not worked because the faculty member has been difficult for some reason. It would be a negative factor in those cases."

Why Prior Start-up Experience Increases the Appropriateness of a Spin-off

TLO office directors offered a variety of reasons why prior inventor start-up experience increases the appropriateness of a spin-off company as a commercialization vehicle. First, the inventor's prior start-up experience makes them knowledgeable about the entrepreneurial process which leads them to have appropriate expectations about what will happen at different stages of the spin-off process. People have better firm organizing routines and decision making skills if they have established firms before (Bruderl et al, 1992). As the Director of the TLO at University J explained

"They've been through it before and they're experienced and they know what they're doing."

The greater understanding of what a start-up entails makes the inventor more accepting of the underlying uncertainty of new technology companies. As the director of the TLO at University FF explained,

"In our experience, a more experienced inventor is very helpful. An inventor who has been through the process knows what to expect. Having been involved in a start-up before gives them a clearer understanding of what is expected, a little less anxiety and little more acceptance of the uncertainty that's associated with a start-up. That's a positive too."

This understanding also increases the likelihood that they have the sense of dedication and commitment that is necessary to have a successful spin-off. As the director of the TLO at University TT explained,

“I put a lot more emphasis on somebody who has direct experience in working in a start-up whether they’ve actually run a start-up or they have participated in the start-up in any capacity. That gives them a much broader sense of dedication to what it takes to make a business like that successful. It shows how hard it is. How much dedication and time is required on the part of the individuals that undertake it so those that do enter into the decision on whether or not to proceed with a start-up are well informed.”

Prior start-up experience makes inventors more realistic about the usefulness of their technology to a new company. Because there is more to the creation of a successful spin-off company than good technology, this realism is beneficial to understanding all of the difficult steps necessary to create a viable new organization. As the Director of the TLO at University X explained,

“If they’ve had successful start-ups in the past it makes it much easier because they can see their expectations. They are more realistic. Sometimes you’ll get someone who has never done it and they think that their technology is the center of everything and they can’t understand why it is not driving the development of their company.”

Similarly, the director of the TLO at University CCC explained,

“If a faculty member involved in two or three start-ups comes in with a patent that makes a big difference because they’re much more realistic when they’ve been through it than the ones that haven’t been through it.”

Furthermore, the director of the TLO at University BBB explained,

“Any experience is better than no experience. If it failed because the technology didn’t do well or there wasn’t enough money in the area to fund it or they couldn’t find the management team that they needed, then that kind of faculty member could be pretty desirable to us. Because they’ve got some war stories and a much more realistic perspective of what it really takes.”

Prior start-up experience also makes the inventors more likely to involve talented business people as their partners. As the director of the TLO at University UU explained,

“It’s absolutely fantastic if you have a stable of people who’ve been involved in a company that was successful. They know they understand that they can’t do it alone.”

Finally, prior start-up experience makes inventors more willing to bear the risk that new ventures entail. As the director of the TLO at University VV explained,

“If they’ve had experience with a start-up before it’s the best indicator of whether they might be good at it. One thing that makes faculty not the greatest people for start-ups is that faculty members by their nature are generally fairly risk averse. That’s one reason they’re faculty member that’s why tenure appeals to them.”

Second, inventor start-up experience generates confidence of others in their judgment that an invention should be exploited by a start-up. Given the uncertainty facing university inventions, it is difficult to judge whether university inventions should be commercialized through the creation of spin-off companies. The risk that the people involved in a new venture will not be able to work together to develop a successful new company is high with all new ventures. In the case of university spin-offs it is even higher given the early stage of most university technology and the relative absence of managerial skills amongst academic investigators. Therefore, knowing that an inventor has participated in a successful spin-off in the past reduces the managerial risk facing the new venture. As the Director of the TLO at University T explained,

“Experience with starting companies off their inventions before lowers the risk by a good order of magnitude in and of itself. Nothing succeeds as much as previous success.”

Similarly, the director of the TLO at University R explained,

“If they’ve done it before, that makes you have much more confidence in their judgment.”

Furthermore, the director of the TLO at University Z explained,

“We have several folks out of our computer science department that fit that mold [serial entrepreneurs] and literally sit on the boards of venture firms. Several that I can think of bring their own level of credibility to the discussion.”

The confidence engendered by inventor start-up experience extends to investors. Inventors who have companies founded in the past find it easier for to raise money for subsequent ventures because their start-up experience provides them credibility with the investor community. As the Director of the TLO at University I explained,

“You’d like inventors who have had start-up experience, particularly successful ones, because that makes them very fundable. It’s not an absolute requirement at all, but boy it’s nice.”

Similarly, the director of the TLO at University AAA explained,

I think having done it is important. There’s nothing better than a track record as far as trying to go out there and raise money. I mean financial investors like to bet on people who have done it before.”

In some cases, inventors with successful prior start-up experience have a name and a track record that evokes a strong positive response in investors, making spin-offs to exploit their inventions very appropriate. As the Director of the TLO at University Y explained,

“We have inventors who have been involved with successful start-ups in the past and have a track record. These technologies are a lot more attractive to do a start up with. There is an automatic reaction to the name of successful inventors.”

Similarly, the director of the TLO at University S explained,

“Some inventors have names that alone will drive a start-up because they have been successful many times before. Take George Whiteside at Harvard. I don’t think you have to say anything else. You just had to put up the sign ‘George is interested in a start-up’ and people come out of the woodwork.”

Furthermore, the director of the TLO at University LL explained,

“Inventors who already have experience and successes at creating start-ups are going to have an easier time attracting venture capital. So in a sense you are looking at the inventors as your sales people at least at the outset. Are they folks that are going to attract the attention of the venture capital folks?”

5. Inventor Prior Industry Experience Increases the Appropriateness of a Spin-off

Most of the TLO directors indicated that inventor experience working with industry, either through employment in a company or through consulting to the private sector, would make a spin-off company a more appropriate commercialization vehicle. As the director of the TLO at University EE explained,

“Yes, it would be very helpful if I thought that the faculty member had worked much in the private sector.”

Similarly, the director of the TLO at University VV explained,

“The more business experience that they have the better off you are, whether it’s experience through consulting or whatever.”

Why Prior Inventor Industry Experience Increases Appropriateness of a Spin-off

The directors of the TLOs offered several explanations for why prior inventor industry experience increases the appropriateness of a spin-off as a commercialization vehicle. One reason is that such experience gives inventors useful skills for starting companies (Shane, 2004). Inventors with industry experience understand more about finance sales, logistics, marketing management, and organization. It also gives inventors knowledge of customer needs (Vohora et al, 2002), including an understanding of business models, operations, and customer needs. Inventors with industry experience have a greater sense of how to meet customer needs or how to find people who have an understanding of how to meet customer needs. Moreover, it may even provide the inventor with information about particular companies that would become customers of the spin-off (Shane, 2004).

A second reason that industry experience makes a spin-off a more appropriate commercialization vehicle is that it helps inventors to understand the difference between business and academia and reduces academic naiveté about technology commercialization (Shane, 2004). As the director of the TLO at University SS explained,

“We have some faculty who have worked in industry or have consulted with industry for many years. And then there are those who are very naïve about the way industry works, and certainly a faculty member who has more experience with companies would be more appealing for a start-up.”

A particularly important difference between academia and industry that industry experience provides is an understanding of the financial orientation of technology development in industry. The director of the TLO at University O explained the value of understanding financial orientation. He said,

“Inventor experience working with industry would give us a warm and fuzzy feeling, yes. Any outside of academia experience, even if they were researchers in a private company which lives and dies by the bottom line. I think they would be more attuned to the issues to make start-up companies successful.”

Similarly, the director of the TLO at University JJ pointed out,

“Industry is quite different from academia and knowing how scientific industries or technical industries work would be great. That means understanding just basic business concepts from the time value of money all the way to intellectual property and negotiation. That would be quite helpful to these guys.

Another important difference between academia and industry that industry experience provides is an understanding of timeliness. Business depends on a sense of urgency and time constraints not present in academia. To successfully launch companies, academics need to understand the importance of externally imposed deadlines. Industry experience provides inventors with knowledge of these time constraints. The director of the TLO at University FF described how industry experience provided this benefit. He said,

“Our faculty [members] that have had industrial experience understand what’s involved in starting up a company. They understand timelines and are more accepting and appreciative of the urgency of getting things done in a certain time frame. Those inventors that have not had industrial experience would tend to struggle a bit more in appreciating why timelines are important and what urgency is all about.”

A third reason why inventor industry experience makes a spin-off a more appropriate commercialization vehicle is that it gives inventors insight into how the industry in which the invention would be applied works. This knowledge helps to position a start-up appropriately within that industry. As the Director of the TLO at University T explained,

“Having experience interfacing with industry is certainly helpful. It’s probably one of our most useful indicators. It helps position the process or product in light of what he or she knows about that current industry.”

In particular, industry experience leads inventors to understand the role of start-up companies in commercializing inventions in an industry. As the Director of the TLO at University N explained,

“If they’ve got industrial background, they have a deeper understanding of what industry is about....They have good insights into the way that their innovation fits within the state of the art. We have very strong education assessment and measurement research here. These folks are really tapped into the education industry. They understand how it works. These folks have a pretty good feel for whether a technology is something that would lend itself well to a start-up or

something that might be better suited as a licensing opportunity to an existing company.”

Industry experience provides knowledge of product development process, which is necessary for the spin-off to undertake if it is to be successful. As the director of the TLO at University C explained,

“A lot of inventors don’t understand what’s involved in running a business and selling a product so industry experience helps make them realistic about what is practical from an industrial standpoint.”

Similarly, the director of the TLO at University E explained,

“Inventor experience in working with industry is a big plus. People who have been scientists in industry realize what it takes to get products to market.”

Furthermore, the director of the TLO at University XX explained,

“The things you need to worry about in developing products are different than what you worry about when you’re trying to push the forefront of science. And you need to know customer needs and things like that. You speak the language so involvement with industry is very valuable. If the professor understands industry then I think they speak the same language and they can they’ll find it interesting. Whereas if they don’t understand industry how the process of product development works then they tend not to be very cooperative it’s foreign and they it’s like having trying to speak Chinese with someone if you’re an English speaker.”

A fourth reason why inventor industry experience makes a spin-off a more appropriate commercialization vehicle is that it gives others confidence that the inventor knows what technology is appropriate for start-up company. Several TLO directors explain that this credibility is important in persuading them to support the idea of a spin-off. As the Director of the TLO at University R explained,

“It would probably give them more credibility in their proposal for a start-up. You tend to think they know what they’re talking about. They will probably start out with a modest advantage when you are evaluating a proposal to do a start-up.”

Similarly, the director of the TLO at University KK explained,

“It would give us a warm and fuzzy feeling knowing that somebody coming in is very familiar with an industry. We recognize that when they put their disclosure out there, they wouldn’t be disclosing if they didn’t think they had a possibility of success.”

Specifically, industry experience gives the TLO confidence in the inventor’s judgment that a start-up is a good idea, as well as what market applications the new company would pursue and a sense of how the spin-off would compete with existing firms. As the Director of the TLO at University L explained,

“It matters because they come into it making a better analysis of where they think it should go. When you sit down and have a discussion with them about whether to license it to an existing entity versus a start-up, it is a much better conversation. You can get at the various applications, at the strength and weaknesses of the existing companies and the directions that they’re going.”

Similarly, the director of the TLO at University KK explains,

“The more they’re down the experience curve, the more likely that they’ll be looking at their disclosure in such a way that they’ll define the invention and craft the disclosure in a context that’s more user friendly for a start-up scenario.”

6. *Inventor Prior Product Development Experience Increases the Appropriateness of a Spin-off*

Many of the directors of the TLOs explain that inventor prior product development experience increases the appropriateness of a spin-off as the vehicle to commercialize a university invention.¹ The director of the TLO at University I summarized the consensus view saying,

“It’s extremely helpful, but most faculty don’t have it. It would push us less away from a start-up if an inventor had it.”

Similarly, the Director of the TLO at University DD explained,

I would have more confidence in the formation of a university spin-off if “they [the inventors] have been involved in the process of product development, particularly if they’ve been a project manager or something like that.”

Why Prior Inventor Product Development Experience Increases Appropriateness of a Spin-off

The directors of the TLOs offered a variety of reasons for why inventor product development experience increases the appropriateness of a spin-off company as the vehicle to commercialize a university invention. One reason is that this experience makes the inventor more willing to be involved in the development of the technology, which would help a spin-off to develop new products from the academic invention. This view was summarized by the Director of the TLO at University CC who explained,

“If the inventor has product development experience, then they would probably be interested in working on the development of the technology and I would think that a start-up would be more appropriate.”

¹ However, the TLO directors felt that the effect of inventor product development experience on the appropriateness of spin-offs should not be overstated. Many TLO directors explained that most university inventors do not have product development experience. In addition, the director of the TLO at University II explained, *“We see it as a positive factor, but it’s not that big a deal because we don’t want them running product development. That could be a big disaster. We want the company to run product development.”*

A second reason that inventor product development experience makes a spin-off company a more appropriate vehicle to commercialize a university invention is that this experience helps inventors to select the right technologies around which to base a start-up. The director of the TLO at University Q summarizes this point of view, saying,

“He would have the knowledge about whether this thing should be the stuff for a start-up company.”

In particular, product development experience is valuable to assessing whether the invention would be more appropriate within an existing company or would be better in a start-up. This judgment is, of course, crucial to the determination of whether or not a start-up is appropriate. The Director of the TLO at University N summarizes this perspective. He says that, in his experience, inventors who have had product development jobs often say things like,

“Wow, knowing what I know about the industry and the way that products are developed there, this would fit really well into an existing product development stream within these corporations or they might say it doesn’t fit at all. Given all the infrastructure investments that the industry has made so far, the only way that I can see it carrying forward is if we build something from the ground up.”

Similarly, the director of the TLO at University LL explains,

“Having product development experience is going to mean that the information that you give us about this particular invention is going to be better information with respect to the business model and the commercial potential. So in that sense we would be able to weight their opinion a little bit more because of their background.”

A third reason that inventor product development experience makes a spin-off company a more appropriate commercialization vehicle is that product development experience makes inventors recognize the importance of product development as an important step between invention and manufacture of products. Because product development tends to involve more specific practical business information than is the case for research, those inventors with product development experience tend to have more of the knowledge necessary to help move technology from inventions to products on the market (Shane, 2004). As the director of the TLO at University QQ explained,

“Professors without relevant business experience don’t know how long and arduous it is to commercialize anything, even something that is deemed by the lab to be commercially ready.”

Similarly, the director of the TLO at University CCC explained,

“That’s critical because a lot of our a lot of people a lot of the faculty think because they have good research, the product is just going take care of itself. The development aspect of D is very big and it’s based on a early stage technology. If they’ve worked on a in their lab with companies that have development experience that could be that could be a plus.”

Furthermore, the director of the TLO at University PP explained,

“It enables them to focus more on productization in the market for their science as opposed to the value of the actual science itself. They think that the science is wonderful and it usually is, but it may not be that interesting in the market place.”

To have fruitful discussions with business people about the technology, inventors need to see the potential products that would emerge from it. University inventors with product development experience are better than other inventors at visualizing product applications from their inventions. As the director of the TLO at University ZZ explains,

“They have to be able to visualize the product and buy into the value to society of that particular product. The prototyping is important the ability to see it going beyond just research.”

A fourth reason that inventor product development experience makes a spin-off company a more appropriate commercialization vehicle is that product development experience gives inventors an expectation of what it will take to motivate investors. As the director of the TLO at University KK explains,

“Product development experience gives the expectation factor of what it takes to get from a very embryonic technology to something that would spark an inventor to reach into his purse or wallet and put money up.”

Similarly, the director of the TLO at University BBB explained,

“If we’ve got a faculty member that has the skill sets that we think will allow them to be more effective in assisting the company with some of its day to day operations that that becomes a better match. In a start-up situation we’ve got sell to investors. They’re going to have a better feel and have the ability to do their own thinking about our technology. So they’re less reliant upon us to tell them what it can do. If we’ve got an articulate suave inventor then we know that they’re going to be somebody that that can help us clear the initial hurdle. And that is find somebody that may be interested in funding this so we’ve got we’ve got to sell this we’ve got to be able to sell the concept to somebody.”

Small Company Experience is Particularly Important

Many of the TLO directors believe that the product development experience is more valuable to inventors if it took place in small or start-up companies. Several of them even expressed the opinion that inventor product development experience would only influence their view of the appropriateness of a spin-off positively if the product development experience took place in small or start-up companies. The director of the TLO at University D summarized this view, saying,

“It would be a plus if they’ve been in the kinds of environments where they you would experience what you need to make a start-up go. Someone who worked for General Motors even in product development wouldn’t necessarily have the tools that would make them the ideal entrepreneur.”

The main issue with product development experience in large companies is that does not provide the inventors with the kind of hands-on experience that is necessary to help the inventor assess the appropriateness of a spin-off as the vehicle to move a technology

forward. This view was summarized by the director of the TLO at University K, who explained,

“If they’ve had experience in product development but they worked at Pfizer and they had four secretaries and 20 people at their beck and call. They’re going to get into an empty laboratory with nobody their and they won’t know how to do anything. You’ve really got to preserve your capital at the beginning and you’re not going to want to have someone who can only marshal the troops.”

7. Inventor Prior Social Ties with Investors in Start-ups Increases the Appropriateness of a Spin-off

Most of the TLO directors indicated that inventors’ social ties with investors make spin-off companies more appropriate vehicles to commercialize university inventions. Because investors rarely invest in start-up companies that do not come to them through referrals, these social ties provide an important mechanism to encourage the financing of spin-offs. The Director of the TLO at University CC summarized this view, explaining,

“If the inventor has close ties with a venture group, then yeah, it leans me to a start-up.”

Why Inventor Prior Social Ties with Investors in Start-ups Increases the Appropriateness of a Spin-off

The primary reason why TLO directors see spin-offs as more appropriate vehicles to commercialize university inventions if investors have social ties to investors is that these ties increase the probability that the spin-off will obtain external funding. As the director of the TLO at University HH explained,

“We’ve had some faculty that have had very close ties with venture capitalists and angel networks and basically got the funding to back up those ties. So that’s definitely going to be a plus in any final decision to start-up the company.”

Similarly, the director of the TLO at University BBB explained,

“We’re looking for anything that makes an opportunity more fundable. Early stage investing is a contact sport and it’s an investment made in relationships every bit as much if not more as it is an investment made in a particular technology. So if we know that our investigator is well respected in the business community then we know that we’ve got a more fundable opportunity.”

One mechanism through which the process of existing inventor social ties with investors works to make spin-offs more appropriate vehicles to commercialize university inventions is to reduce the potential for opportunism on the part of entrepreneurs. New firms have limited history making it difficult to judge their potential based on their past performance. When those new firms also exploit uncertain new technology, for which inventors have significant information advantages over others, social ties facilitate the ability to finance new businesses. Social ties to investors create incentives to preserve the relationship with investors for future interactions, provide a way to sanction bad actors, and provide information about hard to observe attributes (Shane, 2004). Therefore, inventor social ties to potential investors should make spin-offs more appropriate.

Another mechanism through which the process of existing inventor social ties with investors works to make spin-offs more appropriate vehicles to commercialize university inventions is to provide credibility to entrepreneurs to get them access to investors. Those inventors with relationships with potential investors are viewed by the investors as more credible than other inventors. The director of the TLO at University Z summarized this argument, saying,

“It helps just from the standpoint of visibility. That’s credibility and a foot in the door with the venture firm. It gives comfort to the venture firm saying that this is a real person and we trust them and their technology.”

A third mechanism through which the process of existing inventor social ties with investors work to make spin-offs more appropriate vehicles to commercialize university inventions is to increase the pool of potential investors. Because financing an early stage technology business is a contact sport, a spin-off is more likely to be financed if more people are selling the venture to investors as a financing opportunity. This position was summarize by the director of the TLO at University V who explained,

“The more horses you have pulling the wagon the better off you are. So if you’ve got an entrepreneurial inventor who’s out rattling in the community selling their own technology and talking to investors, that’s good. A lot are lab rats and couldn’t face that type of lifestyle. But if you find one of those, you work with them.”

Similarly, the director of the TLO at University XX explained,

“Whenever you’re doing business development, networking is key. If they have some contacts that could be useful that’s just another hurdle you’re going to have to cross. And if they’ve already have some of those contacts that you don’t have then that would tend to increase the probability that you’re going to do a start-up.”

A second reason why inventors pre-existing social ties to investors increases the appropriateness of university spin-offs as vehicles to commercialize university inventions is that those inventors provide the inventors with valuable advice. As a result, inventors with these social ties receive more information about how to successfully exploit their inventions through the creation of spin-offs. The director of the TLO at University L summarized this perspective, saying,

“It’s definitely going to be more positive if they have ties with these folks because they’re going to get advice in starting a company.”

A third, related, reason why inventor social ties to investors increase the appropriateness of spin-offs as vehicles to commercialize university inventions is that those ties provide the TLO with a good reference point to verify the inventors’ beliefs about the value of the business opportunities that they see in their inventions. The director of the TLO at University N summarized this position saying,

“It might mean that we’ve got some readily identifiable external parties that we can talk to about our assessment and get their thoughts on whether they see an investment or not.”

Similarly, the director of the TLO at University TT explained,

“If a discussion has occurred already and there is an interest level that might persuade us to move faster with some things if the interest level can be corroborated. If I can call up a VC and find out that they are indeed interested and they’ve proceeded fairly far along the due diligence path, then that might provide additional incentive to proceed and get involved through the VCs and help the company to raise funds.”

8. Inventor Prestige Increases the Appropriateness of a Spin-off

Most of TLO directors indicated that inventor prestige has a positive effect on the appropriateness of university spin-offs as vehicles to commercialize university inventions. The director of the TLO at University C summarized this point of view, explaining,

“The stature of the inventor matters. It’s the pedigree of the person. Is he from the National Academy of Sciences? That’s going to add a lot of weight.”

Similarly, the director of the TLO at University I explained,

“It certainly helps if at least one member of the inventing team is very well known in their field. Nobel prizes don’t hurt.”

At some institutions, the prestige of the investigator is paramount in affecting the TLO assessment of whether a start-up is an appropriate vehicle to commercialize a university invention. For example, the director of the TLO at University II explained,

“Our ideal inventor is someone who is very well known and well regarded in their field.”

Similarly, the director of the TLO at University P explained,

“Inventor profile is the most important opportunity assessment criterion. There are investigators that we work with that are well know, well established, and have track records in terms of scientific literature. You could take an investigator that’s never had a commercial success but one that’s a Macarthur winner or a Nobel Prize winner or very respected in their field and that could be the basis for a start-up.”

Why Inventor Prestige Increases the Appropriateness of a Spin-off

The TLO directors offered two different explanations for why inventor prestige increases the appropriateness of spin-offs as vehicle to commercialize university inventions. The first explanation is that inventor prestige adds credibility to claims about the value of the technology. Because university inventions are early stage and highly uncertain, no one knows if the claims made about the technologies will come true. Given the technical and market uncertainty of university inventions, investors and other external stakeholders tend to back more prestigious actors because those stakeholders see inventor status as a signal of the technical and market value of the invention (Shane and Khurana, 2003).

Inventors with high prestige provide a sense of credibility to the claims about the value of the technology that are hard to ascertain. Therefore, investors are more likely to meet with and subsequently fund inventors of greater prestige. The director of the TLO at University A summarized this explanation when he said,

“It’s also the credibility. If you have the right inventor you can have a start-up because it’s his invention and he’s written papers on the subject matter. You can lock in that marketplace with those papers and you can have instant credibility.”

The second explanation why inventor prestige increases the appropriateness of a spin-off as a vehicle to commercialize a university invention is that inventor prestige represents underlying ability. Star scientists have tacit knowledge that has commercial value (Zucker et al, 1998b). This explanation was best summarized by the director of the TLO at TLO at University K explained,

“The more esteemed they are in their career, the better. I’ve got Nobel Prize winners that VCs would throw money at for no particular business plan for no particular technology just to back the person. If they’re really well known in their field, it helps a lot.”

Characteristics of the Invention

Three characteristics of a university invention increase the appropriateness of a spin-off as a vehicle to commercialize the technology: (1) with the exception of biotechnology, being a platform technology, (2) being a disruptive technology, and (3) being a stand alone invention.

1. Having a Platform Technology Increases the Appropriateness of a Spin-off

Although some TLO directors explained that single application technologies can provide the basis of a spin-off if the market is large enough, or the path to market is very clear, the vast majority of TLO directors explained that the appropriateness of a spin-off as a vehicle to commercialize a university invention increases if the invention is a platform technology. The director of the TLO at University V summarized this point of view, explaining,

“One characteristic that singles out start-ups to me is having a large platform technology.”

Similarly, the director of the TLO at University FF explained,

“We always think of start-up companies as requiring a platform technology – something that can be the basis of a variety of products or services. I would say that’s probably the major difference.”

In contrast, the TLO directors believe that inventions that are likely to lead to single products should be licensed to established companies, especially if the envisioned product from the invention is likely to lead to a product that fits the portfolio of a particular company.² As the director of the TLO at University P explained,

² In addition, a single product invention might generate reasonable returns on the financial investment of an existing company, even though it doesn’t justify the creation of

“Disclosures which represent technologies that can be visualized as a product that fits within an existing manufacturing, marketing and distribution channel should be considered licenses and not start-ups. Disclosures that represent technologies upon which multiple products can emerge are most appropriate to be considered start-ups.”

Why Platform Technologies Increase the Appropriateness of Spin-off Companies

The TLO directors offered a variety of reasons why platform technologies increase the appropriateness of a spin-off company as the vehicle to commercialize a university invention. First, platform technologies offer new companies the ability to change direction if the initial market applications identified for the technology turn out not to work (Tornatzky et al, 1995). These options are important given the uncertainty of the future development of the invention and the lack of existing products or services for new companies to fall back on (Shane, 2004). As the director of the TLO at University SS explained,

“You don’t want to put all your eggs in one basket. The likelihood that somebody who comes after you will have a competing product is a lot higher and the risk of competition is much higher if you have a single product. If you have a platform, you can have multiple products. So if one doesn’t work out, you still have a couple of other options.”

Similarly, the director of the TLO at University XX explained,

“You take a lot of risk in trying in forming a start-up company and so you want to have something that has pretty broad market potential as well as a strong product concept. Usually what you start with is not what you end up going to market with. You need some options just to explore a given market or see how that technology is going to apply to a market. It may not fit properly and you need to have other options.”

Furthermore, the director of the TLO at University TT explained,

“I like to see platform technologies. If a certain individual vertical or market isn’t sufficient, or is overcrowded, or the technology isn’t a solid match because of the price performance curve, the company is going to need to bounce like a pinball machine and go into a different area. If you have a platform technology that can be used in lots of different areas that will give the capability to go into other different areas if necessary.”

a new company. As the TLO director at University AAA explained, *“If I’m a small company and I have a franchise in veterinary drugs and XYZ University has a veterinary drug, that’s going to yield me 20 million in revenue. I have a sales force out there. If I put another product into my portfolio, I can spread that SG & A over more products. I’m going to end up with higher margins this eventually would be a pretty attractive 20 million dollar deal. So ultimately the advantage to me as a company to do a small deal may be very significant. I’ve added a new drug. I’ve increased my margins. I’ve made some money the contribution margin on that may be huge.”*

Finally, the director of the TLO at University L summarized the value of having market options, saying,

“It gives you a lot of different ways to go. Time and time again, it seems that success stories are companies using platform technologies. They start out going in one direction and after some R&D they determine that they have to retool and go in another direction.”

The TLO directors also explained that investors are well aware of the value of options that platform technologies provide to new companies. They are more likely to finance spin-offs that have platform technologies because those technologies give the companies options that enhance their survival and performance. As the director of the TLO at University NN explains,

“The platform presents a really good business case for a start-up because there are so many different ways in which the technology can be developed. It just becomes more attractive to investors.”

Similarly, the director of the TLO at University N explained this process, saying,

“It really comes down to ROI if you’re looking for a company that will receive venture capital or even significant angel investment. Obviously, if it’s a one trick pony that’s not as interesting as if it had a couple of different directions to go.”

Second, platform technologies increase the appropriateness of spin-offs as vehicles to commercialize university inventions because they make it easier for those companies to identify the follow-on products that the companies need to survive. Therefore, these technologies make it easier for a new company to develop a family of products, which makes spinning off a company to exploit the invention more appropriate (Shane 2004). The director of the TLO at University CC summarized this view, explaining,

“If it’s a one product technology, then they’ve got to struggle to figure out the next product. A company can’t just be one product.”

Similarly, the director of the TLO at University ZZ explains,

“They’re not a single technology, they’re a platform technology. If you have a technology that can lead into other products, you can have multiple products as opposed to one shot. You see very few companies that just sell one product.”

Furthermore, the director of the TLO at University AAA explained,

“Platforms allow you to not only capture a potential a larger markets but also build on those platforms to consistently generate generation two, generation three of whatever product you’re selling.”

The TLO directors also explained that investors are well aware of the value of follow on products to the survival of new companies. They are more likely to finance spin-offs that have platform technologies because those technologies facilitate the formation of multi-product companies. As the director of the TLO at University BBB explained,

Investors don’t want a one trick pony. They want to know that the technology is broad enough that you might have a therapeutic as well as a diagnostic

opportunity or that you may have numerous small molecules that you can develop. And you can have second and third generation compounds that can improve upon the side affect concerns of the first generation and or those various small molecules can potentially be used for different disease processes.”

Similarly, the director of the TLO at University II explained the preference of venture investors said, “

“Investors want to see huge potential down the road. You have more chance of having significant growth in the company – a significant upside on capitalization and equity building – if you have multiple applications under the same technology.”

The multiple products that platform technologies make it possible for spin-offs to create can often have different timelines, which may enable them to better manage cash flows. This ability to manage cash flows helps to enhance the performance of spin-off companies, and so increases their appropriateness. In particular, platform technologies allow spin-off companies to create short and long term sources of cash flow and amortize their costs over a larger revenue pool (Shane 2004). As the TLO director at University SS explained,

“For a start-up we really want a platform. I want multiple products to be developed on different timelines so you work on one and you can take that to market. As that gets down the road a little bit, you start on the second. If you have more funding you can do more in parallel than if the funding comes in slower. Then you take a more serial approach.

Third, platform technologies increase the appropriateness of spin-offs as vehicles to commercialize university inventions because they offer lots of options to the licensee to find other sources of revenue than directly commercializing the technology itself. This is important to spin-off companies, which often have no other source of revenue during the time that the technology is being commercialized. The director of the TLO at University DD explained how multiple sources of revenue from an invention benefits a start-up, and increases the appropriateness of a spin-off. He says,

“It’s always positive if it has a number of applications. Then you have the ability to think strategically about how you could launch a start-up. For example, you could take certain applications for the start-up and use other applications application areas to partner or sublicense our or something.”

Biopharmaceuticals Are the Exception

The TLO directors did indicate that when spin-offs are appropriate vehicles to commercialize non-platform technologies, those inventions tend to lie in biopharmaceuticals. As the director of the TLO at University N explained,

“I think that the platform nature is not as significant on the biotech and pharma side in start-up formation. You can look at track records for a number of companies.”

In biopharmaceuticals, some TLO directors believe that having a clear path to market is more important than having a platform technology in affecting the appropriateness of a spin-off as the vehicle to commercialize a university invention. The director of the TLO at University K explained this exception, saying,

“We used to talk 8 years ago about how it’s got to be a platform rather than a product. It sure doesn’t seem so anymore. Now I think it’s more important to have a vision of a clear path to market, a vision of where the components along the path that are needed are going to come from. Then if someone’s looking for something in that area, you’ll be able to catch their attention.”

The main reason for the exception to the platform rule in biotechnology is that biotechnology spin-offs are often development tools to advance a technology to the stage at which a later stage biotechnology company or pharmaceutical firm can pick it up through strategic alliance, license or acquisition. Given the very large size of the market for biopharmaceuticals, it can often be worthwhile to develop a biopharmaceutical invention that has only one market application. The director of the TLO at University U explained this process, saying,

“It depends on what the purpose of your start-up is. If the purpose of my start-up is to develop a new chemical entity and advance it to the point where I can convince a second or third line biotechnology company to pick it up and develop it further and then spin that off to one of the major pharmaceutical companies, then a one trick could be a useful worthwhile start-up.”

2. Having a Disruptive Technology Increases the Appropriateness of a Spin-off

Researchers believe that spin-off companies are more appropriate vehicles for commercializing disruptive technologies for because incremental technologies complement the products and business activities of existing companies that already have expertise in a particular market or technical field (Shane, 2004). Several studies support this argument: Vohora et al (2002) conducted four case studies of university spin-offs and found that all four technologies were disruptive technologies. Shane (2001a) examined the hazard of spin-off company founding for 1397 MIT-assigned patents between 1980 and 1996 and found that the radicality of the inventions – the degree to which they drew on new technical paradigms –increased the likelihood that spin-off companies would form to exploit the inventions.

The TLO directors interviewed in this study also explained that when university inventions are disruptive technologies, the appropriateness of spin-off companies as the vehicle to commercialize university inventions increases. The Director of the TLO at University QQ summarizes the perspective of the vast majority of the TLO directors when he said,

“If we see something that could truly engender a new field because it’s so groundbreaking that it could lead to a particular business niche, that invention might be ripe for development into a start-up company.”

In contrast, if the invention is just an incremental improvement on an existing product, then the invention is best licensed to an established company. As the Director of the TLO at University N stated,

“Incremental additions to an already mature technology, a non-exclusive approach [of licensing to established companies] would be a better way to go.”

Why Disruptive Technologies Increase the Appropriateness of Spin-off Companies

TLO directors offered several reasons why disruptive technologies make spin-off companies more appropriate vehicles to commercialize university inventions. One reason is that established companies reject disruptive technologies. Companies tend to create routines that reduce information overload by filtering information so that only relevant information reaches decision makers (Henderson, 1993). These filters mean that established companies tend to accept only inventions similar to the inventions that are already being used in their organizations and reject all other technologies (Shane, 2004). Moreover, disruptive technologies do not fit well into existing companies’ product lines and require extensive changes to their operations to be used.³ The director of the TLO at University C described this tendency of established companies to reject disruptive technologies. He explained,

“A lot of companies have a hard time trying to fit those disruptive technologies into their business plans. Big companies don’t see the opportunity. They are just too consumed with their own product lines.”

Decision makers in established firms also reject disruptive technologies because those decision makers are risk averse and disruptive technologies are risky. As the director of the TLO at University KK explained,

“The more radical it is, the less likely it is that the established firm – particularly those that are answering to share holders – are willing to take the chance. They are risk averse. So you move it forward by doing a start-up company to prove that it works.”

The decision makers in established firms reject disruptive technologies because the technology challenges the existing paradigm in a field. Thus, the new technology is seen as the “wrong” way of doing something. The managers in established companies often cannot see the value of the new technology to their operations. As a result, efforts to

³ When technologies fit well into an existing company’s product line, it makes sense for the TLO to license the invention to that existing company. As the Director of the TLO at University I explained, *“If it’s something that would fit into an existing company’s product line quite straightforwardly, and they’re likely to license it, I would prefer to license it to an existing company.”* Similarly, the director of the TLO at University Z explained, *“Absolutely, incremental technology in a known area makes a lot of sense to license to an existing company and not as a start-up. It just doesn’t work terribly well otherwise.”* Furthermore, the director of the TLO at University QQ explained, *“If something is an incremental improvement over the prior art it could reasonably be licensed into a company that is commercializing whatever it improves.”*

license disruptive technologies to established firms often fail.⁴ As the Director of the TLO at University DD explained,

“Generally speaking if it’s a paradigm shift as opposed to incremental that tends to be a disruptive technology which is harder to license. And therefore, you are compelled to create a start-up to keep the technology going.”

Similarly, the director of the TLO at University QQ explains,

“If it’s something that we’ve tried but can’t license to existing companies because existing companies have neither the vision nor the passion to really bring it to fruition. Sometimes, only the inventor can do that.”

Furthermore, the director of the TLO at University BBB explained,

“By definition one of the criteria for a start-up is that an existing company is not interested in licensing it. Existing companies won’t license if it’s a pioneering or a paradigm shifting technology.”

Established companies reject disruptive technologies because these technologies demand changes to the organizations’ routines and processes. As the director of the TLO at University NN explained, “

“It’s probably better as a start-up if it’s radical and it’s going to disrupt the way that business is done now. Businesses don’t license in technologies that are disruptive to their own processes. It’s possible that you could find a licensee that was interested in disrupting other people’s processes if they wanted to enter into a certain space. But if it’s really disruptive technology, it’s hard to get somebody in the business to license it in.”

Established companies reject disruptive technologies because those inventions require them to change their capital investments. In particular, they require the existing asset base to be scrapped and new capital investments to be made. As the director of the TLO at University LL explained,

⁴ The TLO directors also explained that they are often worried that established companies which do express interest in disruptive technologies have no intention of ever commercializing it. Rather, they want to license those inventions to shelve them. Given this potential, licensing officers often see spin-offs as a more appropriate commercialization vehicle. The director of the TLO at University Y described a case at his institution that illustrates this point. He said, *“Another case where we did a start-up was one where we had a new method of looking at binding between proteins that’s different from any approach that’s currently out on the market. It’s hard to get existing companies to license if you have a competitive product or a displacement product. And while a few companies are willing to look at these technologies, as a university we are never sure whether they would really develop it or whether they would just shelve it. So if we can get a start-up off the ground whose existence depends on making that technology successful, we feel they have a better chance of getting it out.”*

“For start-ups, it might be something that requires a huge paradigm shift in capital investments for an industry and there just aren’t wheels in that industry to make that change among the established companies.”

Because established companies do not license disruptive technologies, spin-off company creation becomes the most appropriate option to commercialize those inventions.⁵ The director of the TLO at University AA described this situation, saying,

“We look at whether or not the technology is complementary to an existing company’s product line or is what one of our faculty members here calls disruptive. If it is so new and novel that it would not make sense to license it to an existing company, it is best commercialized through a start-up company. It would be too disruptive to the existing company to introduce it into its current product line. It would be too costly, too time consuming, etc...So how easy would it be for an existing company to assimilate our technology into their existing product and manufacturing capabilities. Would it cause this company to retool a plant or something like that?”

A second reason why disruptive technologies make spin-off companies more appropriate vehicles to commercialize university inventions is that established companies cannot compete as easily with start-ups when the start-ups have disruptive technologies.⁶ Therefore, the TLO directors see disruptive technologies as providing spin-offs with an important competitive advantage. As the director of the TLO at University I explained,

“You want a technology that’s sufficiently different from what’s out there in industry now that they are not putting themselves in direct competition with existing companies.”

Similarly, the director of the TLO at University SS explained,

⁵ The director of the TLO at University FF provides an example of how a disruptive technology at his university was commercialized by a start-up after efforts to license it to established companies failed. He said, *“We had a technology, called thermal acoustic cooling, that was truly innovative. It is a way of producing cooling without refrigerants or compressors or anything like that. It was very creative, very different and also very disruptive. We went to every company that we could think of in the refrigeration industry and every compressor company that should have been interested in this technology. They’d spend weeks and months studying it and studying it, and in the end, nobody did anything. They said they just couldn’t get their hands around it, it was so different. As we went down the path with multiple companies and always got the same answer, we said let’s come at it from a different point of view – to form a start-up based on this technology.”*

⁶ In addition, disruptive technologies reduce the likelihood that the licensee of the invention will experience problems with freedom to operate. As the director of the TLO at University JJ explained, *“Usually they’re not improvements on something else that’s out there so that the person who’s starting up does not have to worry about getting a lot of freedom to operate licenses from other parties that control the base technology.”*

“If it’s not a novel approach and there’s already a solution out there to a problem and your invention is only an incremental improvement to that, then you have competition right away.”

Furthermore, the director of the TLO at University U explained,

“You canvas the landscape to see if there is a natural fit for the technology at an existing business as opposed to doing a start-up. If you have an evolutionary invention instead of a revolutionary invention and you’re a start-up, you simply can’t get a toehold in the market.”

The limited competitive response of established companies to spin-offs that exploit disruptive technologies results from the tendency of disruptive technologies to make the investments of established firms obsolete. This argument is consistent with the technology management literature in general, which argues that existing firms are less likely than new firms to adopt disruptive new technologies because those technologies cannibalize their investments in existing assets (Utterback, 1994). Disruptive technologies might require changes in the materials used in products, or the means of creating those products, change the routines and procedures of those firms or develop new product lines. New firms, which do not have existing assets that can be cannibalized, are more likely to adopt disruptive technologies than established firms that have these assets (Shane 2004). The director of the TLO at University N explained this process. He said,

“If you’ve got a brand new way of building automobiles or making integrated circuits, it is really important point to consider the disruptiveness to existing infrastructure within already established companies. Obviously if you’ve got the potential to render obsolete really astronomical levels of capital investment, it’s not very likely that an existing company is going to walk away from that kind of infrastructure investment. If they’ve got products in the market that are clear cash cows and you’re going to supplant them with some new innovations that truly disrupt their markets, that is going to be an issue. You’re going to need to look at a start-up rather than license to an existing player.”

The investments that disruptive technologies cannibalize also take the form of human capital. Disruptive technologies draw on different production and marketing skills than firms have. Given the cost and effort to develop firm skills, established companies do not want to alter them and so cede disruptive technologies based on new skills to spin-off companies (Shane 2001a). The Director of the TLO at University S explained,

“If it was too radical, [established] companies might be reluctant to take it on because it requires doing things differently. They would have to do the R&D work differently with a different team of people. It changes the business. With a start-up that’s not such a concern.”

A third reason that disruptive technologies make spin-offs more appropriate vehicles to commercialize university inventions is that disruptive technologies require more agile and flexible companies to be engaged in the product development process. New, small

firms tend to be more agile entities than large, established companies. As the director of the TLO at University YY explained,

A radical improvement has a better chance of getting to the next step through a start-up. Start-ups are more agile and can be more flexible in the various ways that they need to go about proving a technology. The more radical it is, then the greater the element of undefined market space. We've got the greatest thing since sliced bread but we're not sure what that is in terms of its use.

A fourth reason that disruptive technologies make spin-off companies more appropriate vehicles to commercialize university inventions is that financing new companies with disruptive technologies is easier than financing new companies with incremental technologies. Because spin-offs lack cash flow from existing operations, they are dependent on external financing to function. Anything that facilitates their financing makes spin-off companies more appropriate. The director of the TLO at University BB explained that investors favor disruptive technologies, saying,

"Investors like to hear that it's radical or disruptive and it's going to capture the market. So, that's an influence as to whether it should be a start-up or not."

Similarly, the Director of the TLO at University X explained,

"If it's truly radical that will attract typical venture capital funding, which would make it more attractive as a start-up."

Furthermore, the director of the TLO at University WW explained,

"If it's an incremental improvement it's going to be very difficult to convince investors. So it really most investors would want to say that the invention is either a disruptive technology or something very radical."

Investors are more likely to invest in spin-offs exploiting disruptive technologies than in spin-offs exploiting incremental technologies because the former offer enough of a potential return to justify the cost of making a financial investment in creating them, but the latter do not. The director of the TLO at University O explained this process, saying,

"They get attention. It's not just me. It's investors who are looking for the company to be able to raise money to get the product out in the market place. This can't just be a minor 20 to 30 percent improvement over existing products. It needs to be a totally disruptive product for people to take notice."

Similarly, the director of the TLO at University T explained,

"It's got to address a new unmet need or find a way to do something that's currently being done and improve its effectiveness by at least 100 percent. There's got to be significant enough commercial catch in these things. Otherwise they're really not worth the time and effort. If you've discovered some new uses for something that is currently existing, there may be some ability to do something, but it's probably nowhere near as great an opportunity as if you take it back to the company that has the original IP position on it. They can basically expand their product to another application."

Furthermore, the director of the TLO at University BBB explained,

“A venture capitalist isn’t very interested in a me-too product. Early stage investors are accustomed to taking a higher risk than perhaps a company might be looking to add to its product pipeline. It’s got a higher risk associated with it but it’s also got a higher up side. And venture capitalists are looking for a return on their investment. So they need something that’s going to increase its valuation more quickly than a pharmaceutical company because a pharmaceutical company is looking for sales to occur year after year after year. A venture capitalist wants out shortly after an IPO so pioneer pioneering technologies are better suited for that sort of return on investment structure.”

3. *Having a Stand Alone Invention Increases the Appropriateness of a Spin-off*

Most TLO directors indicate that stand alone inventions increase, and systemic inventions decrease, the appropriateness of spin-off as vehicles to commercialize university inventions. As the director of the TLO at University QQ explained,

“If it’s something like a component part that wouldn’t usually be the basis of a start-up.”

Similarly, the director of the TLO at University II explained,

“Start-ups make more sense here you can create the whole product instead of just part of the system. The example I give is a drug where you’ve got the technology and can put it in a bottle. All of the value of the technology is in that bottle. The flip side is a car – a system with 10,000 components – and the component you’ve got is a battery technology.”

Reasons Why Stand Alone Technologies Are More Appropriate For Spin-offs

The TLO directors offered several reasons why stand alone inventions increase the appropriateness of spin-off companies as vehicles to commercialize university inventions. First, the value of stand alone inventions to new companies does not depend on other technology assets of the firm. However, the value of systemic technologies to new companies depends in large part on what other parts of the technologies are held by the new company. If complementary parts of systemic technologies are held by established firms, new firms either have to partner with established firms to use the technology, which results in bargaining problems, or invest in duplicative assets to replicate this technology, which is costly (Shane, 2004). As a result, discrete technologies are more valuable to spin-offs than systemic technologies, making spin-offs more appropriate vehicles to commercialize discrete technologies than systemic ones.⁷ The director of the

⁷ In contrast, an invention that is part of a systemic technology will often benefit the performance of that system. Therefore, the component is likely to be valuable to an existing company and is best licensed to the firm that controls the rest of the system. As the director of the TLO at University SS explained, *“If it’s part of a system, you can license it to the companies that are developing the system because you’ve got a component that’s going to make their system better and more competitive. If you can license it to them, that’s what you would want to do. Manufacturing and distributing the component is not what I would call the ideal start-up.”*

TLO at University DD explained the problem of creating a spin-off company from a university invention when the technology is systemic. He said,

“Start-ups are based on technologies that are more stand-alone. Many university inventions are a piece of a very big technology puzzle. It’s a new toggle switch and you need all kinds of things to go with that. That’s not for a start-up, but for going out to an existing company that can pick it up. What I’m talking about is the complexity of the product. If it’s highly complicated and you’ve got to bring a whole lot of things together, that argues against a start-up. It’s more straightforward if it’s here’s the invention and all you’ve got to do is a prototype. That argues for a start-up. Biological is easier than physical sciences. In biological you see start-ups based on a technology that is more readily stand alone, whereas engineering usually requires a variety of components that adds to the complexity problem. We have a better optical wave guide but to do anything with that you’ve got to package a bunch of other technologies and you’ve got to go out and bring together and interact with a bunch of companies that are difficult to work with.”

A second reason why stand-alone technologies increase the appropriateness of spin-off companies as vehicles to commercialize university inventions is that the capital costs for creating spin-offs based on systemic technologies are often too high to justify their formation. The rate of return on the investment in the creation of the company becomes too low given the risk incurred by the investors. The director of the TLO at University U explained why capital costs are too high for creating spin-offs from systemic technologies. He said,

“Take a way to do something in metallurgy that gives a much better composition of material for titanium. It’s pretty difficult to sit down and decide to be a company to build engine turbines for jet aircraft because it takes so much capital. You end up licensing out to a GE aircraft engine instead of trying to do a start-up.”

Similarly, the director of the TLO at University J explained,

“I’m not going to build a nuclear power plant in northeast Ohio in order to license some valve technology for the nuclear industry. It just doesn’t make sense.”

A third reason why stand-alone inventions increase the appropriateness of spin-off companies as vehicles to commercialize university inventions lies in the cost and difficulty of obtaining the intellectual property to create a business around a systemic technology. In general, it is difficult for a new company to obtain the patent rights to the rest of a systemic technology. As the director of the TLO at University VV explained,

“A stand alone would be better than part of a system. If you’ve got engineer a whole system it’s usually more complex. There are usually other patent rights that have to be obtained and things like that make it more difficult for a start-up.”

To create a spin-off with a systemic technologies, the companies controlling the complementary technologies would have to cross license with the spin-off, and convincing these companies to cross-license is often very difficult to engineer. The

companies controlling the complementary technology have little incentive to license their multiple patents in return for access to the spin-offs few patents. Moreover, even if they will make such asymmetric trades, the cross licensing arrangement leaves the spin-off without an intellectual property-based competitive advantage. As the director of the TLO at University C explained,

“In certain industries like consumer electronic everybody trading patents to everyone else. Unless you have something critical, it is very difficult because you would have to cross license.”

Similarly, the director of the TLO at University OO explained,

“If you’re going to have to combine the invention with other technologies that are out there, you may be better off going with an established company that already has some of those pieces. That might be the only way you can get it licensed.”

Finally, cross-licensing raises the cost of forming a spin-off, not to mention the problems of managing equity investments if the cross-licensor wants to take equity in return for his or her technology.⁸ The director of the TLO at University G explained,

“It’s easier if you have a technology that’s stand alone so the start-up doesn’t have to end license lots of other technologies to make it work. The start-up doesn’t have its own IP portfolio right now. It’s going to cost them and cause them problems to in-license other people’s technology to make this work. The person who is providing the technology will want a piece of the company as a reward for that in-license. And that can cause them problems with investors if everybody wants a piece of their company. They’re going to lose control of it.”

Characteristics of the Intellectual Property Protection That Can be Obtained

Five characteristics of the intellectual property position that can be obtained on a university invention increase the appropriateness of a spin-off as a vehicle to commercialize it: (1) with the exception of inventions for which further development within the university is not appropriate, patentability; (2) the ability to obtain a composition of matter patent; (3) with the exception of technical fields in which patents are not effective, the scope of patent claims; (4) Un-crowded intellectual property space around the invention; and (5) clear title to intellectual property held by the university.

1. Patentability of the Invention Makes a Spin-off More Appropriate

Most of the TLO directors explained that spin-off companies are more appropriate vehicles for commercializing university inventions if patents can be obtained to protect the inventions. The director of the TLO at University DD explained this view, saying,

⁸ Professional investors in technology start-ups recognize this problem. Therefore, it is also easier to raise capital for spin-offs based on stand alone technologies than spin-offs based on systemic technologies. As the director of the TLO at University WW explained, *“For the start-up invention it really needs to be a stand alone. The first responsibility of a start-up is to be able to raise money. If you cannot even practice your invention without having to take a license form somebody else. It’s going to be a bit difficult to raise money.”*

“Our ability to manage the start-up process is diminished significantly if there is no patent or copyright. We’ve been involved in a start-up where we’ve ended up using a trademark as the intellectual property vehicle, but those are rare.”

Reasons Why Patentable Inventions are More Appropriate for Spin-offs

The TLO directors offered several reasons why patentable inventions are more appropriate for spin-offs than non-patentable inventions. The first reason is that it is more difficult to license trade secrets to spin-off companies than to established companies.⁹ It is very difficult to finance a new company based on trade secrets because potential investors want to see hard assets. The director of the TLO at University B summarized this argument, saying,

“If you’re looking for outside investors, they are going to get a long more comfort from a legal document like a patent which is a hard asset as opposed to a trade secret which goes home every night and can be hired by someone else.”

Moreover, it is more difficult to value start-ups based on trade secrets than based on patents because the value of trade secrets lie more in the implementation of a technology than is the case with patented inventions. As the Director of the TLO at University Y explained,

“It’s not a necessary condition to get a patent or software copyright to do a start-up. We are actually in the middle of trying to do a more service based startup. But those are not going to be as easily spun out as some of the more protected technologies are going to be. The exit strategy for technology that doesn’t have protection is harder to define because it’s in the execution of the implementation that there’s going to be value.”

As a result, the valuation of spin-offs based on trade secrets is often too low to justify the creation of new companies to exploit those inventions. As the director of the TLO at University ZZ explains,

“If it’s not patentable - if the protection is more through copyrights or through secrecy - then we don’t go the start-up route. The desired valuation of the start-up would be difficult to get.”

The second reason why the patentability of an invention increases the appropriateness of a spin-off as a vehicle to commercialize it is that patents provide excludability and excludability is important to a new firm’s competitive advantage.¹⁰ Because other competitive advantages are not generally present at the founding of companies, patents

⁹ This is a relative concept. The TLO directors believe that it is extremely difficult for universities to license trade secrets to any entity because universities are terrible at keeping secrets.

¹⁰ The usefulness of patents as a barrier to imitation also influences the ability to finance a spin-off. Investors in high technology companies tend to finance spin-offs with patent protection because patents provide a documented competitive advantage (Bhide, 2000). As the director of the TLO at University MM explains, *“Without a patent there is no exclusivity that a start-up can get. Therefore investors are not likely to invest.”*

provide one of the few barriers to imitation present while companies build their value chain and figure out ways of meeting customer needs. As the director of the TLO at University LL explained,

“Having some kind of competitive advantage is important and quite often you get that by having some excludability over your intellectual property. Generally speaking it is going to be hard to get a competitive advantage without some kind of ability to exclude others.”

Similarly, the director of the TLO at University U explained,

“If you don’t have a proprietary position from a start-up, then you have a problem because you have no way to stop other people from copying. A start-up will need to rely on a fundamentally valid and sound patent position in order to protect that market niche because they are not big enough to defend it through market size and sales and advertising and all the things you do when you get to be a Fortune 500 company.”

Exception for Inventions in Which Further Development Inside the University Is Not Appropriate

One exception to above argument – that patentability of an invention makes a spin-off a more appropriate vehicle to commercialize a university invention – occurs when further technical development would primarily generate trade secrets that might be valuable to a new firm. Inventions of this type are most appropriate to exploit through spin-off companies even if the initial invention itself is not patentable. The director of the TLO at University II explained why. He said,

“Inventions for which further development inside the university isn’t appropriate because you really want to create a body of intellectual property protection that is based on trade secrets. So a start-up takes our technology and develops it over the next few years and generates trade secrets. A small start-up offers a very valuable incentive that focuses on one technology where they can add a lot of value.”

2. *The Ability to Obtain Composition of Matter Patents Increases the Appropriateness of Spin-offs*

Most of the TLO directors explained that the type of patent that can be obtained on an invention influences the appropriateness of a spin-off as the commercialization vehicle. In most technical fields, spin-offs are more appropriate if utility or composition of matter patents can be obtained than if only process, design or method patents can be obtained.¹¹ As the director of the TLO at University II explained,

¹¹ This is not to say that spin-offs require composition of matter patents. Rather, the threshold for the market opportunity is lower than when composition of matter patents can be obtained than when other types of patents can be obtained because the competitive risk of spin-offs based on composition of matter patents is lower than those based on other types of patents. As Director of the TLO at University N explained, *“At the moment we are forming a start-up with a very strongly established venture capital group where we do not have composition of matter rights. We only have method rights. But the*

“To the extent that you can get composition of matter patents it is better [for start-ups]. Something tangible is better than a method patent, and a design patent is pretty much worthless.”

Why Composition of Matter Patents Make Spin-offs More Appropriate

The TLO directors offered several reasons why composition-of-matter patents make spin-off companies more appropriate vehicles to commercialize university inventions. One reason why is that composition of matter patents are stronger and better at deterring imitation.¹² Therefore, they provide better source of competitive advantage, particularly in the early days of a company’s life, when it is particularly vulnerable to imitation. As the director of the TLO at University SS explained,

“We certainly look for a strong intellectual property position. We get inventions lots of times on method patents and those are typically not as strong as a composition of matter patent. The strength of the intellectual property portfolio is important. For start-ups, you typically need some sort of intellectual property protection.”

A second reason why composition-of-matter patents make spin-offs more appropriate is that these types of patents are easier to enforce. Because spin-off companies are highly dependent on the barriers to imitation created by their patents, the formation of spin-offs is influenced by patent effectiveness.¹³ As the Director of the TLO at University C explained,

“We have a bias against process patents because they’re so difficult to police. Unless there is no other obvious way of making something, process patents are weak... Composition of matter patents are the strongest. Method patents are less important.”

opportunity is so compelling and it is meeting such a long sought need in this particular area of therapy. Certain formulation or use claims, but where you might have an opportunity to move quickly to market, might be able to generate the necessary return on investment to bring your investors forward.”

¹² Professional investors tend to be savvy about the value of different types of patents. Because composition of matter patents are stronger and reduce competitive risk, it is easier for spin-offs to raise capital with composition of matter patents than with other types of patents. As the Director of the TLO at University O explained, *“A composition of matter patent gives all the investors a warm and fuzzy feeling. If it’s a process patent then it’s going to be very difficult.”*

¹³ The effect of composition of matter patents on the appropriateness of spin-offs is also higher the more effect patents are as a barrier to imitation in an industry. As the Director of the TLO at University L explained, *“Depending on the industry it’s going to matter more or less. In the pharmaceutical industry, they would much rather prefer a composition of matter patent than a method of use patent.”*

3. The Scope of Patent Claims Increases the Appropriateness of Spin-Offs

Although most of the TLO directors believe that broad scope patents are valuable to all licensees, they also said that the scope of claims increase the appropriateness of spin-off companies as vehicles to commercialize university inventions. The director of the TLO at University AA explained,

“You’re not going to license technology to a start-up company that has very narrow protection. It’s just not going to happen. So the broader the patent protection the more likely it’s going down the start-up route.”

Similarly, the director of the TLO at University TT explained,

“If we can only get a very narrow slice of protection in terms of patenting, it doesn’t serve as a very good foundation for the start-up of a company because almost every company that’s spun out of a university needs that strong foundation.”

Furthermore, the director of the TLO at University J explained,

“It is a lot harder to launch a start-up and have it succeed unless you have strong intellectual property in a patent. You need scope - broad and defensible patent claims.”

Why the Scope of Patent Claims Increase the Appropriateness of Spin-offs

TLO directors offered several reasons why the scope of patent claims increases the appropriateness of a spin-off company as the vehicle to commercialize a university invention. The most important reason offered by the TLO directors was the breadth of patent claims increases the number of competing products and services that can be blocked by the invention (Merges and Nelson, 1990).¹⁴ As a result, breadth of patent claims increases the strength of the patent as a competitive advantage. As the director of the TLO at University Z explained,

“I look at the breadth of the main claims that I expect to get from this technology. What’s the main claim and what’s the business that it protects. What am I really defending here in terms of the main claims? That’s what’s going to drive the decision.”

Similarly, the director of the TLO at University LL explains,

“The broader the scope of the claims, the more folks you exclude and the more likely you are to get a competitive advantage or to get other companies coming to you to get the technology.”

Furthermore, the director of the TLO at University MM explains,

¹⁴ A patent is a legal right to exclude others from imitation. Its value depends, in large part, on how much does it exclude, the director of the TLO at University AAA explained, *“The other thing we look is the scope of the claims. I’m looking at the scope of the claims because that is the strength of the asset. That is the market you’re protecting. A patent is a legal ability to keep people out of a particular market. What does our legal right prohibit others from doing?”*

“It’s the breadth of claims. What area do they cover? What are the bounds of the claims? Is the claim sufficient enough to stake out a broad enough area in the marketplace?”

In particular, the TLO directors explained that broad scope claims are important in providing a barrier that keeps established companies from imitating the spin-offs’ technologies immediately and driving the new companies out of business before they can gain a foothold in the market. Because large, established firms have the expertise and resources to imitate the technologies developed by university spin-offs, spin-offs need something that precludes those firms from immediately replicating their inventions.¹⁵ As the director of the TLO at University I explained,

“One of the things you need in a startup is a strong intellectual property position. If you don’t have something that’s going to keep the other guys out, particularly the big guys, you’re going to get smashed. You need barriers to entry....How broad a claim can you get? You need to get what’s called a pioneering patent. It covers not just the fact that I can make better if I do it counterclockwise, but it doesn’t matter which way I do it. I’ve covered everything that’s made going in circles.”

Broad patent claims are particularly important to protect the spin-off in the period shortly after it has been founded, when it has no other competitive advantages. Patent protection is one of the few competitive advantages that a new firm can have at the time of formation (Shane, 2004). At the beginning of its life, a firm lacks competitive advantages in manufacturing, marketing or distribution (Teece, 1987). To build the value chain and serve customers, a new company needs some barrier to imitation. The presence of broad scope patents allows the spin-off to build the value chain before competitors can imitate its technology (Shane, 2004). The director of the TLO at University Y summarized the value of broad patent claims as buying the spin-off time to develop its technology when he said,

“If you have fairly key broad patents – the scope of the claims that you can get - you are going to be able to carve out enough of the market niche for a start-up to develop a leadership position in the area.”

Similarly, the director of the TLO at University WW explained,

“For all start-ups the only asset they have at the formation is their IP asset. So if the IP asset is weak or flimsy then it would be very difficult for them. You need to have a fairly strong patent position in whatever your technology is. If existing companies are sitting on a very broad patent portfolio and your technology happens to fall under that broad based umbrella, then there might be a good match. However, if you are creating a start-up company, and you’re essentially trying to defeat some existing company by making their current products obsolete,

¹⁵ With broad patent claims, the spin-off can defend itself against competition even in a crowded market place. As the Director of the TLO at University F explained, *“Even if you have a crowded space, if you have a broad patent, you’ve got the industry by the tail.”*

then it is absolutely essential for the start-up company to have a very strong patent position.”

Furthermore, the director of the TLO at University SS explained,

“If you’re licensing a patent to another company that company is likely to already have expertise, know how or other patents that are relevant. When you are dealing with a start-up company, the intellectual property and the principals of the company are all it really has. So the established company would have much more protection build around the patent that they are licensing versus the start-up.”

A second reason why the scope of patent claims increases the appropriateness of a spin-off as a vehicle to commercialize a university invention is that broad patent claims provide flexibility to the spin-off company. Narrow patent claims can be enough to protect a spin-off if the company is certain about \ product application. However, broad patent claims allow the company to change direction and still have protection against imitation of its core technology. This is important because the spin-off needs to develop a product or service for a wide portion of the market and the ability to shift between segments of the market (Shane, 2004) As the Director of the TLO at University BB explained,

“You want broad claims for a start-ups so if the market goes sour one way, you can shoot in another.”

Similarly, the Director of the TLO at University R explained,

“It all depends on the technology. If the platform is going to go in multiple directions, it needs to be fairly broad. If there is only one or two applications that look like they’re going to be important, then it can be narrow.”

A third reason why the scope of patent claims increases the appropriateness of a spin-off as a vehicle to commercialize a university invention is that it is difficult to obtain adequate value from broad scope patents when they are licensed to established companies¹⁶ Because large, established companies often have other sources of competitive advantage, they do not need breadth of claims to capture value from university inventions. Therefore, they will not pay more to obtain broad patents relative to what they will pay to obtain an average patent. To obtain the worth of these broader patents, universities need to license them to spin-off companies. As the director of the TLO at University JJ explains,

“If you’re able to get an established company to license something with broad claims and pay what we think the value is, then I’d go that way. But a lot of times these larger companies don’t want to pay the value. So we would be inclined to go with a start-up that could perhaps flesh out that value over time.”

¹⁶ Narrow patents may be beneficial to large, established companies, but those same patents would have limited value to spin-off companies. The director of the TLO at University GG explained, “A narrow patent may have a value to a large company but no value or very limited value to a start-up company.”

A third reason why the scope of patent claims increases the appropriateness of a spin-off as a vehicle to commercialize a university invention is that that broad patent claims facilitate raising money for new ventures. Because fund raising is an important component of new firm creation, anything that facilitates fund raising for university spin-offs increases their appropriateness. As the director of the TLO at University NN explained,

“The strength of the claims might influence whether or not VCs will commence funding.”

Similarly, the director of the TLO at University OO explained,

“I think that broader intellectual property protection you can get the better the possibility of a start-up. If your protection is extremely narrow, it’s going to be harder for that start-up to get funding. It’s not a great avenue for a start-up versus something that’s relatively broad.”

Furthermore, the director of the TLO at University Q described the investors’ preference for broad scope patents. He said,

“If I was on the outside – a venture capitalist or someone looking at doing a start-up company – I would want to know how broad the IP protection I’m getting, how broad the scope of the claims.”

Finally, the director of the TLO at University QQ explained,

“It is important to have IP protection because start-ups are marketing their IP and their expertise to investors. The stronger and the better the protection, the more investable they are. They simply can’t start-up without assuring their investors that anyone else could do the same.”

Interaction between Scope of Claims and Capital Costs

The TLO directors pointed out that the effect of the scope of patent claims on the appropriateness of a spin-off company as the vehicle to commercialize a university invention increases with the size of the capital requirement to develop the technology. For inventions which will require high levels of capital investment, broad scope patents are particularly important. The reason is that the importance of deterring imitation increases with the amount of required capital. If the required capital investment is low, the downside loss from imitation is smaller, reducing risk. The director of the TLO at University B explained this interaction, saying,

“The scope of the protection is a direct link to the capital that needs to be invested. If it’s a lot of money that has to be invested like a drug lead, you better have a strong patent portfolio. If it is less money, as in software, it doesn’t matter as much.....”

The high capital costs of drug development mean that the breadth of patent claims is particularly important in influencing the appropriateness of spin-offs in the biopharmaceutical area. As the director of the TLO at University N explained,

“In some sectors, for example pharmaceutical development, if you do not have strong patent rights then you are almost guarantee that you will not have any investors or developers put in what it takes in terms of resources to bring a pharmaceutical or a therapeutic to market. Because it’s going to take hundreds of millions or dollars and a lot of time to get there. In that case, patent rights are really crucial. In other situation the existence of the patent is nice to supplement but not essential. In other cases it’s largely irrelevant.”

Similarly, the director of the TLO at University P explained,

“It’s really a function of the investment. If you’re in the biomedical space and you’re going to be spending tens or hundreds of millions of dollars to go from concept to product, very clearly defined barriers to entry and freedom to operate are essential.”

Technical Fields in Which Patents are not a Major Mechanism for Appropriating the Returns to Innovation are the Exception

The effect of the scope of patent claims on the appropriateness of spin-off companies as vehicles to commercialize university inventions is greater in industries in which patents tend to be more effective at protecting intellectual property. In industries in which patents tend to be ineffective, the scope of claims does less to provide a competitive advantage for new companies than in industries in which patents are effective. The director of the TLO at University P summarized these industry differences, explaining,

“If you are dealing in software or hardware or telecom where patents are not the driving criteria to a future income stream, intellectual property matters less.”

Similarly, the director of the TLO at University N explained said,

“Is strong IP necessary? Well it depends. If the patents are broad but the industry is one where patents don’t matter at all or very significantly then it’s largely irrelevant to the success of the start-up. Let’s say you are in the software arena and you have a breakthrough algorithm that’s going to allow you to do some things with software that hadn’t been possible before that. And the company has got some opportunities to form quickly over a period of 6 to 18 months software products that use that algorithm. That’s all fine, but if in 36 months the industry is going to move to a situation where the next algorithm will basically supplant all previous algorithms, the patents rights that you’ve established are almost like a Maginot line. Everybody just rumbles past that great fixed installation that isn’t relevant in the market place.”

In particular, the scope of patent claims is not important in affecting the appropriateness of spin-off companies in the software industry. In that industry, patents tend not to be a significant barrier to imitation. Hence, the scope of particular patents tends not to be important to the licensing or spin-off process. The director of the TLO at University GG explained this phenomenon, saying,

“We consider the elements of the intellectual property protection that can be applied and what is necessary for the particular realm. Software IP doesn’t always take the form of patents. Sometimes just several million lines of code can

be a substantial barrier to entry. So is there another way [than patents] to create a barrier to entry through proprietary code. Or is the market moving so fast that what they're licensing from the university would move rapidly to obsolescence so their product would not have a long life span."

4. When the Intellectual Property Space around the Invention is not Crowded, Spin-Offs are more Appropriate

Most of the TLO directors indicated that spin-offs are more appropriate commercialization vehicles for university inventions when the intellectual property space around patents is not crowded.¹⁷ The director of the TLO at University S described this phenomenon, saying,

"A patent that looks like it is reasonable free of prior art and is not dominated by issued patents held by other companies is appropriate to a start-up."

Similarly, the Director of the TLO at University AA explained,

"The start-up usually has to get freedom to operate with other intellectual property out there."

Furthermore, the director of the TLO at University XX explained,

"A defensible niche is the sort of the thing you look at with a start-up. If it's crowded I would tend to shy away from doing a start-up."

Reasons Why Uncrowded Intellectual Property Space Makes Spin-offs More Appropriate

The TLO directors offered several reasons why uncrowded intellectual property space around a patent makes a spin-off a more appropriate commercialization vehicle. One reason is that crowded intellectual property space means a lack of freedom to operate; the holder of the patent is unable to practice the art stated in the patent without access to license to other patents. Without the ability to practice the patent's art, a spin-off cannot develop products or services to meet the needs of customers. As the director of the TLO at University YY explained,

"If it's a crowded space, they'll have a difficult time getting into the market. We would lean more toward an established company if it's a crowded space."

The problem here is that crowded intellectual property space increases the probability that the uncertain new product or service that would be developed to exploit the invention would infringe on the patents of other companies.¹⁸ The risk incurred in starting new

¹⁷ Many TLO directors viewed this space as providing freedom to operate. Freedom to operate means that there are no other patents that need to be licensed in order to practice the art.

¹⁸ In addition, the need to develop a product or service based on the patented invention that does not infringe on other patents will require a degree of complexity and sophistication that is difficult for a start-up company to achieve. As the director of the TLO at University VV explained, *"If you have a start-up you want some technology that's not going to be encumbered by a lot of other technology. You want a fair degree of freedom to operate. If it's crowded, it's going to take a lot more sophistication to be able to make a product and sell it."*

companies is high enough without adding to that the competitive risk that the company may develop a product or service that infringes on the product or service of another company. The need to bear that additional risk generally makes spin-offs inappropriate in crowded intellectual property space. The director of the TLO at University II explained this risk. He said,

“It’s very risky if you don’t have freedom to operate. Some companies spend a lot of money and three or four years later find out they can’t operate because of somebody else’s patent and they actually folded up. So yes, I mean not only do you need a broad patent portfolio you need to know that you have freedom to operate.”

Similarly, the director of the TLO at University CCC explained,

“If we had gotten a very minor patent in a very crowded field that would probably tell us that it’s not appropriate for a start-up. The IP position would be so narrow that would be a high risk start-up.”

To be confident that it can practice the art it licenses in crowded intellectual property space, a spin-off would have to obtain licenses from other companies. This, of course, increases the cost of starting a company because licensing fees would need to be paid. This increased cost reduces the appropriateness of a spin-off as the commercialization vehicle. As the Director of the TLO at University Q explained,

“Freedom to operate matters because of the cost of getting it. If we’re talking a half a percent or 1 percent to acquire a bunch of different licenses from somebody, you’re not going to be able to make the margins so that anyone is going to be happy with funding you.”

Moreover, it is often very difficult for spin-offs to even obtain access to related intellectual property because, in many cases, they lack an intellectual property portfolio that motivates others to cross-license with them. Furthermore, even when they have such a portfolio, cross-licensing reduces the spin-off’s ability to use the patented invention as a source of competitive advantage by making it available to other companies. Consequently, a spin-off is rarely appropriate as a mechanism to commercialize a university invention in crowded intellectual property space. As the director of the TLO at University PP explains,

“If there’s a lot of competing technology on the patent landscape and the company would likely have to go out and take a bunch of additional licenses, it doesn’t make sense. We may have an incredible breakthrough platform but to practice it, a start-up might have to go license several other technologies and that can be a problem.”

Unlike large, established companies that can operate in crowded space because they can employ their legal counsel to help them avoid infringement lawsuits, spin-offs cannot afford the time and expense of lawsuits, and need to ensure that they avoid patent infringement. As the Director of the TLO at University DD explained,

“You don’t want to have a start-up in which the intellectual property area is crowded. A start-up isn’t going to be able to defend their intellectual property. It

is fraught with all kinds of later infringement problems. So you are looking for something where there's a clear path. It's not a crowded area."

This means that spin-off companies are less appropriate when the intellectual property protection lies in a gray area and there is no clarity about freedom to operate. The director of the TLO at University HH explained this need for clarity in intellectual property protection. He said, “

"I'm thinking back to the discussions we've had about intellectual property in the start-ups. We really want to have clear ability to project ourselves in the marketplace. We don't want any gray areas in the intellectual property protection. In those areas where we did have some gray areas, we worked hard to craft out our space to protect what we were trying to do."

When intellectual property space is crowded, a more appropriate strategy than creating a spin-off is to license to the holder of the related intellectual property, or a large enough company that has the power to negotiate cross-license agreements to access the intellectual property needed to practice the patent's art. As the director of the TLO at University N explained,

"In an area that is very heavily dominated by an elaborate and expensive intellectual property portfolio for one company, you never really look at that too extensively for a start-up because we know that the freedom to operate in that field is effectively closed off. It tends to limit us to one potential licensee."

Similarly, the director of the TLO at University BBB explained,

"One thing investors insist upon is freedom to operate. A pharmaceutical company may be a little less concerned about that because they may know that there they're in a better position to enter into cross licensing arrangements similar to what the semiconductor industry and others have been doing for years. They're in a better position to do that because they've got a war chest full of hundreds and hundreds of patents and it's easier for them to wade through that kind of quagmire than it is an investor."

A second reason that uncrowded intellectual property space around the licensed patent makes a spin-off company a more appropriate commercialization vehicle is that it makes it easier for spin-off companies to compete once they have developed their new product or service. Because the area around the invention exploited by the spin-off is crowded, there are more companies capable of competing with similar products and services. Given the higher level of competition in crowded intellectual property space, the threshold of technological improvement needed to justify a spin-off is higher than if an area is less crowded. Consequently, fewer inventions are appropriate for spin-off companies in more crowded intellectual property space. As the director of the TLO at University SS explained,

"If you're getting into space where there's a lot of competing patents then it's likely there are other competing commercial products out there. It's hard to do a start-up if you're trying to get into a space that's crowded and very competitive. To do so, you'd better stand way above the others. It's easier for a larger

company to compete in that kind of space in which case you would license them your technology.”

A third reason that uncrowded intellectual property space around the licensed patent makes a spin-off company a more appropriate commercialization vehicle is that it is easier for a spin-off company to raise money from investors if it is operating in less crowded intellectual property space.¹⁹ As the director of the TLO at University M explained,

If there was narrow freedom to operate “it’d be tough to see a start-up. They’d have trouble raising money to even move it forward. You’d probably want a bigger player in that case.”

Similarly, the director of the TLO at University FF explains,

“If you’re going to form a company, we would certainly want to have rock solid patent protection for that intellectual property – something that the entrepreneurs could really hang their hat on when they go out and raise funding. In particular, this means a clearer space – more freedom to operate. Is this a crowded space? Are there lots of companies with lots of patents in a field? That could really complicate the landscape for a start-up company. But if you have something that’s truly new and different and your estimation and your patent attorney’s estimation that this is not a crowded area – there are few if any patents in that area – that would certainly be a stronger case.”

Furthermore, the director of the TLO at University QQ explains,

“It’s more frightening for people to invest in a space where it looks like the competition is so dense that an entry into the market could be precluded or be difficult than if the field is wide open, as was the case when the biotech industry was started in the 80s. It’s simply more reassuring that when you spend all your time and resources on a product based on that IP that you won’t have a lot of me to knock offs out there to content with.”

¹⁹ It is difficult to raise money for a university spin-off whose licensed patents lie in crowded intellectual property space because inventors understand many of the problems described above. To get investors interested in financing them, a spin-off with unclear patent landscape would need to establish a partnership or licensing agreement with the holders of the patents in the closely related area. That, of course, is very hard to do because the holders of the related patents may not want to cooperate with the spin-off. As the Director of the TLO at University W explained, *“Yeah, you need freedom to operate or at least acquirable freedom to operate. If you had only one patent that was going to cause you a problem and you thought you could license it or option it or get some agreement in place to get around that, it’s okay. I think you’d have a harder time attracting investors if you can’t tell them we see a freedom to operate or a patent toward freedom.... If you knew you were dominated by a family of patents elsewhere and you couldn’t get them, you might as well give up on a start-up unless you wanted to make your one phone to ask the holder of the patent portfolio if they want to be your partner.”*

Finally, the director of the TLO at University LL explained,

“If there are questions hanging over the intellectual property, the venture capitalists aren’t going to want to put their money into it.”

A fourth reason that uncrowded intellectual property space makes a spin-off company a more appropriate commercialization vehicle is that it enhances the company’s strategic flexibility.²⁰ Having freedom to operate allows the spin-off company to change direction if the market dictates a new strategy. Because established companies are generally more constrained than spin-offs in their strategies, this flexibility is less important for them than it is for new companies that must iterate until they find a product application in which to use their technology profitably. The director of the TLO at University BB explained the reason why freedom to operate is important in increasing flexibility. He says,

“For a start-up, you need freedom to operate. You need the space. You need the flexibility.”

5. When Universities Have Clear Title to Intellectual Property, Spin-offs Are More Appropriate

Most of the TLO directors explained that the clarity of the university’s title to intellectual property increases the appropriateness of spin-offs as vehicles to commercialize university inventions. As the director of the TLO at University CCC explained,

“As the disclosure that comes in, have the intellectual properties already been spoken for? Do others have an option to a license for example? Normally, at the first pass, we would not look at that as the start-up.”

Why Clear Title to Intellectual Property Makes Spin-offs More Appropriate

The TLO directors offered three reasons why clear title to intellectual property makes spin-offs more appropriate vehicles to commercialize university inventions. First, spin-off companies generally need exclusive licenses to reduce the potential competition that they will face in their early years when they have few sources of competitive advantage other than their intellectual property. Third parties with rights to the same technology make it difficult for spin-offs to obtain exclusive licenses to university inventions, reducing the appropriateness of company formation as a vehicle to commercialize those inventions. As the director of the TLO at University CCC explained,

“We have some centers where the research funders get non-exclusive royalty free rights to the IP. If a faculty member came and said well I want to set up a

²⁰ One TLO director also explained that uncrowded intellectual property space around the university patent makes a spin-off company more appropriate because it makes a spin-off company more attractive as an acquisition target after it develops its technology. Because spin-offs are often development vehicles for university technology, their expected attractiveness as acquisition targets influences the appropriateness of creating them as a way to commercialize a university invention. As the director of the TLO at University OO explained, *“A new intellectual property space or relatively uncharted space in IP protection is a better fit for a start-up because they’ll be more attractive to someone else down the line.”*

company, and 12 other companies had rights to the IP, we would caution the faculty member not to start up because you can't get this exclusively. If it works, these other guys will out spend you. If the technology is encumbered or we're giving away some rights to someone else other than government rights, I think that would be very leery of a start-up."

The second reason why clear title to university inventions makes spin-offs more appropriate vehicles to commercialize university inventions is that, if the title is clear, the spin-off will not have to get clearance from large, established companies to use the intellectual property. Large, established companies, along with the government, are the major entities that fund research at universities. Companies often want the rights of first refusal to use inventions that come out of research that they fund. Therefore, for a company to exploit an industry funded invention, it often has to negotiate with the research sponsor to obtain clear title to the invention. This need alone often makes the creation of a spin-off company less appropriate than licensing to the research sponsor. As the Director of the TLO at University G explained,

"Some of these technologies aren't good for start-ups because they already have third party rights attached to them; they're funded research by a sponsor."

In particular, getting clearance from large companies is a cumbersome activity that slows the process of creating a company and makes it difficult to obtain funding for the new company. As the Director of the TLO at University F explained,

"Having clarity of title that is clear is a huge issue because some technologies in universities don't have clear ownership. If we had a project sponsored by General Motors and General Motors had first crack at a license it is not going to be a start-up opportunity. There are so many hoops you would have to go through with GM if they don't want to commercialize it. The time you lose can also be critical. So to the extent that you have more encumbrances, it is going to be less attractive for a start-up."

The third reason why clear title to university inventions makes university spin-offs more appropriate vehicles to commercialize university inventions is that the time and expense of negotiating with a variety of inventors and institutions to obtain access to necessary intellectual property increases the cost of company formation considerably. Under such circumstances, licensing to one established company that has the power and resources to assemble intellectual property from a variety of institutions is often a more appropriate commercialization strategy. As the director of the TLO at University PP explained,

"In this day and age it is very common to have joint inventions with other institutions. It's not a disqualifier for a start-up, but it's not a plus. When you have to work with another institution it can be a concern. It can slow you down."

Characteristics of the Industry in Which the Invention Would Be Applied

Three characteristics of the industry in which the technology would be applied increase the appropriateness of a spin-off as a vehicle to commercialize a university invention: (1) with the exception for early stage development companies, a non-capital-intensive

industry; (2) with the exception for early stage development companies, a fragmented industry and (3) with the exception of biomedical technologies, a younger industry.

1. The Capital Intensity of the Industry in Which the Invention would be applied Reduces the Appropriateness of a Spin-off

Most of the TLO directors explain that the capital intensity of the industry in which the invention would be applied reduces the appropriateness of a spin-off as a vehicle to commercialize university inventions. As the Director of the TLO at University W explained,

“I don’t think it makes it inappropriate to do a start-up in a capital intensive area, but it makes it harder unless there is something that draws capital to you.”

Why Industry Capital Intensity Decreases the Appropriateness of Spin-Offs

The TLO directors offered several reasons why capital intensity of the industry in which the invention would be applied decreases the appropriateness of a spin-off as a commercialization vehicle. One reason is that capital intensity of the industry means that the relevant stakeholders in the spin-off need to consider more carefully how the new company will obtain the financial resources to develop the technology. This additional scrutiny means that spin-offs will be considered appropriate in fewer cases than when plans for capital acquisition are less important. As the Director of the TLO at University C explained,

“If it’s going to require a huge capital investment then we are going to have to take a hard look at how they are going to be able to raise that sum of money.”

In many cases in which the industry is capital intensive, the spin-off will be considered a less appropriate commercialization vehicle than a license to an established company for which resource acquisition is less likely to be an issue. As the director of the TLO at University YY explained,

Facilities play a big role here. How expensive is it for a company to further develop it, to bring it closer to market? It’s one thing to have the intellectual power, but you also need you need facilities - laboratories and equipment. Not to say a start-up can’t or does not have resources and facilities, but they do not have the degree of resources that an established company would have.

A second reason why the capital intensity of the industry in which the invention will be exploited decreases the appropriateness of a spin-off as a commercialization vehicle is that it makes it harder for the founders of a company to attract the investment necessary to develop the technology. Capital acquisition takes time and effort, and slows the pace of technology development. Because the pace of development will be limited by the ability to raise the necessary funds to undertake it, the creation of a spin-off company in a capital intensive industry will be less appropriate in situations where the time to market matters. As the Director of the TLO at University G explained,

“If it’s a technology that’s going to require millions of dollars to develop then maybe a start-up is not the right way to go. They don’t have the resources and its going to take them a long, long time to attract enough of an investment to develop this technology into a product.”

Spin-off company creation will also be less appropriate as a commercialization vehicle in capital intensive industries because the magnitude of funds necessary to develop a technology in those industries are considered high by the standards of the venture capital market. Because the likelihood that the technology can be developed through a spin-off will be very low if the capital markets do not believe that they can provide the needed level of capital to commercialize an invention, relevant stakeholders are likely to view spin-offs as less appropriate commercialization vehicles than large, established companies with access to greater amounts of capital. The director of the TLO at University AAA illustrated this point with the example of molecular diagnostic technology. He said,

“There are a lot of people with some very interesting molecular diagnostics technology at universities. In order to get a molecular diagnostic product in the marketplace and compete with the likes of the big players in that marketplace you’re I think you’re looking at 125 million dollars capital to get that stuff ready to go. It’s pretty daunting to decide as a small player that you’re going to do a start-up that’s going to require that much money. It’s just a lot of money.”

In some cases, stakeholders might expect that a spin-off company in a capital intensive industry will be unable to raise the money necessary to develop the technology, and the technology might remain undeveloped if the spin-off commercialization model were adopted. If this expectation were true, the probability that the technology is developed is increased by licensing to an established company, making spin-offs a less appropriate vehicle to commercialize university inventions. The director of the TLO at University K explained this expectation in the context of the pharmaceutical industry. He said,

“A lot of the things that I see fit better into an established company because of the capital you’d need to set up a high frequency screening facility, get good chemists, and do tests in animals. These are all very capital intensive steps along the development pathway.”

The capital intensity of the industry will also adversely affect the appropriateness of spin-off companies as commercialization vehicles by increasing the level of founder effort needed to obtain start-up capital. Because the level of effort necessary to raise the capital to start a company is higher in a capital intensive industry than in a non-capital intensive industry, fewer people are willing to undertake that effort in a capital intensive industry. Consequently, the appropriateness of spin-off companies in those industries will be lower than in other industries. As the director of the TLO at University OO explained,

Capital intensity of the industry has an effect on the appropriateness of a spin-off company *“not because it is expensive to start one but because it affects the effort necessary to make the connection to fund a company’s beginning. It’s whether or not people are willing to put in the effort.”*

Similarly, the director of the TLO at University NN explained,

“If you need wet lab space, it can be pretty expensive. It might be difficult to form a start-up that needs wet lab space.”

The director of the TLO at University O described this pattern in the context of semiconductors. He said,

“If a start-up needs a hundred million dollars to make these transistors, that cost can be prohibitive. If they come up with a new transistor or a new semiconductor instrument where it requires a lot of capital to get it to the market place – if it requires a hundred million dollars – then we don’t think it’s a good opportunity for a start-up. If it requires a million dollars or ten million dollars, that funding may be a possibility.”

A third reason why the capital intensity of the industry in which the invention would be exploited makes a spin-off company a less appropriate commercialization vehicle is that it increases the expected financial returns necessary to justify the creation of a new company. Because investors in new technology companies are concerned with their return on investment, the higher the capital investment that they are required to make, the higher the level of profits that the start-up will need to achieve to obtain financing. Consequently, the higher the capital intensity in the industry in which the invention would be exploited, the fewer inventions will be considered appropriate for spin-offs. As the director of the TLO at University EE explained,

“Some of them might require a large investment like a pharmaceutical. Then you may want to go to a pharmaceutical company. You’re never going to get that type of development out of a start-up. If you’re going to need some funding to get to market, it might be difficult to find somebody to invest in it. If it’s got a big potential return, you may still be able to find an investor.”

A fourth reason why the capital intensity of the industry in which the invention would be exploited makes a spin-off company a less appropriate commercialization vehicle is that it increases the dilution of founders’ stakes in the company, and hence, their incentives to create successful firms. All other things being equal, the greater the amount of money that a spin-off must raise to develop a technology, the more ownership dilution that the founders of the company will experience. This expected dilution will reduce the founders’ incentive to engage in entrepreneurial activity, and make spin-off company formation less appropriate. As the Director of the TLO at University R explained,

“Clearly if you’re going to have to raise enormous sums of capital that’s going to be challenging and the dilution to the founders is going to be considerable.”

Similarly, the director of the TLO at University BBB explained,

“The cost to get the technology to market is a huge barrier for any start-up. We know that start-up is going to have to go through multiple rounds of syndicated investment. If part of your reason for doing a start-up is that you’re going to have an equity play, you will ask: how many rounds of dilution am I going to go through before this company hits an IPO? So there are some additional reasons not to do a start-up in the pharmaceutical space that there might not be in sectors where there aren’t huge sums of capital and multiple rounds of investment that are required to get a technology to market.”

To many TLO directors, the capital intensity of the industry in which the invention would be applied explains why spin-offs seem to be more appropriate commercialization vehicles in the software industry than in the semiconductor, medical device, aerospace, or pharmaceutical industries. As the Director of the TLO at University Q explained,

“The medical field, for instance, is too hard to crack. It is too expensive to get something going.”

Similarly, the director of the TLO at University FF explained,

“One extreme would be where the product in question would mean a very expensive manufacturing facility or packaging facility or something like that. That certainly would have a negative impact on the ability to start a company. If you have to invest many millions of dollars just to build a manufacturing facility that could be prohibitive. At the other extreme, there are things like software where you need a computer and an office to put it in. That would certainly have an impact on the suitability for a start-up.”

Exceptions for Development Stage Companies

Several of the TLO directors pointed out that there are a fair number of university spin-offs in capital intensive industries, such as biotechnology.²¹ Therefore, something must explain how spin-offs are created in capital intensive industries, like biotechnology.

The exception to the capital intensity rule described above appears to be the use of development stage companies, whose purpose is simply to move the technology forward to a point where other companies will acquire either the technology or the company. The director of the TLO at University X explained this concept. He said,

“We might need a big chunk of money in phase three [clinical trials], but that doesn’t stop us from forming a company. If it’s an important scientific advance and an existing company won’t come forward, we do a spin-off so we can get to a stage where an existing company or venture group will come forward.”

The main reason why capital intensity of the industry in which the invention would be exploited does not affect the appropriateness of a development stage spin-off company as a commercialization vehicle is that these companies are designed to be acquired before large amounts of capital need to be expended on them. The major expenses of building the value chain are not things that a development stage company will incur. Rather, it will focus its attention almost exclusively on advancing the technology. As the director of the TLO at University Z explained,

“If we view the company as an acquisition target, we would look at it differently than saying we have to create a new silicon chip foundry to market this technology. So it is about how you view the path to market.”

In particular, the development stage company does not focus on the creation of manufacturing, marketing or distribution assets. Consequently, the most costly parts of creating companies in capital intensive industries – manufacturing and marketing – are

²¹ As the director of the TLO at University CC explained, *“I think of biotech as being capital intensive. But there are lots of start-ups in biotech.”*

not something that the spin-off undertakes. The TLO director at University T explained why capital intensity of the industry in which the invention would be exploited does not adversely affect the appropriateness of development stage spin-off companies. He said,

“If it’s going to take tremendous resources to produce the product and establish a sales, distribution, and marketing workforce, these are probably not things that you’re going to want to do through a start-up. But that doesn’t mean that you would license the invention to an established entity. What you would probably do is be looking at the kind of start-up that would do research and development with the idea of eventually finding a strategic partner that would pay for some of the costs. Your company would develop the product until the point that it could be handed off to the sales, marketing and distribution side of the strategic partner or even some of his own development staff.”

2. *The Fragmentation of the Market in Which the Invention would be applied Increases the Appropriateness a Spin-Off*

Although several of the TLO directors expressed the view that the concentration of the market in which the university inventions would be exploited is a factor beyond their analysis, the preponderance of them explained that fragmented markets increase the appropriateness of a spin-off company as commercialization vehicle. As the director of the TLO at University Q explained,

“If it’s concentrated then you probably wouldn’t want to go the route of a start-up.”

Similarly, the director of the TLO at University S explained,

“It would matter a great deal. If there are two players that dominate the world, it’s not likely to be a successful start-up.”

Furthermore, the director of the TLO at University U explained,

“The fundamental thing I am looking for when I evaluate whether or not it is a start-up opportunity is to make sure you are not trying to walk into a market space that’s already dominated by some major player.”

Because the concentration of industry in which the university invention would be exploited reduces the appropriateness of a spin-off company as a commercialization vehicle, some industries are simply not appropriate for spin-off companies. As the Director of the TLO at University V explained,

“You see all sorts of people coming up with things for the automotive industry. The automotive industry is mature and you see almost zero start-ups there. Start-ups would go best in the early going when there is fragmentation and there is an opportunity for some young companies to get started.”

Reasons Why Market Fragmentation Increases the Appropriateness of Spin-offs

The TLO directors offered several reasons the fragmentation of the industry in which the invention would be applied increases the appropriateness of a spin-off as a commercialization vehicle. One reason is that fragmented markets are easier for new

companies to enter than concentrated markets.²² As the director of the TLO at University T explained,

“Concentrated markets with a relatively small number of players are more difficult to enter because you’ve got two or three players that have 95 percent of the market tied up.”

Similarly, the director of the TLO at University EE explained,

“If it’s controlled by a few, it’s much harder to break into that market if you are starting a new company. We’d be better off licensing to one of those companies.”

In concentrated industries, there are few market niches that spin-off companies can enter without competing for customers with large, established companies. Consequently, spin-off companies in concentrated industries must take on large, established companies, which are formidable competitors that can exert market power against challengers. As the director of the TLO at University HH explained,

“I’m thinking of a particular technology that we’re not planning a start-up around and one of the reasons is that the market is focused on basically three large players. There is no way that a start-up could compete against a General Electric, Siemens and Phillips.”

Similarly, the director of the TLO at University GG explained,

“My first thought is that I would not want concentration in the market. I wouldn’t want that much market power in any one particular entity.”

Furthermore, the director of the TLO at University AAA explained,

“Concentration obviously gets to competitive factors that any young company needs to consider. The concentration in an industry may mean that it wouldn’t make a lot of sense for you to go it alone and try and compete. Do I really want to compete in the space with a big player, a monopolistic situation?”

The established companies in concentrated industries have a lot of financial strength that they can bring to bear when they compete with new companies. In particular, established players in a concentrated industry can use their deep pockets to drive the spin-off out of business before it can get a foothold in the market.²³ As the director of the TLO at University DD explained,

²² Fragmented markets also offer the opportunity to a spin-off to use its technology to consolidate the market. A very rewarding strategy for a new firm can be to use technology to consolidate a fragmented market. As the Director of the TLO at University F explained, *“A fragmented market can be a real reward opportunity if you could figure out how to consolidate it with your technology.”*

²³ Because of the power of established firms in concentrated industries, the strength of patent protection necessary for a spin-off to protect its intellectual property against imitation is higher than in fragmented industries. Consequently, the number of inventions that licensing officers believe are protected by sufficiently strong patents to justify the creation of spin-off companies are lower in concentrated industries than in

“Are you getting into a market place that’s dominated by a few players that have a great deal of financial strength? That argues against a start-up?”

Similarly, the director of the TLO at University SS explained,

“If you’re going into a market where there’s a huge hitter, they’ve got a significant part of the market and have deep pockets. They could make it very difficult to get into a new market space. It’s different if you have lots of other competitors. If your product has significant competitive advantages over everybody else, that might be a viable option.”

Furthermore, the director of the TLO at University J explained,

“We’re going to look more to see if the product does really have a position if the market is highly concentrated and it is going against larger and probably well funded competitors.”

Large, established companies in concentrated industries often sell bundled products, which are hard for new companies without those bundled products to compete against. As the director of the TLO at University XX explained,

“Start-up companies can be more successful where you don’t have very concentrated players if you have a whole bunch of big guys and there are not really a lot of little guys that the market will work with. That’s difficult for a start-up. But if there is more of a cottage industry and there’s lots of niches in that industry then that’s better for a start-up. The customers just may not make if you’ve got bundled products and things like that the customers may not want to just buy one product from this little start-up company. They may see a lot of value in bundled systems. The large companies have economies of scale the new technology may not be sufficient to overcome the costs that you have in a start-up. It’s a lot easier if there’s a lot of small guys and they’re all they’re closer to an equal playing field.”

Some TLO directors argue that large, established firms engage in more cross-licensing in concentrated industries. This cross-licensing makes it difficult for new firms to get started because they cannot easily cross-license with established companies. The director of the TLO at University Z offered the following example to illustrate the phenomenon. He said,

“Everybody has this problem. We all have departments of radiology in our medical schools and these folks are turning out software and new coils for MRI machines and making all sorts of interesting discoveries. But it’s a small market and there are five players that are making those kinds of imaging machines – either CAT scanners or MRI. They all cross license with each other left and right. It’s almost impossible to break in there. That has a huge impact on how we view a disclosure whether it’s either a licensing opportunity or a start-up. The same is true in the semiconductor industry where they’re not real receptive to any outside

fragmented industries. As the director of the TLO at University I explained, *“Your ability to defend your patent had better be very good if you’re going up against giants. If you come out with a new catalyst for polyethylene, you may have to fight off Exxon.”*

input and they're extensively cross-licensed, again pretty concentrated in a few hands."

Large, established firms in concentrated industries often control standard setting bodies. Therefore, spin-off companies find it easier to get their technologies approved by standard setting bodies in fragmented industries than in concentrated industries. The greater the difficulty of getting technologies approved by standard setting bodies, the less appropriate are spin-off companies. As the Director of the TLO at University L explained,

"If you go to an industry that is concentrated as far as the number of players and there's regulatory issues that you have to get involved with it's going to be tougher just because you're going up against big players. Say there are industry standards that are being determined by that industry, and the committees that make up those standards are industry membership driven, then you have to get your standards for the technology approved against the partiality in those committees."

A second reason that the fragmentation of the industry in which the invention would be applied increases the appropriateness of a spin-off is that fragmented industries have lower average firm size. The minimum efficient scale of operations in concentrated industries tends to be very high (Audretsch, 1995). The cost of entry is greater in concentrated industries because new firms either have to operate at a less than efficient scale than competitors or raise a large amount of capital to begin operations at a large size (Shane, 2004). This means that spin-off companies in concentrated industries need a great deal of resources just to get started, reducing the appropriateness of spin-off companies in these industries. As the Director of the TLO at University A explained,

"You're not going to build a new car and take on General Motors. You don't have the resources. You can not take on a concentrated industry like the automotive industry."

The issue of minimum efficient scale also means that spin-off companies often need marketing and manufacturing alliances with established firms to bring products to market. The process of establishing contractual relationships with large, established firms is fraught with difficulty. In the absence of a strong patent intellectual property regime, it is difficult for new firms to establish effective alliance agreements with large, established companies due to disclosure problems. To obtain an alliance partner, the spin-off must disclose the value of its technology. However, this disclosure undermines the motivation for the alliance partner to work with the spin-off. Once the knowledge underlying the technology has been disclosed, the alliance partner can exploit it without an alliance with the spin-off. The difficulty establishing alliances with large firms reduces the appropriateness of spin-offs in concentrated industries. As the director of the TLO at University Y explained,

"The concentration of players is also a factor. For example, in the semiconductor industry, where you need a relationship with some of the big players to get a product to market, we'd be less inclined to start something new."

Exception for Early Stage Development Companies

The TLO directors explained that there was an importance exception to the observation that spin-off companies were less appropriate in concentrated industries: early stage development companies. When spin-offs are designed to simply move the development of the technology closer to a stage where a new product or service can be introduced to the market place, industry concentration is not a handicap. The major disadvantages of industry concentration for new firms occur only after the firm has entered the product market.²⁴ As the director of the TLO at University N explained,

“If the market is dominated by a small number of large players, the question comes up: how do those dominant players handle relationships with others. Perhaps there’s a situation where we can form a start-up that plays some significant role as an early developer of potentially interesting technology.”

Similarly, the director of the TLO at University BB explained,

“A concentrated market is a tough one for a start-up, but I wouldn’t lean away from a start-up in one. The company just has to understand it. They have to go out there to position themselves to be bought or license the product to an existing company.”

Furthermore, the director of the TLO at University P said,

“If you have the technology and it’s most appropriate to a limited number of companies [and] you can’t generate licensing interest, then your only alternative is to use a start-up as a financing vehicle to move the technology forward, recognizing that the exit is going to be a trade sale to one of those three companies that turned you down before.”

3. The Age of the Industry in Which the Invention Would be Applied Decreases the Appropriateness of a Spin-off

The TLO directors explain that the age of the industry in which the invention would be applied decreases the appropriateness of a spin-off company as a commercialization vehicle.²⁵ As the Director of the TLO at University B explained,

“Start-ups do better in markets that are younger, newer and fresher.”

²⁴ In fact, some TLO directors believe that concentrated markets are good for development stage spin-offs because the large companies in those industries engage in bidding wars to obtain technology that spin-offs have moved forward to commercialization and made less risky. As the director of the TLO at University X explained, *“In a very concentrated market we move the technology along far enough that we are able to take advantage of the concentration and have the big players in a bidding war to license it.”*

²⁵ However, some TLO directors believe that spin-offs are most appropriate when the industry in which an invention would be applied is young, but not brand new. As the Director of the TLO at University BB explained, the best market is *“young but not immature. You need proof that there is a market there but not a market that is dying.”*

The effect of industry maturity on the appropriateness of a spin-off as the commercialization vehicle for an invention means spin-offs are fundamentally inappropriate in certain industries. As the Director of the TLO at University U explained, *“You will find that most of the activity in startups is in the life sciences. In mature industries, like automotive, aerospace, aircraft, oil and gas, it is difficult to find university start-ups.”*

Similarly, the director of the TLO at University CC explained, *“The aeronautics industry is really old school and it’s going to be really hard for a start-up to break into that market. I think the IT market is constantly changing and is easier to break into that market.”*

Reasons Why Age of the Industry in Which the Invention Would Be Applied Makes Spin-offs Less Appropriate

The TLO directors offer several reasons why the age of the industry in which the invention would be applied make a spin-off company a less appropriate commercialization vehicle.²⁶ First, at the inception of an industry, there are no established firm licensees. The only potential licensees for university inventions are spin-off companies. Because there is no alternative to spin-off companies in new industries, spin-offs are relatively more appropriate commercialization vehicles in younger industries. As the director of the TLO at University Y explained,

“In an emerging market, there is no established company to license to, so you are looking at new startup ventures to develop that market.”

Similarly, the Director of the TLO at University N explained,

²⁶ Some of these reasons are not discussed in the text because they summarize the correlation between industry age and previously mentioned factors that influence the appropriateness of spin-off companies. For instance, many of the arguments that the TLO directors made about the inappropriateness of spin-offs in older industries invoked the mechanisms behind industry concentration because industries often tend toward concentration as they age. The director of the TLO at University R explained that for spin-offs, *“I think you want the market to be younger and not dominated by 800 pound gorillas. It’s too hard to dislodge an 800 pound gorilla.”* Similarly, the director of the TLO at University G explained that in older markets *“you get a lot of entrenched companies and it is hard to break into. There may be five or six major operators in the market and they’ve got the market pretty well tied up. It’s tough to break in unless you have something really revolutionary.”* Other TLO directors argued that spin-off companies are more appropriate in young industries because the intellectual property space around technologies tends to get more crowded as industries mature, invoking the arguments about spin-offs and freedom to operate. As the director of the TLO at University JJ explained, *“I think it’s easier to have real ground breaking technologies in biotech simply because it’s such a new area. For engineering and a lot of the established sciences, most of the disclosures we’re receiving are based on improvements upon what else is out there.”*

“If the marketplace is very young, or possibly even non-existent, then you are going to have a devil of a time licensing it to an existing company because there might not be one. So in that regard, age does play a role, particularly if the market is exceedingly young and not well developed.”

Second, when a field is young, the technical base of knowledge has had less time to accumulate. As a result, newer entrants are less severely handicapped by learning curve disadvantages in younger industries than in older ones (Shane, 2001b). Because spin-off companies are, by definition, new entrants, they are less appropriate commercialization vehicles in industries in which new firms are further behind established firms on the learning curve. As the director of the TLO at University VV explained,

“If it’s just starting, an early market, that’s a good thing for a start-up. Everybody is starting at the same place. You can get there and you can establish your part of the market without so much competition. And if you get there early the competition hadn’t really moved in yet.”

Third, as industries age, the nature of innovation shifts from products to processes, and cost reduction becomes more important to successful firm performance (Utterback, 1994). Established firms perform better than new firms at process innovation and cost-based competition because they benefit more from learning curves and scale economies (Shane 2001b). This advantage of established firms in older industries means that spin-offs tend to be less appropriate commercialization vehicles in those industries. As the director of the TLO at University DD explained,

“If it’s a new market we’d probably be more open to a start-up. It’s more conducive than a very old market where things are more commodity based. In an older market the whole system is more entrenched. So yeah, I would say that the younger market is more conducive to a start-up.”

Similarly, the director of the TLO at University XX explained,

“If the industry is fairly mature it can be difficult for a start-up to get into because they just nobody is looking for innovation there. They ultimately buy on this price and maybe and service.”

Fourth, over time, customers develop relationships with their suppliers and become used to the products and technologies provided by them. This means that entry is more difficult in older industries because the switching costs (psychological or real) for customers are higher in those industries. Consequently, it is more difficult to attract customers to the products and services of university spin-offs in older industries, making spin-offs less appropriate commercialization vehicles in those industries than in younger industries. As the director of the TLO at University YY explained,

If you’ve got a mature market space for the products coming out of that technology, you most likely have companies that are already in that space. So you’ve got competition. That would not favor a start-up. If it’s more mature, you probably lean more toward an established company. If it’s less mature you lean toward a start-up.

Similarly, the director of the TLO at University SS explained, “

If it's a new market you may be able to get in. There would be no established competition. If you're going into an established market, you really need to have a novel approach and your products really have to have a significant competitive advantage. If it's an established market, you're asking your customers to switch from their current products to new products and that's not as easy.”

Furthermore, the director of the TLO at University RR explained,

“If it's a very mature industry that is well entrenched in its way of doing things and you come forward with a technology that's clearly superior but would require a shift in the way the industry operates and might require a great deal of investment and retooling to your superior method, your chances of being successful are questionable.”

Fifth, older industries tend to be relatively slow growing.²⁷ Slow growth makes entry more difficult for spin-off companies because the new company's growth is either limited to the growth rate of the industry (which is often too low to support a new high technology company) or the new company must take customers away from established firms, which is very difficult to do. As the director of the TLO at University XX explained,

“If it's growing rapidly I think there're probably more opportunities for start-ups. If the players that are currently in there adequately serve it and know it real well that makes it more difficult. I mean you're really trying to find something like where somebody isn't serving that customer's need. And it's probably a higher probably if you're growing rapidly.”

Investors recognize the relationship between industry age and industry growth. Consequently, it is also easier to finance spin-off companies in young, growing industries. Part of the ease of financing new companies in young growing industries is that average returns on investment in new companies in those industries tend to be higher.²⁸ As the director of the TLO at University II explained,

²⁷ Often the growth is so slow in older industries that those industries are actually dying. The TLO directors explained that spin-off companies do not make sense in dying industries. As the director of the TLO at University W explained, “*You're looking more at the future than the past. Is the market trending toward closing down? I certainly wouldn't encourage somebody to try to do a start-up with a new player for 8-track stereo.*” Similarly, the director of the TLO at University TT explained, “*If it's a dying market opportunity but a large market - lets take textile for example- probably not. You've got to take a look at the trend you've got to see if it's a brand new market opportunity that's going to grow to a large one or an existing one that's going to continue to grow even larger.*”

²⁸ New companies also find fund raising easier in new industries for other reasons. Investors have a preference for new industries because those industries are more exciting. As the Director of the TLO at University C explained, “*The newer stuff is what looks more exciting to investors.*” In addition, the lack of consolidation in the industry

“I think that start-ups are less likely in old industries. Investors are smart. They want to put their money into a growing company in a growing industry. They’re looking for 20X returns and their not going to get those in an industry that’s shrinking.”

Exception for Biomedical Industries

The directors of the TLOs explained that the industry maturity arguments described above do hold in biomedical industries. In these industries, spin-offs tend to be appropriate commercialization vehicles even through the industries are mature. As the director of the TLO at University M explained,

“A mature market doesn’t hold in the life sciences. If you said that the cancer market was mature, it’s mature only for the drugs that are in place today. If you have a better drug, then the whole market opens up to you. Mature market probably deals more with IT than in life sciences.”

Similarly, the director of the TLO at University K explained,

“In biomedical we’re not discovering too many new diseases. Cancer has been around a long time. Cardiovascular problems have been around a long time.”

CONCLUSIONS

The study sought to explain what makes spin-offs more appropriate commercialization vehicles for certain types of university inventions than for others by interviewing the directors of technology licensing offices at U.S. universities. The analysis that produced this report was conducted from transcripts of semi-structured telephone interviews with TLO directors at 55 universities using standard qualitative methods.

The study indicated that four categories of factors make some university inventions more appropriate for spin-offs than others: characteristics of the inventors, characteristics of the inventions, characteristics of the intellectual property position that can be obtained on the inventions, and characteristics of the industry in which the technologies would be exploited.

Eight characteristics of the inventors increase the appropriateness of a spin-off as a vehicle to commercialize a university invention:

1. *With the exception of inventions for which knowledge is well-codified, the willingness of the inventor to be involved in the further development of the technology*
2. *Inventor commitment to the concept of a start-up company*
3. *Inventor personal attributes of low need for control, ability to work with others, good communication skills, and willingness to seek complementary skills in others*
4. *Inventor prior start-up experience*

provides new companies with better alternatives for exit. As the director of the TLO at University ZZ explains, *“The newer the market, the better off we are. You haven’t gone through a consolidation in that market, and as the market matures you’ll see those. So you have a good exit strategy.”*

5. *Inventor prior industry experience*
6. *Inventor prior product development experience*
7. *Inventor prior social ties with investors in start-ups*
8. *Inventor prestige*

Three characteristics of the invention increase the appropriateness of a spin-off as a commercialization vehicle:

1. *With the exception of biotechnology, a platform technology*
2. *A disruptive technology*
3. *A stand alone invention*

Five characteristics of the intellectual property position that can be obtained on the invention increase the appropriateness of a spin-off as a commercialization vehicle:

1. *With the exception of inventions for which further development within the university is not appropriate, patentability*
2. *The ability to obtain a composition of matter patent*
3. *With the exception of technical fields in which patents are not effective, the scope of patent claims*
4. *Un-crowded intellectual property space around the invention*
5. *Clear title to intellectual property held by the university*

Three characteristics of the industry in which the technology would be applied increase the appropriateness of a spin-off as a commercialization vehicle:

1. *With the exception for early stage development companies, a non capital-intensive industry*
2. *With the exception for early stage development companies, industry fragmentation*
3. *With the exception of biomedical technologies, industry youth*

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Appendix 1: List of TLO Office Directors Who Participated in the Study

Steven Auvil	University of Maryland, Baltimore County
Jim Baxendale	University of Kansas
Lou Berneman	University of Pennsylvania
Joyce Brinton	Harvard University
Richard Cahoon	Cornell University
Mark Coburn	University of Rochester
Donna Cookmeyer	North Carolina State University
Mark Coticchia	Case Western Reserve University
Mark Crowell	University of North Carolina
Dan Davis	University of Oklahoma
David Day	University of Florida
Kathleen Denis	Rockefeller University
Richard Franson	Virginia Commonwealth University
John Fraser	Florida State University
Michael Fritz	University of Illinois
Don Gerhart	University of Oregon
Kannan Grant	University of Nebraska
George Harker	Georgia Institute of Technology
Ron Huss	Penn State University
Don Keach	University of Kentucky
Todd Keiller	University of Vermont
Ken Kirkland	Iowa State University
Rich Kordal	University of Cincinnati
Dan Kory	University of Toledo
Kathy Ku	Stanford University
Steve Kubisen	Utah State University
Jacob Maczuga	Tulane University
Mike Martin	Virginia Tech
Jeanie McGuire	Florida Atlantic University
Jerry McGuire	University of North Carolina at Greensboro
Chris McKinney	Vanderbilt University
Gary Meyer	Ohio University
Carol Mimura	University of California at Berkeley
Indrani Mukarji	Northwestern University
Jennifer Murphy	George Mason University
Lita Nelsen	Massachusetts Institute of Technology
Tony Nevshemal	University of Wyoming
Jack Pincus	Indiana University
Jim Poulos	University of Maryland
Charles Rancourt	Rennslear Polytechnic Institute
Fred Reinhardt	Wayne State University
Bryan Renk	University of Wisconsin
Lisa Rooney	University of South Carolina
Jim Severson	University of Washington

Tom Sharpe	University of Missouri
Todd Sherer	Emory University
Peter Slade	University of Arizona
Ashley Stevens	Boston University
Larry Steranka	Brandeis University
Simran Trana	Purdue University
Mark Wdowik	University of North Carolina at Charlotte
Bruce Wheaton	University of Iowa
Greg Wilson	Kent State University
Bob Woolridge	Carnegie Mellon University
James Zanewicz	University of Louisville