

**Surprises and Counter-Intuitive Findings about What Makes University Inventions  
Appropriate for Spin-offs**

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## **EXECUTIVE SUMMARY**

This report is a follow-on study to my report “What Makes University Inventions Appropriate for Spin-offs?” conducted for the National Institute of Advanced Industrial Science and Technology in Japan and released in 2005. This study extends the work of the previous study. In particular, it summarizes key surprises and counterintuitive findings about university spin-offs from semi-structured interviews conducted with 55 directors of technology licensing offices at U.S. universities.

The study examined three categories of factors that previous research has indicated make some university inventions more appropriate for spin-offs than others: 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.

The TLO directors reported four characteristics of the inventions that do not affect the appropriateness of university spin-offs as vehicles to commercialize university inventions in ways suggested by previous research.

1. *The stage of development at the time of invention disclosure*
2. *The time horizon to bring the technology to market*
3. *The complexity of the product development process*
4. *The basic technology type*

The TLO directors reported one characteristic of the invention that does not affect the appropriateness of university spin-offs as vehicles to commercialize university inventions in ways suggested by previous research.

1. *The number of patents that can be obtained to protect the invention*

The TLO directors reported three characteristics of the inventions that do not affect the appropriateness of university spin-offs as vehicles to commercialize university inventions in ways suggested by previous research.

1. *The importance of manufacturing and marketing and distribution to the value chain of the industry in which the invention would be applied*
2. *The size of the market in which the invention would be applied*
3. *Investors interest in funding the industry in which the invention would be applied*

## **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. These companies are 108 times more likely than the average new firm to go public, and create more jobs than the average new business in the United States (Shane 2004). The induced investment in technology development by spin-off companies is greater than that by established company licensees (Pressman et al, 1995). 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 them 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 follows on my report “What Makes University Inventions Appropriate for Spin-offs?” conducted for the National Institute of Advanced Industrial Science and Technology in Japan and released in 2005. It extends the work of the previous study by summarizing key surprises and counterintuitive findings about the effect of the technologies, the intellectual property protection that can be obtained on those inventions, and the industries in which those inventions would be applied on the appropriateness of university spin-offs as commercialization vehicles.

## **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 U.S. 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**

I examined three categories of factors thought to make some university inventions more appropriate for spin-offs than others – 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. The evidence collected from the TLO directors fails to support existing arguments for a variety of factors that make university spin-offs appropriate commercialization vehicles.

### **Characteristics of the Invention**

The interviews with the TLO directors revealed that four characteristics of a university invention thought to increase the appropriateness of spin-offs as commercialization vehicles– (1) the stage of development at the time that the invention is disclosed, (2) the time horizon to market, (3) the complexity of the product development process, and (4) the technology type – do not influence the appropriateness of a spin-off.

#### ***1. The Stage of Development at the Time the Invention is Disclosed Does Not Matter***

TLO directors believe that the stage of development at the time that the invention is disclosed does not influence the appropriateness of spin-off companies as commercialization vehicles. The TLO directors report countervailing effects for the stage of invention development on the appropriateness of spin-offs. Moreover, many TLO directors indicated that the stage of development does not affect the appropriateness of a spin-off company as a commercialization vehicle.

#### **Countervailing effects: Reasons why spin-offs are appropriate vehicles to commercialize early stage inventions**

The TLO directors report countervailing effects of the stage of invention development on the appropriateness spin-offs as commercialization vehicles. Many TLO directors believe that spin-offs are better vehicles to commercialize early stage inventions than late stage inventions.

The TLO directors offered several reasons why spin-offs are appropriate vehicles to commercialize early stage inventions. First, it is important to secure inventor involvement for early stage inventions because those inventions typically cannot advance without the participation of the inventors who have tacit knowledge about the technology that is not contained in the patent documents themselves. As the director of the TLO at University XX explained,

*“The inventors have to be interested in assisting with the commercialization. These technologies are by and large very early stage and are not well understood from an industrial standpoint because they haven’t been taken to market and manufactured. And so you need the inventor to be cooperative.”*

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

*“These tend to be very early stage technologies. The investors need the world’s expert on this technology, the researcher, to continue to be committed to developing that technology.”*

Inventor involvement is easier to secure through the creation of new companies. As the director of the TLO at University GG explained,

*“If you are talking about an algorithm with some broad applications, you are not going to get anyone to buy it until it’s a prototype. If the inventors continued involvement is critical to the development of the technology, a start-up can be a development vehicle to get the technology to where it is commercially viable.”*

Spin-offs facilitate inventor involvement because new companies are more likely to be collocated with the university. This collocation provides better communication with the inventor, which is necessary to facilitate the inventor’s involvement in further development of the technology. As the director of the TLO at University BBB explained,

*“Established companies certainly have relationships with investigators, but they don’t locate themselves in our backyard. The communication, therefore, isn’t as effective and it can be with a start-up. The start-up can be virtually on the university’s premises and that close proximity in communication is critical. That’s easier to make happen in a start-up environment than it is with a major company located in another country.”*

Second, spin-offs are appropriate vehicles to commercialize early stage inventions because the uncertainty surrounding these inventions makes it difficult to license them to established firms (Shane, 2004). As the director of the TLO at University V explained,

*“Another characteristic that singles out start-ups to me is a technology early enough not to be interesting to large corporations.”*

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

*“Things that are very new in their stage of development would not be snapped up by an established company. So there wouldn’t be any takers and if the only taker was a start-up where the faculty member said he or she wanted to move forward with it, we would be inclined to give it to them.”*

The ability to license a university invention to an established company requires development to a stage where the buyers believe that the technical uncertainty has been reduced and they can see that the technology works (Shane, 2004). The managers in established companies need to be able to look at a technology and see its efficacy to make a licensing decision. Lack of evidence of efficacy makes it difficult to value technology and inclines established companies to wait and see what value the technology turns out to have. As the director of the TLO at University EE explained,

*“Some of the inventions are very early stage and it’s appropriate for a start-up in order to further develop them become more commercially viable. It’s often hard to find other companies willing to invest in them. Companies aren’t interested until you’ve taken them to a certain point. The faculty members are interested in the development of their technology and they might be able to develop it-prototype or do some proof of concept before they can be marketed. That might be a reason to do a start-up, to enable it to reach that point.”*

This process is facilitated by the creation of a spin-off company that develops the technology and then is acquired by or licenses to a large, established firm. Spin-offs provide a vehicle for conducting the additional development necessary to attract the interest of established companies. As the director of the TLO at University D explained,

*“Something that is so early stage that nobody else is going to deal with it means that a start-up may be the only avenue that you have to take get it taken to the next stage. In essence the start-up serves as an intermediate development gap mechanism to take the technology to a certain stage and someone comes in and acquires the company.”*

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

*“If they’re so embryonic that there’s a stage of having a start-up company develop the product before the midsized to big companies are interested in wading into the risk game.”*

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

*“If it’s really early development a start-up is appropriate because they can do that first bit of development and then find a bigger partner.”*

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

*“Existing companies don’t have the same sort of vision on the long term that a start-up would have. One of the ways to get promising early stage technologies into products is to do a start-up – to be a holding company and do a lot of early stage value-added proof of concept in order to get an existing company interested in taking a license and investing in product development.”*

Third, spin-offs are appropriate vehicles to commercialize early stage inventions because large established companies do not want to bear technical risk. Established companies do not have a comparative advantage in technology development and seek technologies that they know work. Their managers cannot be given sufficient incentives to bear the risk of early stage technology development. Moreover, they lack many of the skills necessary

for that activity. Furthermore, even when the personnel in large, established companies have these skills, they will not be assigned to development activity if they are also skilled at other activities. Established companies have a financial incentive to assign the best people to those activities which generate current revenues (Shane, 2004). As the director of the TLO at University OO explained,

*“Established companies want proof that the invention accomplishes what you think it’s going to do and they don’t want to have to put money into it to prove that. They have their own projects going with their funding and their research budgets are very limited now compared to what they once were and they don’t want to invest in technology from outside their corporate structure. They’re not going to want to pay royalties versus keeping everything for themselves right down the line. They want to know that there’s a pretty good chance that it’s going to work before they put any work into it all.”*

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

*“The stage of development is relevant in making a decision about a start-up. Is it ready to be commercialized or does it need additional development? Where it’s very early stage technology that needs some further development we look at a start-up. The technical risk is still fairly high at the stage where we file the patent application. So we find a mechanism to reduce that technical risk and typically we look to a start-up company to do that.”*

Fourth, spin-offs are appropriate vehicles to commercialize early stage inventions because the government has special programs for technology development only if the exploiter of that technology is a small company. The bias of government to subsidize technology development by small enterprises makes the creation of spin-offs an attractive vehicle to finance early stage technology. As the director of the TLO at University OO explained,

*“If it’s early stage and isn’t proven, it’s good for a start-up because your start-up can get SBIR or STTR funding and lots of other funds that come without strings attached from the government to move the technology forward.”*

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

*“The others that are good candidates to build a company around are things that are awfully early. We could move the technology along through SBIR and STTR support. So we might be able to help a faculty member start a company to help advance that technology through the SBIR/STTR route.”*

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

*“Some of the inventions would do better as start-ups because they need some extra development. The start-up route is the only way to really get these inventions developed. If you have somebody who is willing to put in a lot of sweat equity to develop the technology to a point where it can be commercialized, if somebody is willing to create a company around it and go get SBIR money, then it’s good for a start-up. Then the big companies look at start-ups and when they become successful, they buy them and get the technology that way.”*

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

*“We see start-ups as a good way to further develop the technology, which in most the majority of cases coming out of any university is pretty basic and fundamental. The marketplace is down the road and a lot of work needs to go into further developing the technology, working out issues about it, and gaining an understanding of what space will this technology be applied. A start-up gives you a structure to pursue funding, such as the SBIR’s, or STTRs, to work on proof of principle, look at application spaces, expose it to potential partners, bring it along the development path through the gap away from pure research results into more commercial applications. If we think that the technology is just not as defined in the marketplace as it needs to be and it needs more work to get there, or where we got we got the solution to a problem that we haven’t defined and we have to find out what the problem is and articulate it and then test it out in terms of the market space to see if there’s any value to it, the commercialization process would be better served through a start-up.”*

Fifth, spin-offs are appropriate vehicles to commercialize early stage inventions because established companies concentrate on technologies that currently have commercial application. Thus, established firms often see the spin-offs as complementary entities, advancing the technology to the point at which they can use it (Shane, 2004). The director of the TLO at University OO summarizes this perspective saying,

*“Technologies which need some research done to move it forward before it would be ready for a larger company are appropriate for start-ups. More or less, the start-ups around here have their primary purpose to move technology forward from a very basic research stage to a more advanced stage where it’s actually ready for licensing. As things are further along – if you’ve got phase I studies or some validation information – you might be able to get a Lilly or someone like that interested. If it’s early stage, you need a start up to move it along to a point where someone else would be interested. Most biotech start-ups basically exist to move things to a stage where they get bought out by someone else. The start-up gets bought out by a larger company. If something is ready for market, odds are you don’t need a start-up to move it out.”*

Sixth, spin-offs are appropriate vehicles to commercialize early stage inventions because they enhance the value of technology. Universities can earn more from licensing inventions to spin-offs in which they can make equity investments because licensed technologies bring very little revenue the value from technology lies largely in the subsequent development of products and services that meet customer needs, not in the initial technology idea itself. As the director of the TLO at University AAA explained,

*“If we were to do a bit more it would exponentially increase the value so it’s not the right time to go to a company. And so the fact is that is that in those instances we’re really positioning this company for acquisition. And so I mean and I think and so when we do it very often we’ll start a company and say okay what do we need to do to develop this product further. To where it will be an attractive target for a company that ultimately would buy it or maybe even license out the*

*technology. A good strong platform technology that still needs further development that would exponentially increase its value is another reason we may want to do a spin out.”*

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

*“We do start-ups simply because existing companies with strategic interest, infrastructure, management and finance are not interested in licensing the early stage technology opportunities we have on any basis that we find reasonable. They are unwilling to provide us with due diligence to ensure development of the technology or they’re unwilling to value it on any reasonable basis. They’re unwilling to give us pass through future income rights because what we’re providing is so early and this is directly related to the product that will generate the revenue.”*

### **Countervailing effects: Reasons why spin-offs are not appropriate vehicles to exploit early stage inventions**

In contrast to the TLO directors quoted above, many other TLO directors think that spin-offs are not appropriate vehicles to commercialize early stage inventions. As the director of the TLO at University S said, *“Closer to being a product is more appropriate for start-ups.”*

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

*“On our disclosure form we ask people the stage of development – is it a concept, design, prototype, production model – the later the stage, the more it contributes to us seeing it as a start-up candidate.”*

The TLO directors offered several reasons why spin-offs are not appropriate vehicles to commercialize early stage inventions. First, early stage inventions require a lot of capital to develop the technology to the point where it is appropriate for the market. By virtue of their existing cash flow, established companies have better access to capital than spin-offs. As the director of the TLO at University A explained,

*“When a faculty member comes to us say I’d like to do a start-up, we ask, ‘where are you going get the hundred two hundred thousand dollars to move it off of your bench top into a product?’”*

Second, spin-offs are not appropriate vehicles to commercialize early stage university inventions because they require significant human resources to develop. Large, established companies often have better access to the research and development personnel needed to advance early stage technology. As the director of the TLO at University G explained

*“If it’s a very early stage invention, it’s going to need a lot of work to make it into a product. It’s going to take a big team to do this. What’s the expertise of the start-up? What resources do they have to develop this? We might want to discourage the inventors from forming a company to exploit the technologies. [Later stage inventions are better for start-ups.] It’s going to take less effort to develop it into a useful product. A piece of software, for instance, might be*

*almost ready to shrink wrap and sell. It might be rapidly developed into a series of products. And you want something to start the company with that you can get a first product out quickly. You've got some cash flow coming into the company. That will make it attractive to show investors so you can develop a series of products down the line."*

Third, spin-offs are not appropriate vehicles to commercialize early stage university inventions because they are difficult to finance through financial markets. Spin-offs must fund technology development by raising money in financial markets because they do not have existing cash flow to allocate to technology development. However, investors will not invest in the development of early stage technologies for which there is not yet significant evidence of efficacy; the problems of uncertainty and moral hazard are too high in these cases. As a result, large, established companies that can allocate cash flow from their existing operations are better able to pay for the development of early stage technologies.<sup>1</sup> As the director of the TLO at University FF explained,

*"It would be hard to convince somebody to finance a company based on a technology at the conceptual stage of development. But something that was at a later stage of development where perhaps you already have a prototype where you could demonstrate what the product is would be a much better candidate for a start-up."*

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

*"How far along is it? Has it been proven? VCs are going to ask that. You're not going to be able to sell it if you haven't proven it. If it's just a concept that somebody has and it has not been reduced to practice – it hasn't been proven out or validated through a prototype then it's going to be very difficult to ascertain."*

Fourth, spin-offs are not appropriate vehicles to commercialize early stage university inventions because the amount of capital that needs to be obtained to develop the technologies exceeds what financial markets are willing to provide to new firms. When this is the case, large, established companies are often better commercialization vehicles. As the director of the TLO at University DD explained,

*"If you have something that's a little further down the pipeline in terms of yes, you've got a prototype, that would lend itself to being a start-up because the investment necessary to take it from where it is right now to the product launch stage is lower. If that number is relatively low, then you think start-up. If you think \$50 million you don't think start-up."*

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<sup>1</sup> Moreover, investors also favor companies based on later stage technologies because they are closer to market. Closeness to the market enhances investors' rate of return by reducing the amount of time before the investors receive a payback on their investment. As the director of the TLO at University K explained, *"Most of the people I talk to in the venture capital community would love to have something that has some human data instead of not, or at least animal data and these are things that people don't have early on."* Similarly, the director of the TLO at University I explained, *"The further along it is, the easier it is to get funded."*

Fifth, spin-offs are not appropriate vehicles to commercialize early stage university inventions because the time horizons to get to market are long for these technologies. Because new firms have no other source of cash flow, they cannot develop very long horizon technologies. They simply run out of cash before such technologies are developed. Large, established companies, which have cash flow from other operations, can invest that cash in the development of early stage technologies, and can exploit early stage university inventions. As the director of the TLO at University LL explained,

*“If something is really early stage and there’s a lot more R&D that has to be done rather than something that just needs some tweaks and it’ll be ready to be sold, a start-up is harder to do. It will be harder to build a start-up around something that is in the early stage of development. Part of that is getting the money in hand to do the R&D. It is harder if you have to do a lot more investment in actually getting something to work and do development for 5 to 10 years. That’s going to make it very hard to keep a start-up going.”*

### **Reasons why the stage of development does not matter**

In addition to showing the countervailing points of view expressed by the TLO directors about the effects of stage of development of the technology on the appropriateness of a spin-off as a commercialization vehicle, the interviews also indicated that many TLO believe that the stage of development of the technology at the time of invention disclosure does not affect the appropriateness of spin-off companies as commercialization vehicles. As the director of the TLO at University Z explained,

*“Stage of development doesn’t influence the choice between start-ups and licensing to established companies.”*

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

*“We would be indifferent about the stage of development because the prototype itself doesn’t say anything about whether they could form a business or not.”*

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

*“It’s not that those further along are more appropriate for a startup. It’s just that they are closer to being called a start-up. You might see something and say what to we have to do to get it to the point where we can decide whether there’s a company possible out of this. If somebody brings you a proof of concept, then it’s farther down that pathway than if someone brings you this prototype that’s got a bunch of data and you show that it works. Those are different kinds of inventions and they call both lead to a start-up. One will take longer time and more effort to get to the point where you can say, ‘fine, let’s make a start-up out of it.’”*

The TLO directors offered a variety of reasons why the stage of development does not affect the appropriateness of spin-offs as commercialization vehicles. First, later stage technologies are better for all types of licenses. Thus, there is no relative advantage of the stage of development for spin-offs as opposed to established company licensees. As the director of the TLO at University F explained,

*“If it is further along, I’d like it better for a new company and an existing company. It’s better if it’s more developed. I’d love to have more data. If it’s a gadget, I’d love to have a prototype.”*

Second, the stage of development does not affect the appropriateness of spin-offs as commercialization vehicles because the stage of development is largely a function of technology type. As a result, biotechnologies tend to be licensed from universities at a very early stage of development, whether the licensee is a spin-off or an established company, and software tends to be licensed from universities at a late stage of development, regardless of who the licensee is. As the director of the TLO at University J explained,

*“It depends upon the technology. Biomed is different than electrical engineering and computer science. It is really dependent on the technology.”*

Similarly, the director of the TLO at University R explained the difference between physical and life sciences. He said,

*“It depends on the market sector. In the life sciences, you really do not get proof of principle until it works in humans. But you may not be able to get there with academic sources of funding. In the physical sciences, you may well have to have a working prototype before you can start a venture.”*

Third, the stage of development does not affect the appropriateness of spin-offs as commercialization vehicles because the advantages and disadvantages of early and late stage inventions offset each other. As a result, there is no net effect of stage of development on the appropriateness of spin-offs. As the director of the TLO at University H explained,

*“I don’t think that the stage of development of the invention at the time of disclosure matters. If you’re very early stage, the ultimate product has to be really special with clear and convincing competitive advantages and a large enough market to offer a tremendous return on the investors’ money in order to make that work as a business. In contrast, the thing that’s about to go to market attracts a different kind of investor, but is equally valid in terms of a business opportunity.”*

## **2. The Time Horizon to Bring the Invention to Market Does Not Matter**

TLO directors believe that the time horizon to bring the invention to market does not influence the appropriateness of spin-off companies as commercialization vehicles. The TLO directors report countervailing effects for the time to market on the appropriateness of spin-offs. Moreover, many TLO directors indicated that the time horizon to market does not matter for the appropriateness of spin-off companies as commercialization vehicles.

### **Countervailing effects: Reasons why spin-offs are better vehicles to commercialize inventions with a shorter time to market**

The TLO directors report countervailing effects of the time to market on the appropriateness spin-offs as commercialization vehicles. Many TLO directors believe

that spin-offs are better vehicles to commercialize inventions with a shorter time to market. As the director of the TLO at University X explained, *“Generally things that are closer to market are better for start-ups.”*

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

*“The most prominent factor in determining a start-up is time to market. A shorter time to market will lead you in a direction of a start-up.”*

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

*“A piece of software might be an ideal kind of thing to license to a start-up because it doesn’t need a lot of development.”*

The TLO directors offered several reasons why spin-offs are more appropriate vehicles to commercialize inventions with a shorter time to market. First, spin-offs require external financing to develop university technologies; and spin-offs are easier to finance if the time to market is shorter.<sup>2</sup> As the director of the TLO at University RR explained, *“If it’s got a shorter time horizon, it will tend to be easier to get investment capital.”*

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

*“Venture capitalists look at a five year horizon. They want to cash out in five years. If you have something that’s 12 years to market, then that’s two funds and they have to have a lot of faith. There’s got to be some spark, some personal connection to get them interested.”*

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

*“The closer to the market it is, the easier it is to get funding. If we’ve got something in the biological space that’s human or animal data or if we’ve got working prototypes or even if the university is using it successfully it is easier.”*

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<sup>2</sup> However, some TLO directors expressed the opposite view about the time to market and the appropriateness of a spin-off company as a commercialization vehicle. For instance, the director of the TLO at University AAA explained, *“Sometimes it sometimes when something is too long it just you just know it’s not going to be attractive toward a licensee but you believe it’s something that can be venture financed. Those some of those time horizons are huge it’s almost a non-starter to do a license. If it was a compound if it was something where the where the path was clearer the time horizon would probably have like a clinical drug the time horizon would have led you to a licensee. Because you’re going to get milestones and people can digest it and the company knows exactly what it is and what it does and why they need it.”* Moreover, the TLO directors indicated that, in some fields, people will invest in technologies with long time horizons. As the director of the TLO at University H explained, *“It is not necessarily difficult to raise money for a start-up with an invention with a long time to market if it’s a compelling story. I’ll give you a concrete example. One of our start-ups involves a drug for Alzheimer’s. It’s two guys who aren’t particularly wealthy and you know the cost of drug development, clinical trials and FDA approval. But what I found early on is that there’s enough money and interest in Alzheimer’s because of how costly it is to the country. So there’s enough people who will fund these preliminary developments. They can get all the way up to phase one clinical trials through SSTRs and SBIRs.”* The disagreement between TLO directors on whether longer time horizons made it relatively easier or harder for spin-off companies to finance the development of new technologies suggested that time to market does not influence the appropriateness of spin-off companies as commercialization vehicles.

*When it's an interesting idea, but it's very early and there's no data on it yet, then it's very difficult to get financing for it."*

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

*"If you have a new human therapeutic, you're looking at such a long time line to get it on the market that only a big established company with lots of resources would be interested in pursuing that. It's just too long term for your typical venture investor."*

Investors do not like to finance new companies exploiting technologies with a long time to market because the long time horizon adversely affects their financial returns. The longer the time to market, the lower the investors return on their investment will be. As the director of the TLO at University Z explained,

*"We've had potential investors run away from a start-up once they start to understand the time frame. An example is what it's going to take to get this through the FDA. There's how much time and how much money."*

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

*They're looking at return on investment in a reasonable period of time. When they invest they want they want some assurance that their investment is going to provide a return on their investment. If the company has to spend dollars on a very resource intensive technology that would that would put them further out onto the timeline and needs a lot more time to get there, they may be premature for the investor.*

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

*"VCs really want to know when they will be getting their money back or doubling their money. They are often not willing to wait 10 or 12 years so it factors into the start-up equation."*

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

*"If it's very long term, that time horizon argues against a start-up. You're going to have to be able to justify some reasonable return."*

Investors do not like to finance new companies exploiting technologies with a long time to market because they have to bear more risk if the time horizon is longer. As a result, their risk-return ratio becomes less favorable. As the director of the TLO at University W explained,

*"It can't be so speculative that everybody says that's really cool, but you might not be able to sell that for fifteen years. It needs to be at a point where you can see where you want to end up for sure. You need to see a finite timeline to market. You don't want something that's so speculative that you would have to change either the regulatory environment or make a second discovery on the way to the market. If you have a shorter time horizon, it would diminish the risk to the investors. Anything that helps diminish risk for the investors is going to be a plus for a start-up."*

Investors do not like to finance new companies exploiting technologies with a long time to market because the long time horizon means that they have to reinvest. Investors do not like to make additional rounds of investment because the additional investments cur into their financial returns. Therefore, finding investors for a company with a long time to market is often difficult. As the director of the TLO at University UU explained,

*“I mean if drugs with serious regulatory complications to it, then that’s a long time to market. If you try to keep it in a start-up that’s one that’s 15 years old and it’s in preclinical trials now from this institution. That’s a long time the only way you survive for that length of time is to find people willing to pump money into it at various stages.”*

Second, spin-offs are more appropriate vehicles to commercialize inventions with a shorter time to market because they lack the cash to pay universities for the patents that they license. Because start-up companies lack cash flow from other activities to pay the patent costs on the university inventions, universities often have to pay the costs of patents licensed to spin-offs and seek reimbursement when the licensee sells its product. The longer is the time to market, the longer the university will have to pay patent costs with no guarantee that it will ever be repaid. The director of the TLO at University G described this problem, saying,

*“We are incurring patent costs and we want someone to repay those patent costs. But startups don’t have any money. If it is going to be ten years down the road, that’s going to be tough for us.”*

Third, spin-offs are more appropriate vehicles to commercialize inventions with a shorter time to market because long time horizons often mean a large capital investment necessary to get to market. Large, established companies are often better than small start-up companies at raising the large amounts of capital necessary to take a university technology to market when the time horizon to market is long. As the director of the TLO at University GG explained,

*“I think it’s a cost thing. We look at how much money is necessary to get this company off the ground and what’s the likelihood of getting it. When you look at what kind of dollars are needed to get something started and you can get three hundred thousand dollars from a local economic development agency for something that’s a good start for software and you can get a product to market in 12 to 18 months, that’s different than if you’re looking at a drug compound or synthetic bone and you’re talking ten years and 100 million dollars. If you have something that’s going to take 20 million dollars in venture capital, what’s the chance of getting that within a reasonable horizon? So that’s definitely a factor.”*

Fourth, spin-offs are more appropriate vehicles to commercialize inventions with a shorter time to market because the path to a product is clearer. Because new businesses lack cash flow from existing operations, they need a clear path to market to have a reasonable chance that they can develop a product before they run out of cash from investors. As the director of the TLO at University HH explained,

*“The technology has to be either pretty close to being transformed into a product or there is at least a predicted path of development where we could see it turning into a product if research and development was favorable. I think it is a safe assumption to make that a lot of our technologies are disclosed and then take an average of three or four years to generate any interest in licensing. If you have a prototype or if you have a suite of technologies that you could come up with a prototype around, that’s going to more likely be the basis of a start-up company. We see more start-up companies around software for instance that have in my mind a little shorter time to development. The software we come up with is maybe 80 to 90 percent already a product and then it just maybe needs some tweaking to become a commercial product.”*

Fifth, spin-offs are more appropriate vehicles to commercialize inventions with a shorter time to market because the shorter time horizon means that the company will have to rely on the development of fewer complementary technologies outside of the control of the firm to make the university technology a viable product. As a result, the probability of creating a useful new product from a university invention is increased. As the director of the TLO at University KK explained,

*“If there are issues concerning materials that aren’t available or haven’t been invented yet that are a big part of moving it to the next level that can be a negative for a start-up.”*

#### **Countervailing effects: Reasons why spin-offs are worse vehicles to commercialize inventions with a short time to market**

In contrast to the arguments presented above, several TLO directors identified an important reason why spin-offs are not appropriate vehicles to commercialize inventions with a shorter time to market. When the time to market is short, companies will need to scale up production quickly. Under these circumstances, the scale up capability of large firms provides an advantage to commercialization. As the director of the TLO at University YY explained,

*It all depends on how far away is the market. If the technology is so close to commercialization and ready to go with tweaks and you could be hitting the big time in three years, you may need to be in an established company just so that you have the scale up questions resolved. But if you see the potential 5, 10 years down the road again, the start-up company has a better ability to be flexible with shaping and molding the technology to meet that anticipated potential. Obviously the further away you are the less defined and less certain you are that that it’s real, which also plays into a start-up probably more.*

#### **Reasons why the time to market does not matter**

In addition to the countervailing points of view about the effects of time to market on the appropriateness of a spin-off as a commercialization vehicle summarized above, several TLO directors indicated that the time to market would not affect the appropriateness of a spin-off company as a commercialization vehicle.

The TLO directors offered several reasons why the time to market would not matter. First, a shorter time to market benefits both spin-offs and established firm licensees. Because all firms benefit from a shorter time to market, spin-offs do not have any relative advantage when the time to market is shorter. As the director of the TLO at University B explained,

*“The farther along you are, the more you reduce the risk, which makes it more attractive to both an existing company and to a start-up.”*

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

*“In a pharmaceutical scenario where you’re in drug discovery, that’s going to take a lot of time whether you’re moving toward a license or whether you’re going the start-up route.”*

Second, the time to market does not matter for the appropriateness of spin-offs as commercialization vehicles because spin-offs are good for both inventions with long and short time horizons to get to market. As a result, there is no relationship between the appropriateness of spin-offs and the time horizon to market. As the director of the TLO at University B explained,

*“It can go both ways. It can be good for a start-up if it can go to market quickly. Say it is a piece of software that needs to be rewritten and made more rugged but basically can be shrink wrapped and put on a shelf somewhere. On the other hand it might be a pharmaceutical with long lead time that big pharma sees as too early.”*

Third, the time to market does not matter for the appropriateness of spin-offs as commercialization vehicles because the time to market is largely a function of technology type. As a result, biotechnologies tend to have long time horizons, whether the licensee is a spin-off or an established company, and software tends to have short time horizons, regardless of who the licensee is. As the director of the TLO at University R explained,

*“That’s a specific sector thing. You’ve got a lot longer timeline in life sciences than physical sciences.”*

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

*“We have to separate this by technology sphere. In the biopharmaceutical area, companies are required to bridge the development. In engineering and physical sciences, often things are further developed. For companies in the physical sciences and engineering area, it has to be closer to the market place and closer to revenue. The only place people are going to fund science projects is in the biopharmaceutical area. The non-bio people are almost uniformly looking for late stage investment.”*

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

*“I wouldn’t think about time horizon very hard because it depends on the field. I mean if it’s in software you’ll have the product out in a couple of years unless you really screw up. And if it’s in pharmaceuticals, it might be many, many years.”*

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

*“It’s not one of my major considerations. Obviously the quicker you can get going the better, but different technologies in different areas take different lengths of time. If you’re going to do something in the electronics or computer science area you’d better be hitting the ground running because that area tends to turn over every three or four years. You can’t expect to keep things in the market place and stay at the cutting edge for more than five or six years. After that someone is going to come along and improve and enhance that and go on to different things. In the life sciences, the stuff is going to have to go through an FDA approval process. Then you’re looking at 8 to ten years before you actually get a drug onto the market for sale.”*

Because the time to market varies with the type of technology, spin-offs use different business models to exploit different technologies. Thus, the time to market does not affect the appropriateness of spin-off companies as commercialization vehicles so much as it affects the business models that spin-offs use. With technologies that have a long time to market, spin-offs are usually designed to be vehicles to undertake part of the development process, not to be fully integrated companies. As the director of the TLO at University SS explained,

*“We do these start-ups and we know it’s going to be 12 years before they’d have a product to the market. But sometimes it’s useful to start a company and take a technology and add value to it. You form the company and you go after SBIR funding and you add value to your technologies. Then you sell the technology off or you sell the company off. So in those cases you may form a company just to get access to sources of funding that would not be available to an academic institution.”*

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

*“We know the path for maybe getting anything out of it would be shorter for software than a medical device or a drug. But we understand that and the company will start off and get it to a stage and either license it to a bigger biotech or be swallowed up by a bigger biotech. It’s going to take longer. That’s just the way you play the game itself there.”*

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

*“While investors like the later stage, of course all the biotech companies are pretty much early stage. For some start-ups the whole point is that they want to move the product far enough along to get acquired.”*

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

*It is generally recognized that in the biomedical field its 20 years from first observation in the laboratory of a new phenomenon to a product. Most startups in this area are essentially going to be drug delivery companies. So that’s not a 20 year horizon. You’re taking a known compound you’ve identified and you’re going to develop an appropriate delivery mechanism. Start-ups are simply a financial conveyance to move a technology forward. It’s not realistic to think*

*many start-ups are going to become fully integrated operating companies. Investors are being asked to take risks that will eventually be paid off or not by larger companies that have established channels for manufacturing, marketing and distribution.”*

Fourth, the time to market does not matter for the appropriateness of spin-offs as commercialization vehicles universities are simply trying to create jobs by creating start-ups. As long as the spin-offs hire researchers, the length of time to market does not affect their desirability. As the director of the TLO at University N explained,

*“It doesn’t matter for us since job formation is a really important part of what we do here. If we’ve got something that’s really ready to go and we think we can form a viable company that can generate jobs in the region then that’s what we’re going to do.”*

### **3. The Complexity of the Product Development Process Does Not Matter**

TLO directors believe that complexity of the product development does not influence the appropriateness of spin-off companies as commercialization vehicles. The TLO directors report countervailing effects for the complexity of the product development process on the appropriateness of spin-offs. Moreover, many TLO directors indicated that the complexity of the product development process does not matter for the appropriateness of a spin-off company as a commercialization vehicle.

#### **Countervailing effects: Reasons why established companies are better vehicles to commercialize inventions that require a complex product development process**

The TLO directors report countervailing effects of complexity of product development on the appropriateness spin-offs as commercialization vehicles. Many TLO directors believe that spin-offs are worse vehicles to commercialize inventions which require a complex product development process.<sup>3</sup> For example, the director of the TLO at University Q explained,

*“The more complex it is, the more pieces you have to assemble, the less likely you are to succeed with a start-up.”*

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

*“If you try to carry forward a very complicated, very sophisticated development program [with a start-up] that’s a mistake. I think if you can devote your efforts*

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<sup>3</sup> However, other TLO directors indicate that spin-offs are very successful with technologies that require complex product development. For instance, the director of the TLO at University L explained, *“I don’t think the complexity of producing a product or service is going to matter. We have this radiation treatment machine that’s \$2.5 to \$3 million that combines software and hardware. I don’t know if we have a more complex technology and it’s in a start-up and it’s looking really positive. It’s on the market and it’s treating patients. And the time for them to get to market has actually been quicker than other technologies we have.”* The disagreement between TLO directors on whether the complexity of the product development process made it relatively easier or harder for spin-off companies to development new technologies suggested that the complexity of the product development process does not influence the appropriateness of spin-off companies as commercialization vehicles.

*to helping the technology get into the hands of a talented management team with the right access to markets that's a much more effective way to handle things."*

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

*If the process of taking it through to commercialization is very complex, then we want to take a careful look at whether we felt that a start-up company could successfully develop the product to a point where there would be a reasonable strategy for an exit."*

The TLO directors offered several reasons why established companies are better vehicles to commercialize inventions that require a complex product development process. First, product development complexity requires companies to have greater management and production capability. Large, established companies are more likely than start-up firms to possess these capabilities. As the director of the TLO at University S explained,

*"I was at [a university] before this one and one of the technologies that came through was a new approach to sequencing polymers capable of having it take several years to sequence the DNA in a human cell to having it take two hours. Reducing that kind of technology to practice clearly needed a company that had a wide range of competencies from the basic research to all sorts of instrumentation competencies. In that situation, I would not have been keen on licensing to a start-up. If the application is complex and requires multiple disciplines to make it happen then maybe a start-up is not as appropriate as an established company that can do R&D and manufacturing and all the complexities that need to be done to commercialize it."*

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

*"If you have complexity that should just go to an established company who already has the facilities and everything else. To them it may not be that complex, versus complexity for a start-up. They could just bring it into their own operations and it's not complex at all to them where as a start-up you got to build a plant and labs and everything else from scratch. That means a lot of money. At the success of a start-up raising a lot of money that kind of money there better be a hell of a big payoff at the end or you're never going to raise that kind of money to get over the complexity."*

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

*"If they are far enough along, things in the biomedical sciences are best with an established company. They have the methods. They've got the models. They've got the high frequency screening. They have optimization systems. They have all of those things needed to take a human therapeutic forward. It's a tough thing for a brand new company to assemble all of those things."*

Second, established companies are better vehicles to commercialize inventions that require a complex product development process because start-up companies have limited financial resources. Resource constraints make it difficult for start-ups to undertake

complex product development processes. For example, the director of the TLO at University FF explained,

*“To some extent [complexity] does because a start-up typically has limited resources and a finite amount of time to use those resources to move a technology forward toward commercialization. At one extreme we typically think of a new drug candidate as not being suitable for a start-up company because of the long development cycle involved. You can’t expect a product on the market for 10 years or more. So perhaps where it is very complex and very difficult, it is maybe not the best candidate for a start-up company.”*

Because start-ups are resource constrained, they need to get to market and positive cash flow relatively quickly. Complex product development processes make that goal harder to accomplish. As the director of the TLO at University B explained,

*“It could be good for a start-up if it is straightforward to get to market. Then there’s cash flow and other applications to grow out of that.”*

Third, established companies are better vehicles to commercialize inventions that require a complex product development process because complexity of product development means that the licensee will have to obtain more capital, which makes large, established firm licensees, with their access to capital, more desirable. As the director of the TLO at University KK explained,

*“The complexity scenario says that it is going to require more capital. So it might lend itself more towards a licensing scenario where capital isn’t as big an issue. So if it’s more complex, then it’s less likely to be a start-up candidate.”*

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

*“You want something that’s not going to that the R & D is doable by a small company. If it’s very early on it’s going to take a whole lot of work to get to the market. And it might be tough for a start-up company to have the investment legs to get there. The more complex it is, the more research it’s going to take to go forward and the more money it’s going to cost. So in a lot of cases if it’s a very complex it’s nice to have a partner that has worked with that same degree of complexity and knows the technology area, as opposed to a start-up where usually neither of those things are happening.”*

Product development complexity makes raising capital from financial markets, a requirement for product development by new companies, even more difficult.<sup>4</sup> Complexity makes it difficult for entrepreneurs to tell a clear story of the value of the technology in a way that is convincing to investors. As the director of the TLO at University J explained,

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<sup>4</sup> Entrepreneurs often try to compensate for this difficulty by offering more equity in return for financing. However, this approach makes the spin-off route less attractive to the inventors. As the director of the TLO at University O explained, *“If it’s complex, they need lots of money and their going to have to raise money in the market place. They would have to give equity in return for the dollars.”*

*“If it’s very complex, sophisticated to the point where you can’t boil it down to a working model that everyone understands and gets, it’s never going to get out of the gate. You’re never going to be able to find the capital to support it.”*

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

*“When we put a start-up together, we try to do prepackaging so people will understand it and it’ll be attractive. The simpler the path to market, the easier it is to get funded. If you’ve got a complex intellectual property picture where everybody knows that for this invention you’re going to have to get three or four licenses from somewhere else, it’s very difficult to get financing. So complexity is very significant.”*

Product development complexity also increases the length of the time to market, as well as the ability to predict the time horizon. Consequently, it adversely impacts the financial returns that investors can earn. This makes the spin-off route less attractive to investors.

As the director of the TLO at University BBB explained, “

*Things that are expected to have a complicated clinical trial process tend to scare off investors and therefore start-up companies more so than it does the pharmaceutical companies. It comes back to the fact that they want to spend their money more quickly. They want to see that return on investment and a complicated clinical trial process means a long clinical trial process and they’re not going to get the return on investment as quickly.”*

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

*“The less complex is better for a start-up because investors are not going to invest in a company that’s not going to have a return in a foreseeable time frame.”*

Product development complexity also increases the amount of money needed to generate financial returns, which adversely impacts the attractiveness of the investment, making spin-offs less appropriate. As the director of the TLO at University MM explains,

*“Complexity would affect the investment needed to produce a product and the return on investment or it might influence the manufacturing costs.”*

Fourth, established companies are better vehicles to commercialize inventions that require a complex product development process because universities would like to have other entities pay the patent costs. The more complex the product development process, the less likely that spin-offs are going to be successful enough to pay the patent costs on university inventions and the more attractive large, established company licensees who can easily pay patent costs on licensed inventions will look. As the director of the licensing office at University HH explains,

*“If it’s going to be complex it is more likely that an established company with resources to spend a couple hundred thousand on research and development will be more likely to sign a license and pay for patent costs. Give us some up front fees and it is more likely that we’re just going to go that route than mess around with a start-up company that has a lot less likelihood of being successful.”*

**Countervailing effects: Reasons why spin-off companies are better vehicles to commercialize inventions that require a complex product development process**

In contrast to the TLO directors quoted above, other TLO directors think that spin-offs are better vehicles to commercialize inventions that require a complex product development process for two reasons. First, spin-offs can come up with more creative solutions to problems than established companies can identify. The ability to come up with creative solutions is particularly important when the product development process is complex. As the director of the TLO at University YY explained,

*“The complexity of the application space is probably where the start-up company has an advantage. Because they’re entrepreneurial, they can think more out of the box. They are not locked into a product strategy that that an existing company may already have.”*

Second, spin-offs are more appropriate vehicles to commercialize inventions that require a complex product development process because established companies are not interested in complex technologies, and cede them to spin-offs. As the director of the TLO at University P explained,

*“If it’s very complex it would be a huge challenge to get an established company interested in it because of the level of complexity.”*

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

*“If complexity means that there’s some probability of failure in putting all the different pieces together then it’s less attractive as a licensing issue because the key to licensing to an established company is risk. If there’s a lot of risk, you will find very few companies that will be interested until the technology is developed further and the risk is mitigated.”*

**Reasons why product development complexity does not matter**

In addition to the countervailing points of view about the effects of product development complexity on the appropriateness of spin-offs as commercialization vehicles, several TLO directors indicated that the product development complexity would not affect the appropriateness of spin-off companies as commercialization vehicles. As the director of the TLO at University H explained, *“I don’t think that complexity matters for whether or not it should be a start-up.”*

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

*“I’m not sure how high on the list that actually comes through. I don’t think we tend to look at complexity of the product development cycle as a major factor in our decision making.”*

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

*“We’ve seen all kinds of products be commercialized and some are not especially complex, but, if there’s a market, even complex inventions can create new businesses over time. It’s not directly dependent on the complexity.”*

The TLO directors offered several reasons why product development complexity does not affect the appropriateness of spin-off companies as commercialization vehicles. First, complexity affects the commercialization efforts of small, start-up companies and large, established companies equally. As the director of the TLO at University F explained, *“The complexity wouldn’t tend to point you to either a new company or an established company.”* Similarly, the director of the TLO at University X explained, *“Complexity influences whether it’s going to get sold or not sold at all.”*

Second, product development complexity does not affect the appropriateness of spin-off companies as commercialization vehicles because there are effective paths to commercialization by spin-offs for products with both complex and simple product development paths. As a result, the main effect of product development complexity is to determine the approach used by spin-off companies. As the director of the TLO at University TT explained,

*“The complexity will dictate the time to market. So if we’re going the VC route, it can’t be very complex. Otherwise we’re not going to be able to do it. Or it’ll dictate that we have to raise more money in order to accelerate the development and put more people on it. That’s not to say that we won’t go the start-up route because we’re not just looking a VC fundable opportunities. We may package some resources around them and push them in the director of SBIRs to further develop over a 10 year period and maybe help them put together strategic partnerships that’ll help them to get to market faster even if it’s complex.”*

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

*“A lot of the start-ups that I’ve been involved with are in the biomedical space. What’s more complex than taking a drug through the FDA and getting a product to market? It costs \$800 million and it takes 12 years. Yet that’s an approach that a lot of folks are taking. It’s not that a start-up would ultimately commercialize the drug, but they’re going to take it to phase one or phase two and then sell it to big pharma to take it through the clinicals. But that’s a complex process and that’s a viable type of start-up that we would support.”*

#### **4. The Primary Technology Type Does Not Matter**

TLO directors believe that the primary technology type does not influence the appropriateness of spin-off companies as commercialization vehicles. Different types of technology offer different advantages and disadvantages to spin-off companies, rendering no technology type dominant.

#### **The technology type does not affect the appropriateness of spin-off companies**

Many of the TLO directors indicated that the primary technology type does not affect the appropriateness of spin-off companies as the commercialization vehicle. As the director of the TLO at University E explained, *“In terms of appropriateness for a start-up, I don’t think it matters.”* Similarly, the director of the TLO at University O explained, *“The type of technology doesn’t matter at all.”* Furthermore, the director of the TLO at University L explained, *“To my knowledge, the core spheres of technology – biological, chemical, mechanical, electrical, software – don’t matter.”* Finally, the director of the TLO at

University G explained, *“If the technology has value and commercial potential, then it doesn’t matter if it’s biological, mechanical, whatever.”*

### **Different technology types identified**

Some of the TLO directors did indicate that some technology types were more appropriate for spin-off companies than others. However, they disagreed about which technology types are most appropriate for spin-offs. Some of the TLO directors indicated that biotechnologies less appropriate for spin-offs than other technology types. For example, the director of the TLO at University VV explained,

*“We don’t see pharmaceutical products as good start-up company products. We prefer established companies. It’s just so such a long time horizon to market that it’s tough for a small company to develop a pharmaceutical. The odds of actually getting to market are higher with a pharmaceutical firm.”*

These TLO directors tended to indicate that software and engineering technologies were more appropriate for spin-offs than biotechnologies.<sup>5</sup> One reason for the greater appropriateness of software and engineering technologies is the fast time to market. The fast time to market means that spin-offs can be cash flow negative for a shorter period of time. As the director of the TLO at University J explained,

*“The whole area of electrical engineering and computer science is more applied than other areas. Product cycles are short and quick.”*

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

*“The time to market on the engineering stuff and software is usually pretty quick. If you’re talking pharmaceuticals or something like that the time to get things developed and then through all the qualification process it’s extremely long.”*

Furthermore, the director of the TLO at University BB explained, *“Software is better for spin-offs because it doesn’t take as long to get to market.”*

Another reason why software and engineering technologies are more appropriate for spin-off companies is that they are less risky. The lower risk makes it easier for spin-offs to raise money and to pursue product development. As the director of the TLO at University M explained,

*“IT is much easier to do. Life sciences just take so much money, are so high risk and are so long term. Probably anything other than life sciences is much easier than that.”*

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<sup>5</sup> Some TLO directors indicated that spin-offs in software and engineering might not be more appropriate than spin-offs in biotechnology, just easier for inventors to start. Because inventors can start these types of companies without getting outside entrepreneurs involved, the firm creation process is easier, making it more likely to occur. As the director of the TLO at University Y explained, *“Software is seen as a relatively easy way to start up. When you have faculty interested in doing a start-up, it’s usually related to software because there is a component of their consulting and their expertise that comes in. So typically if you have software, you have more faculty members interested in engaging and setting up a company. The resources are also less than for other technologies.”*

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

*“It is easier to do a software start-up because it’s not so expensive and it’s not so risk laden.”*

However, other TLO directors indicated that biotechnologies more appropriate for spin-offs than other technologies. One reason is the greater financial payout for successful company creation with biotechnologies. The higher payout makes the expected value of an investment in creating a spin-out in biotechnology higher than in other technologies. As the director of the TLO at University V explained,

*“It’s the payouts. One big time winner is enough to make you a winner overall because the payoff is so big. You do one drug that turns into a billion dollar product and you’ve washed out the other nine investments and have made money.”*

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

*“The chances of a therapeutic startup making people a bunch of money is probably higher just because the stakes are higher. The failure rate is greater and the success is more rewarded. The down stroke on a company that’s going after a therapeutic market is over several million dollars for starters.”*

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

*“Biological inventions appear to be larger from a dollar point of view than a lot of engineering inventions and that makes them easier to spin out than more basic engineering inventions.”*

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

*“I think biologics and biotech compounds – new molecules or new biotech approaches to therapeutic treatment of disease is in my view the best. I think the payoff potential explains why. The markets are just enormous.”*

Another reason why some TLO directors indicated biotechnologies are more appropriate for spin-offs than other technologies is the strength of intellectual property protection that can be obtained on the inventions. The strong intellectual property protection makes the spin-offs in biotechnology more attractive acquisition targets. As the director of the TLO at University AAA explained,

*“I think that that healthcare patent protected compounds and patent protected medical devices are always a bit more attractive. Those are models that are based more on the strength of your patent than your marketing abilities. If you come up with a cure for cancer and you have the data on it, you don’t have to be savvy a marketing guy to sit in front of a cancer company and sell it to them. Most of our spinouts are not necessarily developing products so we can actually get to market ourselves. Most of our spin-offs are position for M & A.”*

### **Reasons why technology type does not matter**

Many of the TLO directors explained that the technology type has no effect on the appropriateness of spin-off companies as commercialization vehicles. They offered

several reasons why. First, different technology types offered different advantages and disadvantages to spin-off companies. As a result, the advantages of one type of technology were offset by the advantages of another. As the director of the TLO at University F explained,

*“The basic underlying technology does not matter particularly. It’s not as simple as pharma takes so long it’s not as good as IT which takes less time. The flip is also true. IT takes less time, but it lasts less long too.”*

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

*“I think software will get you in faster at low risk but maybe lower the reward than say a medical device or drugs which will take a lot long a lot more money but the rewards will be a lot higher. Normally we would still go with go with the start-up in both of those cases and in the intermediate case also with electronics.”*

Second, the technology type has no effect on the appropriateness of spin-off companies as commercialization vehicles because there are effective paths to commercialization by spin-offs for all technology types. As a result, the main effect of technology type is to determine the approach used by spin-off companies. As the director of the TLO at University T explained,

*“I don’t know that any one is necessarily better. I think some of the hurdles to financing these opportunities are different. If you’re looking at chemical, you’re not going to do a start-up on a commodity chemical, but if you have a specialty chemical, you can start a company relatively easily. With therapeutics, on the other hand, you are looking at fairly drawn out development cycles. You’ve got all the vagaries of dealing with biological systems and physiological responses and everything else. But you’ve got significant upside if you can get through all the clinicals appropriately and you have produced something that works better than something else out there and has minimal side effects.”*

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

*“I think each has their own characteristics and different reasons why they go the start-up route. In computer science it doesn’t take much. Anything that’s physical sciences and engineering, those aren’t industries that are real receptive to in licensing. They’d rather buy the company than license the technology. So even though a particular piece of technology may not fit all of the headline criteria for a start-up, I’m more likely to want to move in a start-up there. You’re more likely to prove the principle and then get acquired. Life sciences are easiest to see what the product is – easiest to see the path to market – but the time frames are very, very long.”*

### **Characteristics of the Intellectual Property Protection that can be Obtained**

The interviews with the TLO directors revealed that one characteristic of the intellectual property protection thought to increase the appropriateness of spin-offs as vehicles to commercialize technology – the number of patents that can be obtained – does not appear to influence the appropriateness of spin-offs as predicted.

### ***1. The Number of Patents Does Not Matter***

TLO directors believe that the number of patents that can be obtained on a university invention does not influence the appropriateness of spin-off companies as commercialization vehicles. TLO directors believe that the number of patents has countervailing effects on the appropriateness of spin-offs. Moreover, many TLO directors indicated that the number of patents does not matter for the appropriateness of a spin-off company as a commercialization vehicle.

#### **Countervailing effects: Reasons why obtaining more patents makes spin-offs more appropriate**

The TLO directors report countervailing effects of the number of patents that can be obtained on an invention and the appropriateness of spin-offs as commercialization vehicles. Many TLO directors believe that spin-offs are more appropriate if more patents can be obtained to protect an invention. As the director of the TLO at University BB explained, *“The number of patents you can get influences you toward a start-up”*.

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

*“Almost always in our start-ups there is a suite of patents that are included in the licenses. We try to cluster related technology.”*

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

*“I can’t remember the last time we tried to build a new company around a single patent. We generally work pretty hard to develop the portfolio position from where there an initial observation to stake out additional claims to address other issues related to commercialization.”*

The TLO directors offered several reasons why spin-offs are more appropriate vehicles to commercialize inventions that can be protected by more patents. First, an interlocking wall of patents provides protects an invention better than a single patent (Shane, 2004). Start-ups are more in need of a “picket fence” of patents to protect their technologies than established companies because the start-ups lack alternative sources of competitive advantage. As the director of the TLO at University O explained,

*“How many patents are there in the portfolio? If you have a portfolio of patents, you have better protection for a start-up.”*

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

*“With a suite of patents, it’s more likely that a start-up would work because you have broader coverage. It’s relatively rare that we’re starting up a company around just one patent.”*

Second, spin-offs are more appropriate if more patents can be obtained to protect an invention because the marginal benefit of additional patents is greater to spin-off companies than to established companies. For spin-offs, which lack patents of their own, the second patent to an invention doubles the number of patents that protect an invention. However, for established companies, which have their own patents on inventions related to the ones that they license from universities, a second university patents increases the

number of patents protecting the university invention by less than 100 percent. As the director of the TLO at University GG explained,

*“Are more patents better for a start-up? Yes, to a degree. If we have three patents, does that give a start-up an advantage? Yes. Do three patents make a difference to a large company versus one patent? Probably less so.”*

Third, spin-offs are more appropriate if more patents can be obtained to protect an invention because multiple patents provide barriers to imitation while the value chain to produce the new product or service is developed. Because established companies often have this value chain in place from previous operations, this value is greater in the case of spin-off companies. As the director of the TLO at University U explained,

*“A good patent position would be one that has multiple patents filed across different aspects of the invention that cover a lot of the waterfront. We think of them as a picket fence. We’re trying to build a fence around our intellectual property. You need to push the Mongol hordes back a ways from your castle and you have more time and breathing space to build a company to the point where you’ve developed some brand recognition and you can slide away from relying only on your patent protection to stay in business to where more of the traditional things that make businesses successful – efficient management, appropriate use of capital, market penetration, advertising, sales, customer support, service.”*

Fourth, spin-offs are more appropriate if more patents can be obtained to protect an invention because investors prefer start-up companies with more patents. Therefore, having more patents enhances the ability of university spin-offs to raise external capital. As the director of the TLO at University D explained,

*“Investors look at the portfolio and are impressed with a larger number of patents. A portfolio of patents is usually well received by the investors.”*

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

*“I would rather have I would be more likely to do a start-up on having 10 patents that covered a whole bunch of different things and being able to roll them up in a pool. And have a much a much broader technology portfolio to do a start-up than just to do it about around a one trick pony. And by the way it’s also imminently more fundable if I’m going to go out and try and raise money.”*

Furthermore, the director of the TLO at University II explained, *“Primarily, patents are what interest investors, and the more the better.”*

The TLO directors identified two mechanisms through which multiple patents increase the ability of spin-offs to raise money. Patents are an observable source of competitive advantage, unlike intangible factors such as “know how”. Investors prefer tangible sources of competitive advantage because they are easier to evaluate. This easier evaluation facilitates fund raising by new ventures, which, in turn, makes spin-offs more appropriate. As the director of the TLO at University ZZ explains, *“For start-ups you’d want to have more patents because it provides easier evaluation by investors.”*

In addition, multiple patents also reduce investors' perceived risk. By obtaining patents on a variety of applications, a spin-off can demonstrate protection against a variety of sources of competition. This breadth of protection makes investors more comfortable, and facilitates fund raising. As a result, it makes spin-off companies more appropriate. As the director of the TLO at University T explained,

*“A lot of patent attorneys use this picket fence approach to protection. You have your base patent out there – say a composition of matter – and then you go out and patent all these other utility patents that can be used for cancer, for neurological disease. It's useful. Is it necessary, probably know, but is certainly helpful. It allays the potential investor's fear of investing in something. If you can demonstrate that you've got broad patent coverage and you've got coverage in a number of potential benefits. It certainly works to your benefit if you're just trying to do straight licensing as well, but it would be more beneficial to a start-up.”*

### **Countervailing effects: Reasons why obtaining more patents makes spin-off companies less appropriate**

In contrast to the TLO directors quoted above, other TLO directors do not believe that the number of patents that can be obtained on inventions increase the appropriateness of spin-off companies as commercialization vehicles. As director of the TLO at University FF explained,

*“If you have one solid patent that is truly innovative and creative, that's enough to start a company. The company would then build its own portfolio.”*

In fact, several TLO directors believe that obtaining more patents actually makes spin-off companies less appropriate as commercialization vehicles and offered several reasons why. First, inventions protected by more patents are more expensive. Because spin-offs are capital constrained, they are better off obtaining same intellectual property protection in a more cost effective manner. As the director of the TLO at University DD explained,

*“For a start-up it's a problem to have lots of little patents carving up the domain into little incremental slices. It's expensive to do that. And for a start-up to be laden with an intellectual property portfolio that is really expensive and providing mostly just a picket fence is not good. We're looking for fewer and more powerful patents rather than lots of less powerful patents.”*

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

*“The number of patents you can you can get is a cost problem for whoever has it who has licensed the technology if it's a start-up. They'd better have money if this is going to be a platform for example technology where there's going to be a dozen US patents. They'll go broke.”*

Second, the number of patents that can be obtained on inventions decreases the appropriateness of spin-off companies as commercialization vehicles because start-ups cannot make as effective use of multiple patents as established firms can. Their small size and early stage of development makes it difficult for them to develop multiple

product applications simultaneously, the way that large, established firms can.<sup>6</sup> As the director of the TLO at University M explained,

*“There’s no way that a startup could take advantage of all of it. What they might do is then sublicense out parts of it. But all that does is dilute the return to the university, and that’s not really attractive.”*

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

*“The number of patents you can you can get is a cost problem for whoever has it who has licensed the technology if it’s a start-up. They’d better have money if this is going to be a platform for example technology where there’s going to be a dozen U.S. patents. They’ll go broke.”*

Third, the number of patents that can be obtained on inventions decreases the appropriateness of spin-off companies as commercialization vehicles because universities their licensees to pick up the patent costs. Large, established firms with ongoing operations are more likely than spin-offs to have the cash to be able to do this. Spin-offs often require equity investment in lieu of payment of patent costs (Shane, 2004), requiring universities to pay the cash necessary to obtain the patents. As a result, licensing multiple patents to a spin-off often puts universities in a cash flow that does not exist when licensing to established firms.<sup>7</sup> As the director of the TLO at University YY explained,

*We want our licensees to help us with patent expenses. That could be a factor with some start-ups because it can be very expensive. If we feel as though we’ve got something that’s really substantial, and it’s going to require a multitude of patents in several countries, that could be an expensive bill. The resources the start-up company has could influence us somewhat.*

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

*“If you had a broad portfolio you’d probably be in a better position to license it to an existing company. They would tend to fund the subsequent patent costs. So you don’t have to fund that money and then look to get reimbursed later on.”*

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

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<sup>6</sup> One reason why spin-offs cannot make as good use of multiple patents as established companies is that many TLOs restrict the rights of spin-offs to use patents to specific fields of use. This pressure to focus encourages the successful development of university spin-offs (Shane, 2004). However, it also suggests that spin-offs are better off with patents that protect technologies only in the fields of use in which the new companies operate. As the director of the TLO at University CC explained, *“We don’t usually grant start-ups a license to do whatever they want because we want them to focus. One of the biggest pitfalls of a start-up is that they think they can do everything and we don’t think that they can do everything.”*

<sup>7</sup> However, one TLO director indicated the desire to push the costs of patents out of the technology licensing office would make him more likely to use a spin-off. As the director of the TLO at University Y explained, *“We like to pass of the cost of protection to our licensees. So if we’re going to be filing a lot of patents we would probably want to do a start-up to push the cost out of the office.”*

*“We have to be very sensitive to the cost of patents. It would be better to have a large company that’s paying for all these patent costs. It may be better to license it to an established company versus a start-up.”*

### **Reasons why number of patents that can be obtained does not matter**

In addition to the countervailing points of view about the effect of the number of patents on the appropriateness of spin-offs as commercialization vehicles, several TLO directors indicated that the number of patents was not a relevant factor in determining the appropriateness of a spin-off company as a commercialization vehicle. As the director of the TLO at University Z explained,

*“I do not think at all about the number of patents. I am not going to sit there and worry about divisionals and continuations and say we can branch this out and get a portfolio with ten patents out of this.”*

The TLO directors offered several reasons why the number of patents that can be obtained on an invention does not affect the appropriateness of a spin-off company as a commercialization vehicle. First, the number of patents needed to protect an invention is a function of the technical field. Therefore, the number of patents that can be obtained to protect an invention a reflection of the underlying technology type more than anything else, and has no bearing on the effectiveness of protection. As the director of the TLO at University S explained,

*“The breadth depends on the area. In chemical space, one can get a broad space through the patent office and that kind of patent alone could drive a start-up. But in the area of chip technology where patents tend to be quite narrow, you might need 50 patents.”*

Second, the number of patents that can be obtained on an invention does not affect the appropriateness of a spin-off company as a commercialization vehicle because the content of patent claims is what provides patent protection. Because the content of patent claims is not affected by the number of patents that protect an invention, the number of patents does not provide the greater intellectual property protection that spin-off companies need. As the director of the TLO at University T explained,

*“I don’t think it’s the number of patents. I think it really has to do more with the strength of the claims that you can make.”*

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

*“The number of patents isn’t relevant; it’s the strength of the patents. If you have one patent that is very broad and covers all of your products very well, it would be very difficult to get around. The number of patents is not necessarily relevant to the strength of the intellectual property position.”*

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

*You may have a single patent that is a very broad fundamental platform with a huge multi-billion dollar market potential that has greater inherent value than 25 other patents.”*

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

*“If I had only one patent but it was an absolute dynamite barrier to market patent I would be much happier than if I had a whole portfolio of patents all being very expensive, but that didn’t provide an adequate barrier.”*

Third, the number of patents that can be obtained on an invention does not affect the appropriateness of a spin-off company as a commercialization vehicle because multiple patents only reflect the efforts of the U.S. Patent and Trademark Office to divide patents. Thus, the number of patents is an artifact of the process of obtaining protection and does not reflect the amount of protection that has been obtained. As the director of the TLO at University G explained,

*“The patent office is going to restrict you. If this is an important invention, you are going to have to do a divisional here and we’re going to end up with two patents, but that’s the same [protection] as one. So obviously we try to roll it into one patent to force the costs down.”*

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

*“As patents get prosecuted in the patent office, they get narrowed and we end up filing more patents.”*

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

*“You’re not going to get a single patent with a panorama of claims because the PTO’s going to divisionalize them. The breadth of protection is the diagnostic rather than the number of the patents. Investors like to feel like they’ve got the whole waterfront covered and they’re going to advise you to get more patents. But the only reason to want more patents is because you want more claims.”*

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

*“Number of patents are irrelevant and often dictated by patent laws. A single patent can be divided into multiple patents.”*

Fourth, the number of patents that can be obtained on an invention does not affect the appropriateness of a spin-off company as a commercialization vehicle because the number of patents reflects little more than the strategic choice of the organization filing for the patents. Universities can seek to obtain one patent or multiple patents to protect the same invention. Because the underlying invention and the resulting intellectual property protection are the same, regardless of the institution’s choice about the number of patents to file, the number of patents does not affect the appropriateness of a spin-off as the commercialization vehicle. As the director of the TLO at University OO explains,

*“You can sort something into one patent or you could sort it into 8 or 9 patents. So the number of patents really is irrelevant. It’s the strength of claims and protection that the claims offer. You can have two claims that offer more protection than 15 claims, so you can’t really go by numbers at all.”*

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

*“I think the number itself doesn’t matter, but reflects the way in which you establish the broad footprint in the patent landscape by following on numerous aspects of the invention. Ours tend to be so early in their development that it’s not uncommon to file the initial discovery and then file improvement patents along the way as specific embodiments are developed or additional data indicates new indications, things of that type.”*

### **Characteristics of the Industry in Which the Invention Would Be Applied**

The interviews with the TLO directors revealed that three characteristics of the industry in which a university technology would be applied thought to increase the appropriateness of spin-offs as commercialization vehicles – (1) the importance of manufacturing, marketing and distribution to the value chain; (2) the size of the market, and (3) investor interest in funding the industry – do not influence the appropriateness of a spin-off.

#### ***1. The importance of manufacturing, marketing, and distribution to the industry value chain does not affect the appropriateness of a spin-off as the vehicle to commercialize university inventions.***

Although some TLO directors believe that importance of manufacturing, marketing, and distribution to the industry value chain reduces the appropriateness of spin-offs as commercialization vehicles, many TLO directors indicated that importance of these assets to the industry value chain does not affect the appropriateness of a spin-off company as a commercialization vehicle.

### **Reasons why spin-offs are less appropriate vehicles to exploit inventions in industries in which manufacturing, marketing, and distribution are important to the industry value chain**

Some TLO directors believe that spin-offs are less appropriate in industries in which manufacturing, marketing, and distribution are important to the industry value chain. For instance, the director of the TLO at University G explained,

*“If it’s a technology like a manufacturing process, it could be very difficult for a start-up to commercialize.”*

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

*“If there were significant distribution hurdles and if we didn’t think we could get into the market, we probably wouldn’t start the company. Maybe we had a product that we thought customers would accept and we could get good market share but we just didn’t have the distribution channels to get in there then we probably wouldn’t start-up the company.”*

The TLO directors offered several reasons why spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain. First, when these assets are important to the industry value chain, large, established companies with industry experience are more desirable licensees because they have experience producing and selling similar products. As the director of the TLO at University BBB explained,

*“It matters to the extent that everybody looks at that and says holy cow how am I going to make that drug feasibly and predictably. We tend to think that something like a protein that’s going to be difficult to make is going to be a little bit more appealing to a pharmaceutical company who has been through that before.”*

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

*“I would lean away from start-ups in industries that rely on manufacturing efficiency and things that depend on the strength of the ‘know-how’ that builds up in an existing corporation.”*

Second, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because established firms tend to be much more efficient than start-ups in these industries. Established firms have the advantages of experience and economies of scale in manufacturing and marketing. As the director of the TLO at University V explained,

*“Semiconductors are tough because it’s so well developed. If you come up with a new technology it’s just easier to license it than to start a new company. Industrial processes are awful. If you come up with some new algorithms that make MRI devices work better or make companies have a more efficient manufacturing process, those things are impossible for start-ups.”*

Third, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because spin-offs have to make large capital investments to compete with established firms in these industries. Because spin-offs’ cost of capital is so high they are less likely to be successful than established firms in these industries. As the director of the TLO at University XX explained, *“The capital intensity of manufacturing is going to make it more difficult for a start-up.”*

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

*“If it’s a technology that’s going to involve a lot of advancement – somebody has got to build a plant to make this thing – we are not going to think that this is a very good source to license the technology to because they don’t have the financial wealth unless, of course, the start-up will sublicense to a third party that will manufacture.”*

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

*“It may be that you have to actually manufacture something and that’s going to be it less likely to be a start-up because manufacturing is capital intensive, but it is stuff you need to scale up.”*

The director of the TLO at University DD illustrated this situation by contrasting the semiconductor industry with the software industry. He said,

*We’ve gotten a lot of inventions over the years in semiconductor technology and it’s hard to move that into a start-up because it costs so much money to get the equipment and build the manufacturing capability to build these devices.*

*Software is easier because overhead is low. You don't have to have a manufacturing facility like you do in semiconductors or in biological products."*

Fourth, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because spin-offs face the difficulty of creating an effective distribution system. Given the difficulty of establishing an effective distribution network from scratch, licensing to an established company with a distribution network in place is a more appropriate way to commercialize a university invention. As the director of the TLO at University FF explained,

*"Would a small company have access to the market? How would they gain access? Is there only one customer in the world? Are there hundreds of thousands of customers? How do you access those customers? Are they going to use distribution channels? Are they going to create their own distribution? Those certainly are factors."*

Similarly, the director of the TLO at University DD said,

*"If distribution is complicated, a start-up isn't going to be able to develop a distribution network. That makes it more of a daunting task for your start-up."*

Fifth, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because spin-offs have trouble obtaining access to key assets (Shane 2001). Often these assets are under the control of established firms, particularly if they are specialized (Shane, 2004). To control specialized assets requires ownership solutions to mitigate bargaining problems, and new firms rarely have the financial resources for vertical integration of the value chain (Teece, 1987). The director of the TLO at University A explained the problem of obtaining access to key assets. He said,

*"Some industries rely on retail. Take, for example, the secondary automotive market. There's always an invention a brake light that's going to save insurance companies a million dollars. Well the reality is that you have to be able to sell to the secondary parts market and that's not an easy market to break into. Wal-Mart does not give you space on a shelf because you've got a better solution to a problem."*

Sixth, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because sales are bundled. As a result, spin-offs, which lack a broad product line, cannot get access to customers. As the director of the TLO at University XX explained,

*"If they're fairly standard supply things, you come up against bundled sales. We had one company that had this new syringe. They thought that this was going to allow them to get into the medical market. Well that the syringe market is dominated by J & J and the hospitals just don't buy syringes they buy a whole bunch of stuff. So that the fact the way that distribution system works can be an impediment to trying to do a start-up. You're better off trying to get the thing licensed to someone that has that that channel power."*

Seventh, spin-offs are less appropriate commercialization vehicles in industries in which manufacturing, marketing, and distribution are more important to the industry value chain because they do not have a large enough volume of sales to make their marketing and distribution activities cost effective. As the director of the TLO at University GG explained,

*“They have to describe how they are going to do it. It’s not realistic for a start-up to say I’m going to field 100 sales representatives within some reasonable point of time. So is there an alignment between how the technology does to market or gets to the market and the customers?”*

### **Reasons why the importance of manufacturing, marketing, and distribution to the industry value chain does not matter**

Despite the arguments presented above, several TLO directors indicated that the importance of manufacturing, marketing, and distribution to the industry value chain was not a relevant factor in determining the appropriateness of spin-off companies as commercialization vehicles. As the director of the TLO at University E explained,

*“I would not necessarily be less inclined to have a start-up in an industry that is marketing or manufacturing intensive if the marketplace shows that there is significant sales potential.”*

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

*“That’s more of a business concept as opposed to making a decision at the university whether or not to put the technology into a start-up.”*

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

*“I would say no because it’s too far down the chain. Hopefully, in a few years the CEO of the start-up considers the problem and solves it.”*

Finally, the director of the TLO at University Q explained, *“That’s probably something left to the management team and not this office.”*

The TLO directors offered several reasons why the importance of manufacturing, marketing, and distribution to the industry value chain does not affect the appropriateness of spin-off companies as commercialization vehicles. First, many TLO directors believe that university spin-offs are unlikely to emerge as vertically integrated companies, and are merely vehicles to develop technologies. As a result, these companies will be acquired long before they seek to produce or market products.<sup>8</sup> As the director of the TLO at University Z explained,

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<sup>8</sup> Several of the TLO directors pointed out that the strategy of creating a spin-off that would merely engage in technological development and advance a technology to the point that it would become interesting to a large, established, company was very common among biotechnology spin-offs. As the director of the TLO at University U explained, *“In pharmaceuticals, your intent is to cash out and had it off to somebody else who’s going to take it in and do the actual sales and distribution. That’s done more in the pharmaceutical industry than anywhere else.”* Similarly, the director of the TLO at University Y explained, *“In the biotech industry we know that a start-up is never going to have a marketing arm. At some point if they have a product that’s approved by the FDA they will enter into some kind of relationship with big pharma to take*

*“I don’t think a lot about marketing and distribution. Most of the companies we have been involved in are an acquisition strategy. I wouldn’t say it’s 100 percent but that’s certainly where we see a lot of the activity. We don’t sit down and think about those particular channels to any great extent.”*

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

*“Many of our startups don’t want to grow up to become fully integrated companies. The university does research at the basic level for ten years on something that is typically federally funded. Then when that something is close to being a commercial product it is appropriate for us to start-up a company to work on it for the next 2 to 5 years in what we call translational research model. Their exit strategy is simply to merge or be acquired. They don’t aspire to be a company that has world wide distribution and outreach. They’re simply taking it one step further than what is appropriate for a university to be doing, and then making them attractive to merger or acquisition. It’s just the model that we’ll take it through the translational research stage.”*

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

*“A lot of start-ups from the beginning have an exit strategy. Very few of them want to be in the in the same business when it comes to manufacturing and distribution many of them exit before that comes around. So there are a lots of ways you can create a start-up where those may not be really big issues.”*

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

*“These days many of the start-ups are getting bought by other folks early in their life. If the exit strategy is acquisition rather than say a public offering manufacturing and distribution are less important. While you need to wave your arms around it in a business plan, it’s kind of a placeholder that says to investors that I’ve thought about this stuff rather than here’s the way we are going to do it.”*

Second, the importance of manufacturing, marketing, and distribution to the industry value chain does not affect the appropriateness of spin-off companies as commercialization vehicles because spin-offs can form alliances and partnerships with large, established firms to provide the manufacturing, marketing, and distribution. As the director of the TLO at University F explained,

*“Manufacturing or marketing intensive industries are not necessarily a problem because most start-up companies that we ultimately see are going to somehow partner with a bigger company anyway.”*

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

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*advantage of the marketing and distribution network. So it may have an impact more on the exit strategy of the company than a decision whether to start a company or not.”* Furthermore, the director of the TLO at University M explained, *“When you talk about a life science product all they do is add value to the technology and take it out three to five years and license it to big pharma.”*

*“It hasn’t as much in the therapeutic space because everybody pretty much expects that the distribution and production issues are solved by partnering with big pharma.”*

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

*“If distribution channels are an obstacle, instead of developing your own distribution channels, the model would be to partner with somebody to help you do the distribution. If it were easy to set up the distribution channels, then the company would pursue that by itself.”*

Because of the alliance/partnership option, the importance of manufacturing, marketing, and distribution to the industry value chain does not affect the appropriateness of a spin-off as the commercialization vehicle. Rather, it affects the right strategy for a spin-off to follow to operate in the industry.<sup>9</sup> As the director of the TLO at University RR explained,

*“If you have a start-up company that’s developing a product and the company isn’t going to be integrated into the distribution system, your strategy as a start-up may be to enter into a partnership with a major company that has a lot of marketing muscle. Your strategy may be to be acquired by a company with a lot of marketing muscle so that you don’t have to do it yourself. But if the strategy of the start-up company were to take this all the way to the market and to do that by itself, and it was difficult to compete in that way, that would have an impact.”*

Similarly, as the director of the TLO at University L explained,

*The importance of marketing and distribution just influences “how soon and where they need to go when they put sales and marketing into their operation. Do they outsource it or do they build those sales networks themselves?”*

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

*“If it is a start-up that has to do all of its own manufacturing and its own distribution, that becomes capital intensive and that’s difficult. If they can job it out, that’s good for starting a company. Distribution is always difficult. But if*

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<sup>9</sup> Several of the TLO directors provided the example of biotechnology spin-offs to illustrate why marketing and distribution intensity of an industry need not affect the appropriateness of a spin-off company as a commercialization vehicle. The use of partnerships with pharmaceutical firms to obtain access to marketing and distribution assets solves this problem. As the director of the TLO at University C explained, *“If you look at the biomedical area, they’re pretty marketing intensive. A lot of those companies are not going to be totally vertically integrated. Their ultimate goal is to be acquired or to license. They will partner with big pharma that has that big marketing arm. I think there are opportunities even though you will need marketing and manufacturing as long as you have the right partner down the road.”* Similarly, the director of the TLO at University N explained, *“I wouldn’t think stage of development matters. Looking at the pharma side, there seems to be a significant use of start-up companies as vehicles to bring in some outside invention that moves the technology forward to a point where it’s ready to enter clinical trials with the expectation that the company itself will be an acquisition target or out license to a more established company that is waiting in the wings to see if the early stage work is acceptable. In other senses, I see things that might be very embryonic in their stage of development that do not lend themselves to a start-up.”*

*you can sell the product to a company that gets your distribution rights, then you are okay.”*

Second, the importance of manufacturing, marketing, and distribution to the industry value chain does not affect the appropriateness of spin-off companies as commercialization vehicles because spin-offs can work with contract manufacturers and distributors to produce and market their products. As the director of the TLO at University XX explained,

*“If there are contract manufacturers in the industry, you just contract it out once you develop it. So you rent the equipment basically to have your product made as opposed to having to raise some money to buy it.”*

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

*“Often one can find outsourcing possibilities for manufacturing. So a little company can be outsourcing in the beginning and then could make its own little plant after a while.”*

The director of the TLO at University GG provides the example of the semiconductor industry to illustrate why manufacturing intensity of an industry value chain need not adversely affect the appropriateness of spin-off companies as commercialization vehicles. He said,

*“We have had people that have designed a new form of computer memory and you would need a plant the size of an Intel manufacturing facility and the capabilities aligned with something that Intel would create to exploit it. There’s almost no chance of a start-up being able to pull that off. So we didn’t look to a start-up even though the inventor was inclined to do it in that case. On the other side, we had a company that was spun off in the MEMS field where they could get wafers from the foundries there now – if you give them a design they can produce it for you rather than the things having to go solely to Intel. So being able to access these foundries and get a wafer built to your design and your specs enabled us to do a start-up where five years ago we couldn’t because of manufacturing capabilities.”*

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

*“I think it is really hard to break in if manufacturing capability is important. But semiconductor companies can go to Taiwan and get the manufacturing done. If they can do that, then the start-up is fine. If they have to build a facility themselves, then that’s a whole other story.”*

## **2. The size of the market in which the invention would be applied does not matter**

TLO directors believe that the size of the market in which the invention would be applied does not influence the appropriateness of spin-off companies as commercialization vehicles. The TLO directors report countervailing effects for the size of the market on the appropriateness of an invention as the basis of a start-up. Moreover, many TLO directors indicated that the size of the market does not affect the appropriateness of a spin-off company as a commercialization vehicle.

**Countervailing effects: Reasons why a large market makes spin-offs more appropriate**

The TLO directors report countervailing effects of the size of the market in which the invention would be applied the appropriateness spin-offs as commercialization vehicles. Many TLO directors believe that spin-offs are better vehicles to commercialize university inventions if the market is larger. For example, the director of the TLO at University F explained,

*“For a start-up you certainly want a decent market. I’d don’t think you even want to touch a market potential of less than 100 to 500 million dollars.”*

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

*“We would say a market potential of at least 50 million dollars would seem to be appropriate. Some people would aim higher than that even, but to have a meaningful start-up opportunity, we would really focus on something that has significant potential in the range of \$50 million and up.”*

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

*“For a successful start-up, I think that the market size is going to have to be in the hundreds of millions plus.”*

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

*“There has to be a huge market first and foremost. It could potentially be a \$100 million market or more.”*

The TLO directors offered several reasons why a larger market makes spin-offs more appropriate commercialization vehicles. First, larger markets increase the financial returns to the investors who finance the creation of new companies. As a result, financing spin-offs is easier if markets they will enter are larger. As the director of the TLO at University L explained,

*start-ups need “a relatively large market so that the investors who are involved and who are going to be putting money in can have the opportunity and the probability to see a return.”*

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

*“If you’re going to go after venture funding for your business model, that’s only going to be a viable option if you’re in a sufficient market that’s going to meet the returns requirements for the investors.”*

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

*“Venture capitalists have a high tolerance of technology risk, how likely the technology is to work. But they have no tolerance for market risk. There’s got to be a gargantuan market if the technology works. If not, it’s a non-starter right out of the block.”*

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

*“VCs will only fund the things that have big market numbers. They have to deploy certain amounts of money. And the investment required to get it to the market place often translates into the level of sales that can be expected once it gets there.”*

Second, larger markets make spin-offs more appropriate commercialization vehicles because they allow founders and investors to amortize the cost of setting up a new company across a wider range of potential sales. Because spin-offs have to incur the additional cost of organizing a firm not present with established company licensees, a small market might make sense for an established organization to exploit, but not justify the cost of creating a new organization (Shane 2004). As the director of the TLO at University Y explained,

*“The infrastructure and the mechanism of the start-up is fairly expensive and the ultimate product that you’re going to create has to be able to bear that cost.”*

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

*“The inventors are not going to start-up a company unless they see a pretty robust potential market. I heard someone the other day talk about a hundred million dollar market size.”*

Third, larger markets make spin-offs more appropriate commercialization vehicles because they permit the generation of financial returns that compensate investors for the risk of creating new companies. As the director of the TLO at University SS explained,

*“A market size has to be relevant for the business model and has to make sense. You need a sufficient market size because of the risks associated with a start-up.”*

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

*“You need a defensible niche sufficient to justify the investment and risk of forming the company. So a bigger market is better for start-ups.”*

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

*“You don’t want the market to be too small because most startups are going to have some kind of exit strategy whereby they hope to go public or get bought by somebody and make lots of money.”*

Fourth, larger markets make spin-offs more appropriate commercialization vehicles because the opportunity cost of licensing to an established company will be higher in large markets. Because spin-offs are more successful than established firms at developing new technologies based on university inventions, universities increase the risk of failing to commercialize technologies by licensing to large, established companies. The larger the market is, the greater is the cost of such failure. As the director of the TLO at University TT explained,

*“Start-ups have a real advantage over large corporations when it comes to innovation. If the market opportunity is great, a lot of large companies may not proceed very fast with moving things to market. They’re just looking at product diversification. They may even decide to sell off a division or kill a project just*

*simply because it isn't a core competency. A start-up company that's based on a large market is going to have an opportunity to raise more money. It's going to have strategic partnerships. They're going to be lean and mean be able to get to market faster. All those things enter into a greater probability of success for that company and even from the prospect of commercialization so it makes a lot of sense. If it's a small market opportunity it doesn't mean you won't work it through a start-up but there's a smaller opportunity for that small business to succeed."*

**Countervailing effects: Reasons why a large market makes established companies more appropriate**

In contrast to the TLO directors quoted above, other TLO directors believe that established companies are more appropriate commercialization vehicles if markets are larger and spin-offs are more appropriate commercialization vehicles if markets are smaller. As the director of the TLO at University F explained, *"The market niche opportunity would tend to lean me towards a start-up."* Similarly, the director of the TLO at University M explained, *"If the market is large you'd be kind of foolish to license it to a start-up."*

The TLO directors offered several reasons why a small market makes spin-offs more appropriate commercialization vehicles than established firms. First, the small size of spin-off companies allows them to commercialize inventions in markets that are too small to interest large, established firms. As the director of the TLO at University B explained,

*"A start up might be right to take something where the market isn't big enough for an established company to be interested in licensing."*

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

*"Many good start-ups are targeted towards niche markets where large companies simply aren't interested in going until the risk is at a more manageable level. We just started a bunch of companies where market share is not huge. That's not going to get a lot of big companies interested."*

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

*"It might be appropriate for a start-up if it's a niche type product that a large company is not going to be interested in licensing. But it is enough to provide a nice business for the start-up and generate some decent profit down the road."*

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

*"A lot of successful start-ups are done by faculty members. It's a life style business that makes a good income if they just have a niche."*

Second, large market size makes established companies more appropriate commercialization vehicles because spin-offs are often too small to serve a large market effectively. Established companies are better able to develop the production and distribution necessary to meet demand in large markets. As the director of the TLO at University VV explained,

*“If it’s a huge market, a start-up may not be the best opportunity just because of distribution things like that that are tough for a start-up to handle. If it’s a large market you’ve got to make the product, and you’ve got to get it distributed to the entire market. A lot of times for a start-up there’s just not that many people you’re better off in a smaller market a more niche market.”*

Third, large market size makes established companies more appropriate commercialization vehicles because large companies will generate more revenue if they successfully commercialize university technologies. Spin-off firms are often too small to garner a large market share if they are successful at commercialization. As a result, the opportunity cost for universities of licensing to spin-offs in large markets is high.<sup>10</sup> As the director of the TLO at University M explained,

*“Especially if there’s a large market, you’d be foolish to license to a start-up when there’s something that should go to a Pfizer or Merck or Sprint or Microsoft that a start-up couldn’t do justice to, couldn’t get it to market, couldn’t do it quickly, would have to raise a lot of money to do it, and would have to get a sales force. So those that have bigger potential and closer to market pretty much most universities would take a license to an established company.”*

### **Reasons why the size of the market does not matter**

Many of the TLO directors indicated that size of the market was not a relevant factor in determining the appropriateness of a spin-off company as a commercialization vehicle. As the director of the TLO at University D explained, *“I haven’t looked at it from that point of view.”*

The TLO directors offered several reasons why the size of the market does not affect the appropriateness of spin-off companies as a commercialization vehicle. First, the appropriate market size depends on the nature of competition in a market. Because the level of competition varies across industries, market size alone does not determine whether or not spin-offs are appropriate commercialization vehicles. As the director of the TLO at University L explained,

*“It depends on what kind of market there is and how many players are in that market. If there’s not a lot of players then you’re going to have the ability to go smaller. If there’s going to be a lot of players, you’re going to have to have a larger market. Typically you’re not going to get a high percent market penetration if there’s a lot of players because there is so much competition to go against.”*

Second, the size of the market does not affect the appropriateness of spin-off companies as a commercialization vehicle because the appropriate market size depends on the amount of investment required to bring the product to market. Because the size of

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<sup>10</sup> In addition, the some TLO directors believe that the payback from licensing to established companies is faster, which is particularly important as market size increases. As the director of the TLO at University OO explained, *“If it’s going to be a huge multimillion dollar device, odds are you’re going to want to move it to a more established company to get that return back in quicker rather than having to wait the 5 to 10 years for a start-up to get going when your technology is already ready.”*

investment necessary to commercialize a technology varies across inventions, market size alone does not determine whether or not spin-offs are appropriate commercialization vehicles. As the director of the TLO at University I explained,

*“If it’s going to take \$50 million to develop the damn thing, you’d better have a market of more than \$15 million a year. The potential market has to be proportional to the investment that’s going to be required or it’s not going to happen. There’s a lot of need in this world for drugs and vaccines for developing country disease. But they cost just as much to develop as the next beta blocker. If there’s no market, nobody’s going to invest their \$300 million to get the product out.”*

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

*“The question you asked about market size really comes down to return on investment. So the market size must be ‘X’ if our penetration in that market is going to be ‘Y’ and the amount of dollars we are going to invest is ‘Z’. I think all these questions are really critical. Market size alone as a number doesn’t really cut it.”*

Several of the TLO directors pointed out that the relationship between the size of the investment and the size of the market explains why the market size necessary to pursue a pharmaceutical product is much larger than the market size necessary to pursue a software product, regardless of whether a spin-off or an established company was developing the technology. As the director of the TLO at University U explained,

*“Five million in sales would be acceptable for a start-up, but not a pharmaceutical start-up. There you need to have identified a market of substantial size that you can see a way to putting that into one of the major drug companies at some time in the future in order to get it out into the market. Because you have to go through an FDA approval process, you’re pretty much looking at some substantial corporate partners at some point in your development chain to bring that product to market. And that means you need to look at what those companies are calling their threshold entry points. Places like Merck and Pfizer get disinterested in markets less than 3 or 4 hundred million dollars.”*

Similarly the director of the TLO at University BB explained,

*“Market size doesn’t matter. It’s dependent on the product. If it’s a pharmaceutical, I might need a five hundred million dollar market, but I’ve licensed things outside pharma with much smaller markets.”*

Third, the size of the market does not affect the appropriateness of spin-off companies as a commercialization vehicle because the appropriate market size depends on the time to market. There is no market size that is more appropriate for a spin-off company. Regardless of whether a spin-off or an established company is developing the technology, a larger market is necessary when the time to market is greater. As the director of the TLO at University K explained,

*“If something is quick to market, it’s okay if the market is smaller. If it’s going to be a long time to market, it had better be a huge market. When venture capitalists*

*look at these things, they'll take a pretty small market if you're going to get there very quickly."*

Fourth, the size of the market does not affect the appropriateness of spin-off companies as a commercialization vehicle because university spin-offs are developing novel products that will be sold in markets that do not exist or are in their infancy today. Therefore, the current market size is no indication of the potential market for products based on the technology. As the director of the TLO at University WW explained,

*"We are talking about novel products that don't even exist today. Whether the market is 50 billion or 1 billion is not so relevant because essentially you are trying to enter with a revolutionary product. If the market is expanding, the market size might be known only to a certain extent because the market is ever increasing."*

Fifth, the size of the market does not affect the appropriateness of spin-off companies as a commercialization vehicle because universities often create spin-offs with the goal of creating jobs. The ability to generate a new company when a technology otherwise would not be licensed helps to meet this job creation goal, even if the spin-off is pursuing a small market. As the director of the TLO at University X explained,

*"In Vermont or in Maine, there is regional economic development benefit of being able to point to a company that was started."*

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

*"As long as there's enough of a market for a sustainable small business in a local or regional area that's acceptable."*

### **3. Investor interest in funding a particular technology sector does not matter**

TLO directors believe that investor interest in funding a particular technology sector does not affect the appropriateness of spin-off companies as commercialization vehicles. Although some TLO directors believe that investor interest in funding a particular technology sector increases the appropriateness of spin-offs, many other TLO directors indicated that investor interest in funding a particular technology sector is not a factor that affects the appropriateness of spin-off companies as commercialization vehicles.

#### **Reasons why investor interest in funding a technology sector makes spin-offs more appropriate**

Many TLO directors believe that spin-offs are more appropriate commercialization vehicles if investors are interested in funding the technology sector in which the invention falls. The director of the TLO at University C summed up the view of the TLO directors, saying,

*"We think about how popular that industry is to venture capitalists and angel investors in terms of capital availability."*

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

*"There are a lot of places that are putting the tobacco settlement money or other state money or regional money into starter funds, seed funds or loan funds to fund*

*technology in specific sectors. That can certainly influence the way that we position some technologies that might be the basis for a new company.”*

The TLO directors offered several reasons why investor interest in funding a technology sector makes spin-offs more appropriate. First, spin-off companies need venture capital or angel financing to develop. As a result, spin-offs cannot be developed in industries where investors have no appetite for investing in new companies, whether that disinterest is a result of regulation, low profit margins, competitive dynamics or other factors. For example, the director of the TLO at University R explained,

*“Investor in a sector matters. Extractive industries are going to be a tough sell for a start-up even if there’s some equipment or service capability.”*

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

*“It probably needs to be in a commercial market segment that is familiar to or of interest to potential investors.”*

Second, investor interest in funding a technology sector makes spin-offs more appropriate because the ease with which spin-offs can be developed and finances increases with the willingness of investors to provide capital to that industry at that point in time.<sup>11</sup> As the director of the TLO at University F explained,

*“Our first customer is really the investment community. Industries the investment community is more willing to invest in would be better for a start up.”*

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

*“What matters is whether the investment community willing to invest in that field nowadays. They all go in fads. One year it’s hot, and another it’s cold.”*

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

*“Certainly timeliness is important. Investors go through cycles. There was an era not too long ago when any software or dot com idea was readily welcomed, and would result in a company without much resistance. In the present economy, that would not happen.”*

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

*“One would hope to find an industry where venture capital money is there. There are fads, waves of enthusiasm, in the venture community. So there are certain times when it is easier to fund start-ups with certain types of technologies than others.”*

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<sup>11</sup> Spin-off companies are also easier to finance in industries in which investors are more willing to provide capital in that location. Venture capital and angel investments are made in different industries in different locations. Spin-offs are more appropriate of the investors in a location tend to make investments in that industry in the place where the university is located. As the director of the TLO at University XX explained, *“There are certain industries that the venture capitalists and angels in your area tend to invest in. The critical item is whether the capital is looking for investments in the markets that you’re looking to go after. And that will influence whether you want to do a start-up or not.”*

The TLO directors pointed out several examples of the importance of the timing of investor flows to the appropriateness of spin-offs in specific industries. For example, the director of the TLO at University P pointed out the difficulty of funding a telecom spin-off today. He said,

*“What are the investors’ flavors of the month? For example, today it would be virtually impossible to create a new telecom venture because there industry is in the doldrums and no financing is available.”*

Other TLO directors provided the example of the biotechnology industry. For example, the director of the TLO at University SS explained,

*“If you wanted to a do a start-up when biotech was high, you could go after venture money. When the venture markets were down, that wasn’t a viable option.”*

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

*“It does to a certain extent. Right now biotech is a hot field. And so if it has the appropriate attributes – it’s disruptive or if it’s a platform technology – we would say okay because investors are looking for biotech companies.”*

The TLO directors identified the key mechanism underlying the importance of the timing of investor favorability toward specific industries and the appropriateness of spin-off companies as commercialization vehicles.<sup>12</sup> They explained that when investors are interested in a particular technology sector, it is easier to engage them in consideration of financing particular spin-offs. The ability to engage investors about spin-off companies enhances the appropriateness of those companies as commercialization vehicles.<sup>13</sup> As the director of the TLO at University Z explained,

*“Where people are investing now has a great impact. What are people willing to put money in these days? That definitely tends to run and cycles and fads – nanotech for a while, search engines for a while, biotech on and off. That definitely has an impact. Take nanotechnology. You’ve got people willing to invest in nanotechnology. It’s got cache. You can get people engaged. But if we look at something and all the companies that have money have invested already in*

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<sup>12</sup> However, spin-offs may be no more appropriate in industries that investors favor. Instead, they are just more likely to be formed in those industries because TLOs present more companies to investors. As the director of the TLO at University GG explained, *“Would we turn someone down because the venture market wasn’t hot? No, I don’t think so. However, there may be an occasion when something was marginal. If you had something that was in a hot field, there might be an inclination to push it a little more towards at start-up than not. Similarly, the director of the TLO at University PP explains, “It’s such a touch nut to crack to get that initial investment that we have more opportunities than we have to get the effort out of our office to get these companies going. Being practical human beings, we are going to focus our efforts a little more toward those areas where capital seems to be most interested.”*

<sup>13</sup> By the same token, when investors have been unsuccessful in a particular industry, it is difficult for TLOs to get them to consider other spin-offs in those industries, adversely affecting the appropriateness of spin-offs as commercialization vehicles. As the director of the TLO at University AAA explained, *“When you look where venture capital people got burned, it’s hard to come out with models where people have gotten and get them to look at it again.”*

*their nanotechnology firm and they're not going to do any others, that's going to influence how we look at this."*

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

*"Often it's just the herd mentality of venture capitalists. As you know there's been so much hype within the last several years on anything having to do with nano-technology. Because everyone is investing in a particular area, it might influence the investability of an invention in that area."*

### **Why investor interest in a particular technology sector does not influence the appropriateness of spin-offs**

In contrast to the arguments of some of the TLO directors summarized above, other TLO directors explained that the investor interest in particular technology sectors does not influence the appropriateness of spin-offs as commercialization vehicles for a variety of reasons.

First, the length of time that investor fads last is too short to justify making decisions in response to their preferences. As the director of the TLO at University Q explained,

*"I don't think so because that tends to be a fad and if it's a fad then there's something over the next horizon that's going to be the next thing. So it doesn't make any difference to us."*

Second, investor interest in particular technology sectors does not influence the appropriateness of spin-offs as commercialization vehicles because the process of financing university spin-offs is more about matching particular companies to particular investors than it is about market trends. Therefore, aggregate trends tend to have little effect on the decisions of TLOs. As the director of the TLO at University T explained,

*"I think you need to know what tickles your investors fancy. But with some careful research you pretty much find somebody who's interested in almost anything. It's not difficult to find an appropriate investor with the appetite for the kinds of deals you're trying to put together."*

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

*"The investors are all different. There are people in nanotech. There are people in biotech. There are people in IT."*

Third, investor interest in particular technology sectors does not influence the appropriateness of spin-offs as commercialization vehicles because the sources of capital necessary to get spin-off companies started do not shift across technology sectors over time. Although venture capitalists are fickle and faddish, they are rarely important sources of seed stage capital for university-spin-offs, preferring to invest many years down stream from the initial sources of financing that spin-offs are trying to obtain.<sup>14</sup>

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<sup>14</sup> As the director of the TLO at University U explained, "I don't spend a lot of time figuring that out or analyzing whether or not to do a start-up based on that number. Venture capitalists tend not to get involved until way down stream from where we sit inside the tech transfer office. I can't really look at what they're

The sources of seed and pre-seed stage capital for university spin-offs – business angels and government agencies – do not tend to shift across technology sectors identify over time.<sup>15</sup> As the director of the TLO at University HH explained,

*“I don’t think the types of capital we’re talking about are influenced by those factors. They’re just highly risky sort of research development or prototype development activities. So they’re really not influenced by them.”*

## CONCLUSIONS

The study extends the findings in my report “What Makes University Inventions Appropriate for Spin-offs”, conducted for the National Institute of Advanced Industrial Science and Technology in Japan, and released in 2005. This study summarizes key surprises and counterintuitive findings what makes spin-offs more appropriate commercialization vehicles for certain types of university inventions than for others

Drawing on semi-structured interviews conducted with 55 directors of technology licensing offices at U.S. universities, the study examined three categories of factors that previous research has indicated make some university inventions more appropriate for spin-offs than others: 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. The goal of the investigation was to see if the evidence from the interviews with TLO directors was consistent with arguments made in the existing research literature.

As the findings of this study show, the TLO directors reported that four characteristics of the invention do not affect the appropriateness of spin-off companies as commercialization vehicles to in ways suggested by previous research:

1. *The stage of development at the time of invention disclosure*
2. *The time horizon to bring the technology to market*
3. *The complexity of the product development process*
4. *The basic technology type*

The TLO directors reported that one characteristic of the invention does not affect the appropriateness of spin-off companies as commercialization vehicles in ways suggested by previous research:

1. *The number of patents that can be obtained to protect the invention*

The TLO directors reported that three characteristics of the invention do not affect the appropriateness of spin-off companies as vehicles to commercialize university inventions in ways suggested by previous research:

1. *The importance of manufacturing and marketing and distribution to the value chain of the industry in which the invention would be applied*

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putting money into today because the technology I’m looking at may not be in the VC’s arena for another 3 or five years.”

<sup>15</sup> As the director of the TLO at University X explained, “You do most of this based on angel money or SBIR grants. Classical venture groups don’t want to bite on these early stage things anymore.”

2. *The size of the market in which the invention would be applied*
3. *Investors interest in funding the industry in which the invention would be applied*

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

Steven Auvil	University of Maryland, Baltimore County
Jim Barkendale	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 Dennis	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
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 Storenka	Brandeis University
Simran Trana	Purdue University
Mark Wdowick	University of North Carolina at Charlotte
Bruce Wheaton	University of Iowa
Greg Wilson	Kent State University
Bob Woolridge	Carnegie Mellon University
Brian Wrenck	University of Wisconsin
James Zanewicz	University of Louisville