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Technology Transfer: The Rise of the Entrepreneurial University

Mark R. Huson and Randall Morck

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EXECUTIVE SUMMARY

Canadian universities need better ways to commercialize their research and turn it into viable technologies. Typically, a researcher reports a potential breakthrough to her university through a confidential report. Then, technology arising from her findings can be licensed to an existing company or spun out and developed by a new spinoff.

Much of this activity happens through the university's technology transfer office (TTO). TTOs handle everything from IP evaluation and marketing to negotiating and managing licences. On average, Canadian university TTOs handle 5.11 invention disclosures per year, execute 2.93 licences and manage 3.83 university spinoffs. However, figures vary wildly between institutions, ranging from zero to double digits. Income from TTOs is just as variable, with some universities earning millions while others report net losses.

Industry partners are often geographically distant from the universities they work with. Fewer than a third of one Canadian university's licences are with companies in this country. This is because each technology has a best receptor in the private sector, and each business has a field to which it is best suited. To maximize the value of commercialization, technology should be developed by the entity with the highest values use case.

However, there is no guarantee that universities and businesses will find the best assortative matches. Policy-makers may further disrupt things by insisting on local economic development. There is always a trade-off between getting IP to the best overall receptor, or the best local receptor.

Information costs are one of the biggest barriers. The wide variety of research at any university makes it unlikely that a small TTO can support commercialization properly. Consolidating similar technologies in specific TTOs would allow for the concentration of subject matter expertise. To simplify things further, TTOs could let businesses come to them in pursuit of specific technologies. This could be done via web portals that push specific technologies or solutions for problems. This boutique approach will likely create better matches but does not guarantee a local match. It will also require a rethink of TTO staff compensation, with a focus on the quality instead of the quantity of matches.

If governments are determined to use university research to grow the economy, they need to prepare the ground so there are local receptors. Areas with a lot of receptors need access to capital in the form of startup funding. If a technology requires continual input from its creators, capital and receptors are more likely to move to where the researchers are based.

The solution is to increase technological inertia and the agglomerative nature of local tech ecosystems. The key is creating university spinoffs and keeping them local.

The way forward involves creating a provincial office of scientific research and experimental development, using budgetary carrots and sticks to convince universities to change how their TTOs work and developing university programming to enhance the commercialization skills of subject matter experts. Creating a provincial-level refundable commercialization expense program, providing a well-curated portal listing funding and commercialization support, mandating registration/licensing of all fee-taking entrepreneurial support services and educating potential local angel investors all factor into the equation for success as well.

POLICY RECOMMENDATIONS:

- Create a provincial office of scientific research and experimental development (SR&ED) in preparation for startups located in the province.
- Use whatever budgetary carrots and sticks that are available to persuade universities to:
  1. Make changes to universities' technology transfer offices (TTO);
  2. Create university programming that enhances the commercialization skills of deep subject matter expertise (SME); and
  3. Nudge universities to engage in selective specialization, hiring into departments that create technologies with higher complementarities with the technology of local receptors.
- Create a provincial-level refundable *commercialization* expense program made available to all founders who begin commercialization efforts in the province. This will help the province attract technology.
- Mandate registration/licensing of all fee-taking entrepreneurial support services (ESS) in the province:
  - Hair stylists face more scrutiny before they are allowed to cut hair than the ESS that are selling services whose value is far less measurable.

Universities' traditional tasks are the creation and dissemination of knowledge. In Canada, the public funding of universities gives rise to the questions of who owns that knowledge and how it may best be put to use. The current thinking on best use is that universities should identify any created knowledge with market potential and seek to patent and commercialize the discoveries to the direct benefit of the university and if possible, the entire economy at the level at which a university is funded. This role of technology commercialization is sometimes referred to as the third mission of universities.

This focus on garnering economic returns on university research has been criticized as undermining universities' commitments to conduct basic research (Webster 2015). The push for researchers to commercialize their work also raises issues in the evaluation and promotion of academics within their universities. In this piece, we leave those thorny issues aside and focus on policies that might better facilitate the commercialization of university research.

Even within this narrowed query there is the question of what the goal of commercialization should be. An easy view is that the commercialization should monetarily benefit the university in which the knowledge is created. A second view is that the commercialization should be part of a set of policies designed to promote regional development and growth. A third view is that the technology should be put to use for the "uplifting of the whole people" regardless of monetary considerations.[1]

We begin with a brief discussion of the two primary ways that university technology is commercialized and provide some data on the relative usage of those methods. Next, we introduce several participants in the system. We follow that with a discussion of the economics of technology commercialization. We then discuss how the players and the choice of the commercialization pathway affect commercialization and the distribution of its benefits. Finally, we make some recommendations on how these methods might be improved to facilitate technology transfer. We ask the reader to keep the following in mind throughout: The high failure rate of technological adoptions and adaptations coupled with the long gestation period of commercialization make gauging the success of any policies very hard to measure.

1. COMMERCIALIZATION PATHS

Typically, when a university researcher finds what she thinks is a commercializable invention, the first step in protecting the underlying intellectual property (IP) is reporting the innovation to her university via a Report of Invention (ROI). The ROI is confidential and should be filed prior to sharing the innovation via publication or conference presentation. The ROI is the first step in determining the innovation's patentability and commercial potential. The ROI also aids in assuring compliance with university policies and any sponsored research agreements.

After filing the ROI, if the IP is considered commercializable it can be developed in one of two ways. First, the technology can be licensed to an existing commercial entity. Alternatively, the IP can be licensed to a de novo commercial entity referred to as a university spinoff or spinout (USO). The new company may be founded by the researcher who created the IP. These will be discussed in turn.

1.1 LICENSING TO EXISTING COMPANIES

When undertaking licence arrangements, a university looks for potential partners in industry who might be interested in using the innovation. If a partner is found, the university grants use rights to the partner. The partner typically pays for those use rights via a licensing agreement. When licensing to an existing company, equity stakes are not typically used. Instead, fixed licensing fees, royalties, or a combination of the two are used. The licensing revenue is shared between the university, the innovator(s) and the innovators' academic departments. Typically, the split is 1/3 to each of the three parties. Note that in some cases the inventor does the work of finding a commercialization partner and negotiating the licensing deal. In these cases, the sharing of the licensing revenue may shift with a larger fraction going to the inventor.

The graph below uses survey data collected from 30 Canadian institutions over the period 2012–22 by the Association of University Technology Managers (AUTM).[2] It shows the total reported number of licence executions at Canadian universities.

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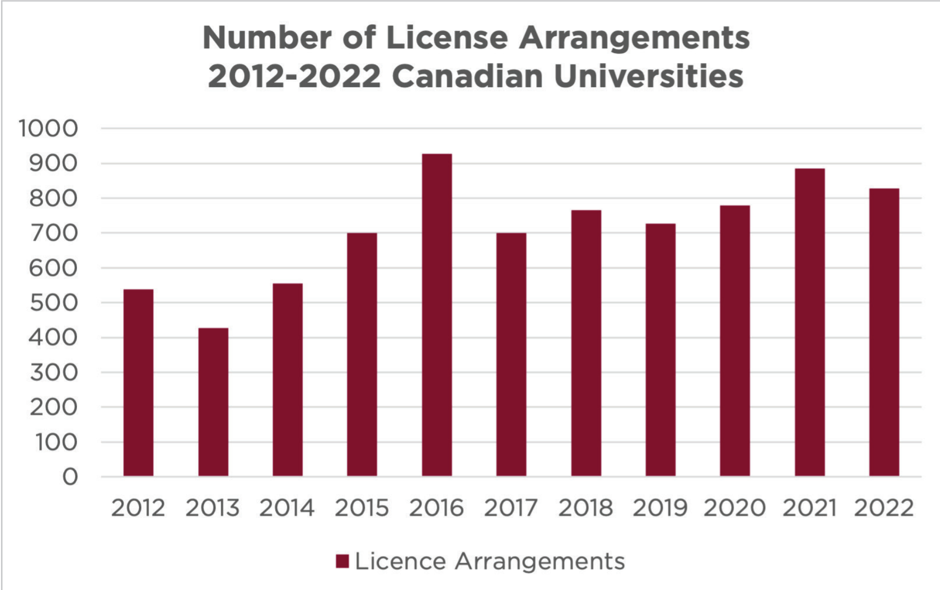
1 See Bailey (2011). The quote is from the convocation speech of Dr. Henry Marshall Tory, founding president of the University of Alberta, at the University of Alberta, October 6, 1908.

2 These data and those used to create Figure 2 are available from AUTM (n.d.).

Figure 1.



There is an upward trend. On average, in 2012–13 there were fewer than 500 licences per year as compared to over 800 per year in 2021–22.

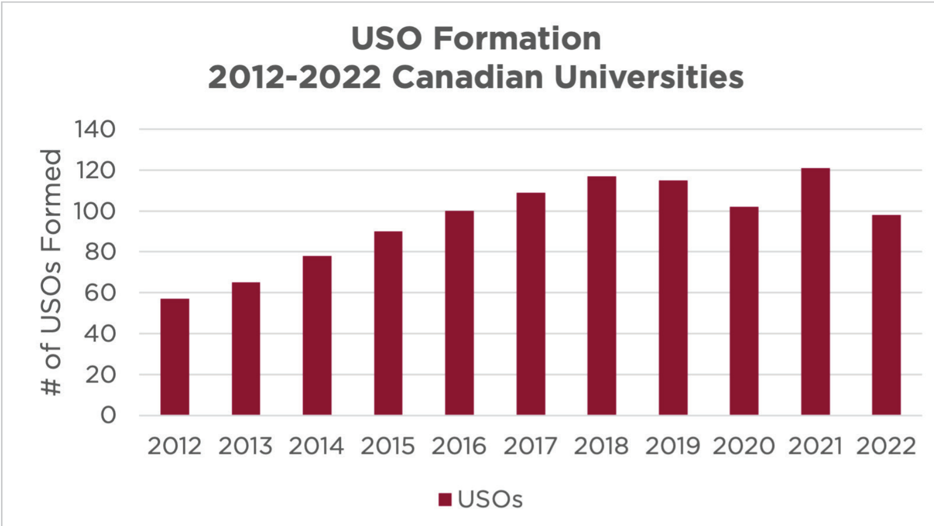
1.2 UNIVERSITY SPINOFFS OR SPINOUTS (USOS)

A spinout occurs when an entrepreneur decides to create a new business based on the innovation. This entrepreneur may or may not be the researcher who created the IP. Typically, the IP is owned by the university and transferred to the spinout company in exchange for participation in the spinoff company's business. Some universities take a flat fee for the licences. Alternatively, a university may select a royalty model where it takes a percentage of the spinoff's revenues (net of contractually agreed-upon expenses). Another way that the university can participate is via an equity stake in the spinoff. Some universities also offer combinations of these participation modes.

Flat fees are less risky for universities but provide no incentives for the university to foster the development of USOs. Royalty models provide incentives but also create monitoring costs for the university. Equity participation generates incentives and entails lower monitoring costs. While both royalty and equity models present greater risk to universities, they also provide universities with incentives to foster the development of their USOs. We note that equity participation increases the likelihood that the USO will be able to attract future equity investments.

The AUTM data show that technology exits universities by USO less frequently than by licensing. However, USO formation is increasing over time.

Figure 2



2. THE PARTICIPANTS

2.1 RESEARCHERS

Research drives innovation. While researchers want to be innovative, not all want to commercialize their inventions. Some researchers who come up with an innovation and file an ROI want nothing more than to go back to their labs and innovate some more. They are not innovating with an eye to commercialization. Other researchers see business opportunities in their IP and want to drive the commercialization of the innovation. These researchers want to create spinoff companies.

Regardless of a researcher's innate desire to see patenting and commercialization, there may be a derived demand for these activities. This is because granting agencies are starting to look at patenting and technical licensing to measure candidates' excellence. Researchers who might have simply filed their ROIs and gone back to their labs may become more insistent that the university patent and attempt to commercialize their IP. This derived demand can lead the technology transfer office to expend resources on marginal innovations.

These researchers are subject matter experts (SMEs). They work in their labs and develop technologies that may or may not have commercial value. If there is commercial value, they may not recognize it. If there is, and they do recognize it, they often lack the expertise required to successfully commercialize the technology.

2.2 THE TECHNOLOGY TRANSFER OFFICE (TTO)

TTOs provide myriad services. Brantnell and Baraldi (2022) provide a list of 23 activities TTOs undertake when presented with a ROI. Not exhaustively, these include IP evaluation, IP protecting (patent writing and filing), IP marketing, licensing initiation and management and at times shareholder. Rather than recreate their analyses, we provide a brief synopsis. Following an ROI, the TTO works with the filing researcher and legal professionals to determine if the IP underlying the innovation is protectable and the best way to protect it. The TTO may provide assistance in assessing the innovation's commercial potential. In the event of a spinoff, the TTO negotiates the terms of the relationship between the university and the newly formed company. If the researcher chooses to have the university license the innovation, the TTO scans the market looking for potential industry partners. If a partner is found, the TTO negotiates the licensing deal for the innovation. It is easy to see how these processes involve a multitude of tasks.

Based on the AUTM survey data, we know the following about TTOs in Canada. The typical TTO has an average (median) staff of 11.5 (8.34) FTEs. The range of staffing is quite broad, with Royal Roads University (B.C.) having on average one FTE and the University of Montreal having 49.3 FTEs on average.[3]

Looking at activities in TTOs, we see that on average a TTO FTE handles 5.11 invention disclosures per year. We also observe that the average number of new patent applications per FTE ranges from zero to 7.91 with an average (median) of 2.93 (2.16). The outputs from these activities are licensing agreements and the formation of USOs. Looking first at licensing, the number of licences executed per FTE is 2.55 but ranges from zero to 11.5. The average number of USOs per institution is 3.83 and ranges from zero to 18 at the University of Calgary.

It is not clear that the TTOs cover their costs. Data on total licensing revenues net of legal fees show that the average net income per FTE is $226,422. The corresponding median is $117,063. These numbers seem high, but we must keep in mind that universities typically only keep 1/3 of licensing revenues (the faculty inventors and their departments split the rest). There is even broader variation in this measure of productivity. The Universities of Toronto and British Columbia report net income per FTE in excess of $1 million. At the other end of the distribution, York University and the Universities of Waterloo, Victoria, Lethbridge and New Brunswick report net losses per FTE.

Research by Nag et al. (2020) using 2018 AUTM data for U.S. universities adds additional context. They report that in 2018, US$71 billion was spent on federally funded research in U.S. universities. In the same year, U.S. TTOs generated only US$2.94 billion in licensing revenue. Valdivia (2013) uses data from AUTM's 2013 survey and estimates that after adjusting for the typical split between the researcher, her department and the university (1/3 of royalty revenues accrues to each), only 16 per cent of TTOs cover their operating costs.

The data collected by AUTM does not lend itself to a more robust productivity analysis. That is, we cannot determine whether the activities of TTO personnel are currently adding value to universities. The revenue numbers are a combination of stock and flow variables. In particular, the gross licensing proceeds in any one year reflect the sum of proceeds from licences originated in the long past and recently initiated licences. Newly executed licences may need time to start producing revenues. The aggregated annual revenue numbers are affected by skewness. The skew comes from what Abrams et al. (2009) call "big hits" or very large one-time successes.

The "big hits" also obscure revenue data because some of them involve sales of capitalized royalty streams which adds further confusion as to the stock-versus-flow nature of the TTOs' revenues. Data sufficient to undertake productivity analyses may be available at the individual TTO level.

An additional issue with looking at TTO licensing revenue is that it only captures a small amount of the actual revenue that technology transfers generate. The typical licensing rate is about two per cent; therefore, capturing the addition to GDP related to a TTO office requires multiplying its licensing revenue by 50. The social scale of TTO activity is considerably larger than the dollars added to a university's budget.

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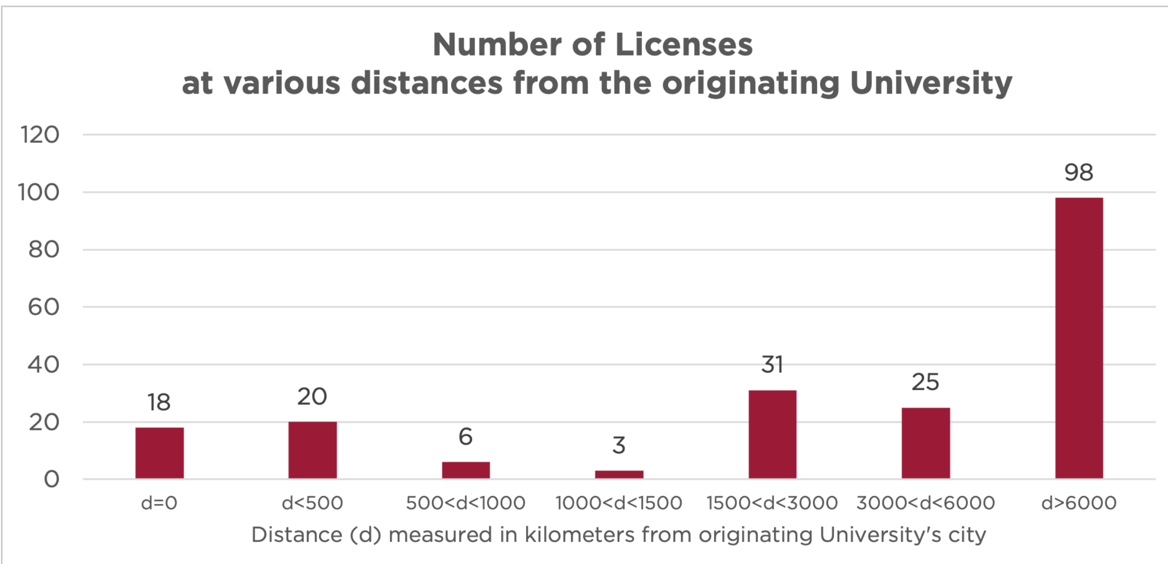
[3] Note that these are averages and medians of each institution's averages over a three-year window.

2.3. INDUSTRY PARTNERS

These are companies and organizations who seek to access IP created by university researchers. They attempt to find technology that will help them to add value to their organizations. They face positive search costs and have finite financial and cognitive resources. They can be located near or far from the licensing university. These institutions are potential customers for university technology. It is important to have an understanding of where potential industry partners shop and buy.

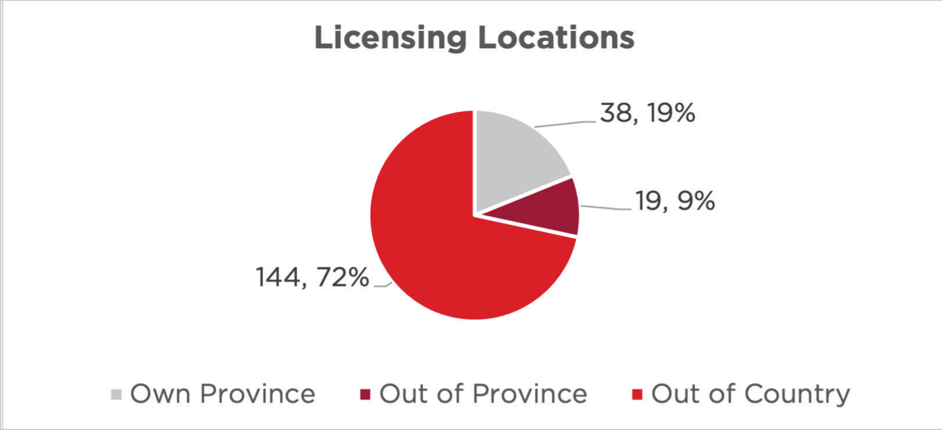
Using proprietary data from the TTO office of a large Canadian university, we examine the geographic location of 201 licensing agreements initiated over the period January 2, 2020, to February 8, 2023, to make statements about where the institution's IP lands. We begin with a measure of distance in kilometres from the originating university. To do this, we measure the latitude and longitude of the city where the university is located and the city where the licensing entity is located. The chart below shows the histogram of distances.

Figure 3.



The average (median) licensee is 5,602 km (3,370 km) away from the originating university. Distances range from zero km (the licensee is in the same city) to 15,694 km (the licensee is on another continent). Only 18 (nine per cent) of licensees are in the same city. Interestingly, we observe that 49 per cent of licence agreements are with entities located more than 6,000 km from the originating university. The pie chart below adds to our understanding of licensing patterns for the university under consideration.

Figure 4.



Only 38 (19 per cent) of the university's IP licences are with entities located in the same province. An additional nine per cent of licences occur within Canada and the bulk of the licence agreements are with entities outside Canada. This institution is a net exporter of IP, in the sense that most of its IP is used out of province.

This phenomenon is not specific to this university. A recent study uses data from licensing programs at Chinese universities over the period 2002 to 2012 to illuminate patterns of IP distribution across China (Gao et al. 2015). Looking at the generation of total licensing by province they find some interesting results. For example, Anhui province generated 308 licences over the 2002–2012 period. Of these, 293 (95 per cent) were licensed locally. This province also licensed 86 technologies from out of province, accounting for 23 per cent of all university licences used in province. Although Anhui imports some IP, its homegrown IP tends to stay at home.

Alternatively, consider Beijing province. It generated a total of 413 IP licences over the study period. Of those, only 138 (33.4 per cent) were to in-province entities. Its locally generated IP is less sticky than the IP developed in Anhui. Interestingly, Beijing entities imported 87 licences from out-of-province entities. Out-of-province licences account for 39 per cent of all licences in Beijing. This shows that Beijing imports as well as exports IP.

Finally, consider Guangdong province. It generated a total of 469 licence agreements and 386 (82 per cent) were in-province licensed. Like Anhui, its local IP tends to stay close. In contrast, firms in Guangdong had 517 licence agreements with out-of-province universities. These out-of-province licences account for 57 per cent of all university licence agreements in the province. Despite keeping most of its IP at home, Guangdong imports even more IP from beyond its borders.

Simply generating IP in an area is no guarantee that it will be used in that area. Anhui and Guangdong both show a certain stickiness of locally generated IP. IP generated in Beijing is less likely to remain in the province. It is also interesting to note that Guangdong has more out-of-province licences than it has in-province licences. Something about that province causes a net inflow of university technology. The next section provides some insights as to why this is the case.

2.4. THE ECONOMICS OF COMMERCIALIZATION

University research covers many areas. The outcome of research in a given area might be a technology that is commercializable. Many technologies may be created in a given area. As an example, consider the technologies available for licensing at the Technology Licensing Office at the Massachusetts Institute of Technology (n.d.). There are 446 opportunities in the chemical and materials space covering (to name a few) licences in polymers (174), composites (52) and nanotech/nanofibres (198). These technologies vary in quality and in their best-use case.

We refer to the organizations that may want to license a technology as receptors. A receptor can be an operating company or a new spinoff company. The founder of the spinoff can, but does not have to, be the researcher whose innovation is being commercialized. Commercialization efforts result in either revenue streams (royalties or equity participation) or lump sum payments (licensing fees) from the receptor to the university. In the case of a spinoff company, the university may receive royalties or take an ownership position in the newly formed company.

Each receptor has an ability to commercialize a technology in a given field. For example, relative to SpaceX, Pfizer will have a comparative advantage at commercializing technologies resulting from pharmacy research. Similarly, SpaceX will have a comparative advantage in commercializing technology generated by the research done in aerospace engineering. The setup for licensing can be seen as an assortative matching problem. When good technologies are paired with good receptors, the total productivity of the match is higher than if a good technology pairs with a less good receptor. Basically, each technology has a “best” receptor and each receptor has a “best” technology. To maximize the value created by the commercialization, the technology should be developed by the entity with the highest value use case.

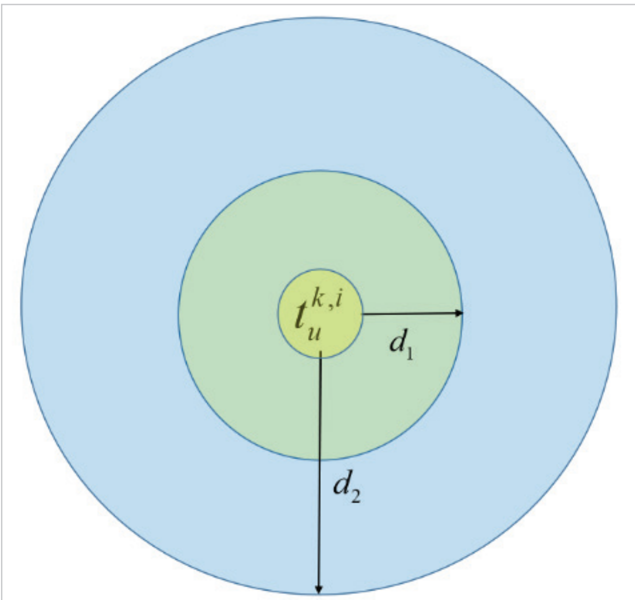
Finding good, better or best matches is not costless. Both the TTO and the receptor incur search and opportunity costs. These costs may outweigh the gains to finding the best match between a receptor and a technology. These costs may limit the number of receptors a TTO engages. They may also cause a receptor to limit the scope of its searches. Imagine a receptor with the highest ability in a given area (say, synthetic biology). Also assume that it has high, but not the highest, ability in another area (say, immunotherapy). The receptor, through numerous past interactions with the university with the best technology in synthetic biology, has developed a cost advantage in negotiations with this university. Likewise, the TTO at this university has a cost advantage in negotiations with this receptor. As a result, the receptor may choose to select this university’s immunotherapy technology even though this is not the best use of the technology. Basically, there are reasons to expect that the assortative matching that places IP in the hands of those best positioned to use it may not occur.

Even if assortative matching did occur and the TTO and university captured the maximum potential gains from the pairing, it is not clear that this outcome is the one that policy-makers have in mind when thinking about universities’ third mission. Suppose that policy-makers have a goal of commercializing university technology locally. That is, policy-makers are willing to trade off match quality for local economic development.

The university’s share is not affected by the distance between it and the receptor since it owns a royalty stream from revenues or holds an equity position in the firm. Increasing the distance over which the university is willing to search increases the likelihood that the university will encounter receptors of higher ability. A university will want an unconstrained search for receptors. Policy-makers, who derive benefits from nearby matches, prefer a more geographically constrained search for a receptor.

The following graphic illustrates this concept. The technology created by a researcher at a university is $t_u^{k,i}$. The university prefers an unconstrained search in the circle with radius d_2 and policy-makers prefer a more localized search in the circle with radius d_1. The larger area covered by the unconstrained search increases the likelihood that the university's search will find a higher quality match.

Figure 5.



It is very likely that the high dimensionality of technologies created by a university's researchers relative to the IP demands of local receptors will result in substantial commercialization of IP occurring outside the local economy. Where a technology lands depends on an area's absorptive capacity for it. If we go back to the example of Guangdong province, we see that 83 of its 469 licensable technologies found superior receptors out of province. That is, 17.7 per cent of locally developed technologies found better homes in different places. More interestingly, of the 903 total technologies licensed in Guangdong, more than half came from other provinces. That is, Guangdong has the absorptive capacity to grow technologies it imports. If we think of technology as seeds and the abilities of receptors as the growing conditions, this sort of outcome is not unexpected. No matter how many orange seeds are generated in Alberta, it would be unwise to plant them here.

Correspondingly, higher university licensing revenues are likely to come from non-constrained receptor searches. Constrained searches where only local receptors are considered will result in fewer and less productive matches. There is a tradeoff between getting the IP into the hands of the best receptor and getting the IP in the hands of the best local receptor.

Note that placing IP with the best local receptor does not guarantee that the IP will contribute to the local economy in the long term. A policy of seeking local receptors will make suboptimal matches. Eventually, the local receptor will either go out of business or realize that a different non-local receptor that is a better match will use the IP more efficiently and sell the technology on. Alternatively, the local receptor could change its geographic location to improve its ability to commercialize the technology.

3. WHAT CAN BE DONE?

Fortunately, we are addressing how to improve the flow of technology from universities to the marketplace. As such, we do not have to weigh in on macro issues affecting the growth of innovative firms like overall patent protection, taxes and legal regimes. We can take those as given and look to policies that local governments can adopt or encourage publicly funded universities to consider. We will take this in two steps. We begin by asking what can be done within universities to enhance the commercialization of technologies. We then address policies that can increase the odds that the seeds of technology find fertile ground locally.

At this point, we note that there are many programs supporting the creation of technologies in universities (e.g., the National Research Council (NRC), the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canadian First Research Excellence Fund (CFREF) and the Canadian Foundation for Innovation (CFI)). There are also programs that some say support commercialization but are research focused. Consider the NRC's Industrial Research Assistance Program (IRAP). Rasmussen (2008) discusses IRAP in a section about Canadian federal programs supporting commercialization. IRAP's web pages say that part of its mission is to "support the development and commercialization of technology" (Government of Canada 2022). However, its very name somewhat gives away the game. Although IRAP provides some commercialization support (Dube and Lisk 2011) and its Youth Employment Program provides resources for commercialization activities, the main IRAP grants are research directed. Moreover, the new Canadian Innovation Corporation (CIC) is doubling down on the commitment to research. We argue that more attention and resources need to be allocated to breaking down impediments to, and creating catalysts for, commercializing the tech created by all of the well-funded research.

3.1 UNIVERSITY-LEVEL CHANGES

Most of the items discussed below involve changes to university policies and governance. As such, it is unclear how policy-makers can directly affect these items. However, being aware of the issues may provide avenues to adjust behaviours using the carrots and sticks embedded in the budgeting process for post-secondary education.

One of the largest impediments to effectively commercializing technologies is information costs. Consider the role of TTO staff in the commercialization process via licensing to non-spinouts.[4] When presented with an ROI, they must determine the merits of pursuing IP protection. This is essentially an analysis of whether the technology is commercializable. If it is, the TTO will initiate patenting the IP. After the IP is properly protected, the quest for a licensing partner begins.

The scope of research activities at any single university makes it unlikely that the relatively small number of TTO staff can effectively support the commercialization efforts for reported inventions. The low activity level per FTE reported above (5.11 invention disclosures per year, 2.93 new patent applications, 2.55 executed licence agreements and 3.83 USOs) hides the fact that these activities are across myriad technologies. Bounded individual rationality makes it unlikely that a thinly staffed TTO can credibly assess whether the technology behind a given ROI merits IP protection. It also almost surely precludes the colocation of the required commercialization expertise with the technologies being created.

Determination of which inventions merit IP protection requires deep SME and is unlikely to be realizable across the broad range of technologies produced by university researchers. We are not

[4] We consider spinouts in section 3.2.

saying that it cannot be done. It is just not likely to be done well unless the TTO staff can specialize in a few rather than all technology categories created by university researchers. Note that most venture capital firms are specialists.

The need for specialization leads to the suggestion that each university in a system does not try to be all things to all researchers. Instead, if many nodes in a system generate similar technologies, consolidating similar technologies in specific TTOs would allow for specialization and the creation of concentrated SME.

Once the IP is protected, the TTO staff could actively market the technology. In these cases, the TTO staff would attempt to identify receptors with whom the technology creates higher value matches. This sort of boutique commercialization requires the TTO staff to have a good idea of both the underlying technology and its appropriate commercialization pathway. It also requires the TTO staff to know the best path to the decision-makers at the receptors. What we have just described is time consuming. It also layers an additional level of SME; specifically, knowledge of individuals and processes at potential receptors. Again, this is potentially solved by creating TTO satellites based on technology areas.

Another way to reduce information costs associated with commercializing protected technologies is to promote the adoption of technology in TTOs. For example, rather than searching for licensing partners, TTOs can let licensing partners come to the technology. There are several web-based portals where TTOs can post outbound licensing opportunities. These are essentially online catalogues listing the technologies and, in some cases, their potential uses. Examples include Government of Canada (n.d.), Cognit.ca and Wellspring's Flintbox. Receptors can "shop" these catalogues and approach universities regarding licensing opportunities. These platforms increase the IP's visibility and, having a wider audience of receptors, increase the likelihood of obtaining a good (i.e., high value) match between the receptor and the technology. These sites also make the job of the TTO staff easier as the IP is bought rather than sold. Unfortunately, these methods of extending the radii of technology awareness do not ensure highest value matches. For that to happen, TTO staff would need to know about the quality of requesting receptors relative to possible receptors who had not yet seen the licensing opportunity.

Another way to have receptors come to the technology is to find industry partners who are actively looking for solutions. That is, rather than push solutions to industry, have industry pull solutions from universities. This is different than creating technology and then looking for possible use cases. In these instances, receptors announce their needs and researchers can determine whether to engage in investigation of solutions. Portals like InPart and Halo list requests for proposals (RFPs) from potential receptors. For example, Kraft Foods is seeking natural ingredient technologies that lower sodium content without lowering (too much) the salty flavour of food (Halo n.d.). It tells researchers and TTOs the parameters of the work and suggests ways for the research to be reimbursed (direct sponsorship, licensing, co-development). Any researchers in the food science space or chemistry space who see this can determine if they are currently conducting or could conduct research to meet this need.

Push models like Wellspring's Flintbox and Cognit, and pull models such as InPart and Halo, will increase the amount of technology that is commercialized. These models do not ensure best or local matches. A poor match may be preferred to no match at all. These solutions are also low cost. More boutique push models will likely create better matches, but do not guarantee local matches. They are expensive because they require specialization to be done well. TTO staff need deep SME and solid relationships with receptor organizations. This will limit the scope of technologies that can be effectively commercialized using this method. Universities should select technology areas where they have a comparative advantage for commercialization via the boutique push method and hire and train TTO staff to undertake the commercialization task in those areas. University systems can further economize by consolidating technologies in specific universities and concentrating expertise. Parts of the IP catalogue not in the boutique push funnel should be placed on the online portals.

The discussion above may lead the reader to wonder whether TTOs should be involved in commercialization beyond establishing IP rights. Negotiation of use rights requires deep SME. Critics of TTOs suggest that they may inhibit commercialization because of their lack of this SME. The boutique model avoids this issue by fostering the development of expertise. One critic of the boutique model worried that it would merely create staff members who can leave and start their own ventures using the skills learned commercializing university IP. The cycling of people with deep SME into the local economy is a feature, not a bug. The recycling of these individuals in the local USO space provides potential receptors for an institution's IP.

Creating boutique push models will require a rethinking of how team members in TTOs are compensated. Current TTO benchmarks (as reported in AUTM studies) relate to the quantity of activities: the number of licence agreements, the number of patent filings and the number of USOs. For instance, regarding patenting activities it is estimated that 70 per cent of provisional patent filings are never filed as actual patents and less than 10 per cent turn into actual patents. Of those, only five per cent are used as the basis of a licence agreement. (Maxwell 2023).

More attention needs to be paid to the activity's quality. Annual licensing revenue does not measure the quality of decisions made in a given year as they will contain royalty flows from past licensing deals. Additionally, new licensing deals that take time to pay off will not be counted. So how do we get current TTOs to care about the quality of the licences they enter into today?

The current split of licensing revenue is 1/3 to each of the researcher, her department and the university. The TTO team member's role in securing that revenue by finding the commercialization conduit needs to be recognized. Allocation of some part of the royalty stream to the TTO member who arranges the licence does two things. First, it ties the individual's pay to the tasks they undertake. Second, it increases the payoff to quality matches, thereby increasing their likelihood. The university and the researchers' departments will now all get smaller slices but the pies should be larger.

The TTO employees' compensation needs careful consideration. Abrams et al. (2009) present survey results indicating only 5.6 per cent of TTO offices they studied had incentives linked to financial outcomes. They also report that only two of 80 TTOs with formal mission statements mentioned financial performance as important. Many TTO officers see their roles as providing faculty service and aiding in the translation of research.[5]

The idea of tying TTO members' pay to the value created by their actions is fine under the view that commercialization is intended to bolster university revenues and/or local economic development.[6] However, consider the following quote from a member of the Stanford TTO, from Brantnell and Baraldi (2022):

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5 Another consideration is that aggressive negotiation of deal terms may seem like it maximizes university payoff. However, aggressive negotiation can reduce the total number of deals done. Thus, in addition to the size of slices, the number and size of pies must be considered.

6 We also note that proper remuneration of the TTO staff could resolve some of the turnover issues contemplated above.

> But we don't necessarily at Stanford view licensing as a money-making operation. It really is more, even the overall licensing strategy here is about finding good homes for technology so that products get made and those technologies end up benefiting society on the largest scale possible.

This view is more in line with putting technology to use for the "uplifting of the whole people." Since you get what you pay for, policy-makers should be clear on their goal when setting incentives.

The discussion above deals with moving technology to receptors. It does not consider the distance between the receptor and the university. This creates a problem if policy-makers also want the commercialization to benefit the local economy. In the past, some governments have tried to move industries and jobs to their locations. This generally does not end well. The Clairtone debacle (discussed below) illustrates the point.

3.2 IMPROVING THE LOCAL ECONOMY WITH UNIVERSITY TECH TRANSFER

Lerner (2009) talks about three types of policy interventions used to stimulate entrepreneurship. Two involve preparing people and places to engage in entrepreneurial activities. The third type directly increases the amount of money available for entrepreneurs. Lerner notes that the third type of program seems to be the most popular and wonders if that is because handing out money is more fun than worrying about underlying conditions. He refers to two interventions that are less popular — making the environment attractive to both entrepreneurs and investors — "as setting the table."

In this paper, we make a similar allusion. Instead of table setting, we are thinking of field preparation. Refer back to Figure 1 and think of the concentric circles around an originating university as regions where commercialization might grow and the technology as seeds. The soil that technology falls on cannot be thin. Policies to prepare the ground would increase the local density of receptors with high ability. Failing to prepare the ground stops nascent firms from taking root and from growing.

To make this point, we turn to Clairtone, a company founded in 1958 by Peter Munk and David Gilmour. It was famous for its sound technology and cutting-edge design. From 1958 to 1965, its sales increased from $60,000 to $11 million, a compound annual growth rate over 100 per cent (Museum of Industry n.d.). It was a technology and marketing juggernaut.

Clairtone President Peter Munk (right) shows Premier Robert L. Stanfield (left) and IEL President Frank H. Sobey the plans for the new Clairtone factory.
Nova Scotia Archives scan 201600321.

Source: Image and text from Museum of Industry (n.d.)

In 1966, lured by a state-of-the art facility designed specifically for Clairtone and paid for by the Nova Scotia government, Clairtone started producing stylish, high-end stereo speakers in Stellarton, NS. This transformed the community and diversified its economy, which until then had relied on a coal mine, a steel plant and the railroad for employment. Things went downhill fast. By 1967, the plant was taken over by a provincial economic development agency and in 1970 sold outright to the Nova Scotia government. The problems that led to this are listed as a workforce not geared to working in manufacturing, poor infrastructure, lack of managerial talent and logistical hang-ups (Munk 2008). Basically, a seed was planted in inappropriate conditions.

The location of receptors is endogenous. That is, firms choose to conduct their operations in locations that optimize the benefits and costs of agglomeration economies. Often, it will be easier to move the technology to the receptor rather than moving the receptor to the technology. It is a question of the gravity of the agglomeration economy and the inertia of the technology. While speaking of gravity, we will note that there is a third element to location choice: access to capital. High concentrations of startup funding also have gravitational pull. Areas with more capital also tend to draw absorptive capacity. Areas like Silicon Valley and Boston's Route 128 tend to have both capital and agglomeration benefits.

The gravity of technology can overcome the gravity of agglomeration and capital. And if technology and human capital required to commercialize it are colocated, they can overcome the gravity of capital. If the technology does not require ongoing input from the developing researchers (that is, it is codified or explicit knowledge), the technology will be more mobile. If the technology is evolving and the researchers and their students are making advances in the area (i.e., there is tacit knowledge in the technology), then the technology is more anchored. Anchored technology, whose advancement is embodied in the innovators' research agenda, has greater inertia. This leads capital and receptors to move to the innovation activity.

As an example of this path to increased local density of high a^k receptors, consider DeepMind's decision to locate its first international research office in Edmonton, Alberta, in 2017. DeepMind is one of the world's leading AI research companies. The computer science department at the University of Alberta is a global leader in reinforcement learning. The talent in Edmonton will keep adding to the technology that will improve AI. Any one piece of technology from the computer science department is movable. The department as a whole is not. It has high gravity. The strength of the University of Alberta AI expertise pulled DeepMind to Edmonton (Hassabis 2017).[7]

To see how the colocation of agglomeration economics and technology affect the gravity of capital, consider technology in the animal nutrition space. A technology in this space will most likely find good receptors somewhere between Topeka, KS and Columbia, MO. This space is called the Kansas City Animal Health Corridor. Companies headquartered in the corridor generate over 50 per cent of global animal health, diagnostic and pet food sales. This provides a rich and deep market for talent and judgment in this technology. Startups in this space draw capital from geographically disparate spaces. For example, Elemental Enzymes raised a US$77 million round from a firm in Silicon Valley. Another firm in the corridor, NewLeaf Symbiotics, raised US$97 million in three rounds from VCs located in Silicon Valley, Chicago, Vancouver and Boston.[8] This is evidence that money will flow to where technologies are best developed.

This leads to our policy recommendations to increase technological inertia and to enhance the agglomerative nature of local ecosystems. We have four recommendations. First, increase

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[7] In 2023 amid a round of layoffs, DeepMind closed its Edmonton office. This provides an excellent opportunity to investigate the inertia of Edmonton's AI talent.

[8] These data are from Pitchbook™.

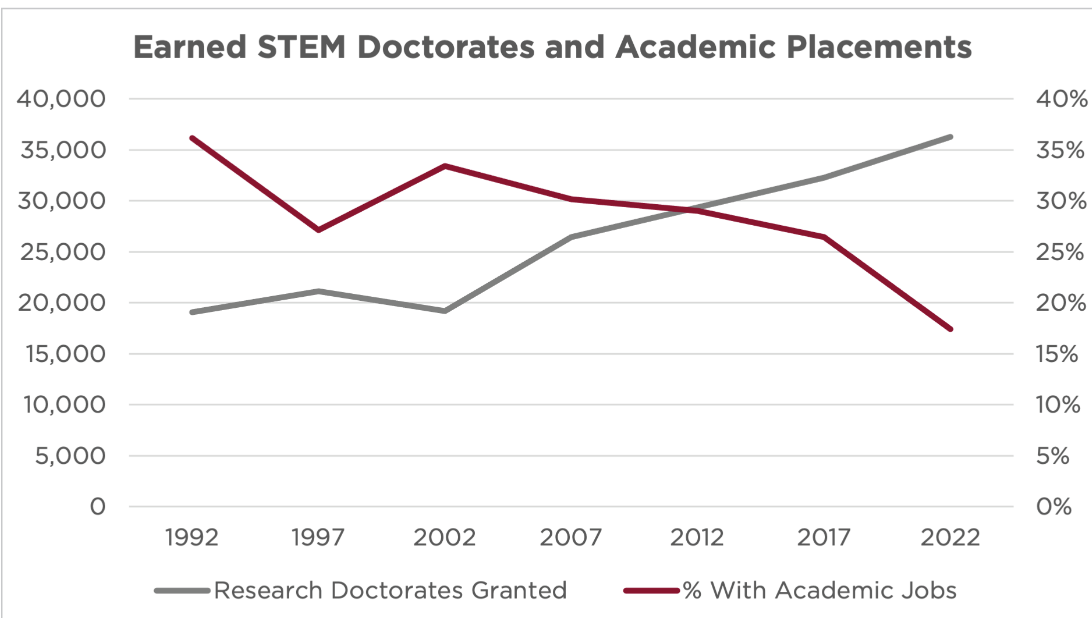
entrepreneurial education among university researchers. Second, simplify the transfer of IP to USOs. Third, provide faculty with career room to pursue commercialization. Finally, increase the breadth and depth of commercialization talent.

USOs and a Local Agglomeration Economy

The reason we make recommendations based on USOs is that, as mentioned above, the location of receptors is endogenous. The inertia of some technology will be able to draw in some receptors. However, the gravity pull of agglomeration economies and large pools of capital will overpower that inertia in many cases. The thing about newly formed USOs is that they will typically begin locally. Then the goal is to keep them local. So we start with preparing IP creators to commercialize and create USOs. We then plead for universities to let the technology out and help it grow. Finally, we outline methods for creating regional agglomeration economies that together with technical inertia, draw capital into a region.

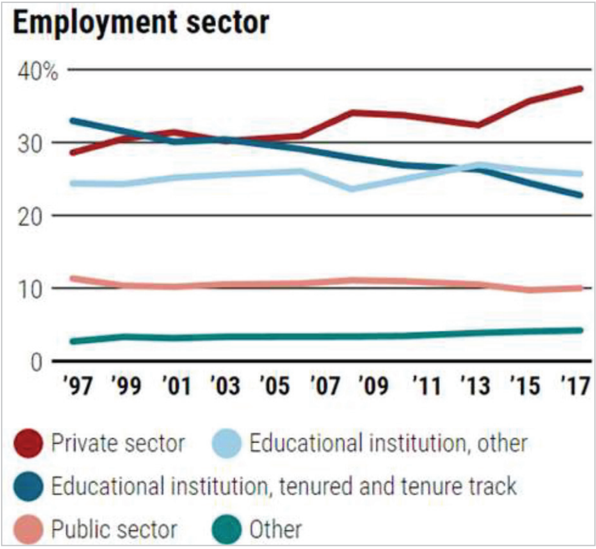
As we mentioned above, not all researchers want to be entrepreneurs. Interestingly, very few even know what this would entail or how to do it. In addition to the faculty who might commercialize technology, doctoral students and post-docs need to learn about commercialization opportunities. Data from the NCSES Survey of Earned Doctorates show that the number of graduate students and post-docs in technical fields outstrips the number of faculty openings (NCSES n.d.). The graph shows the total number of earned doctorates in life, physical, earth and mathematical sciences, plus those earned in engineering. It also shows the percentage of those with earned doctorates who have landed academic positions.

Figure 6



Universities are producing more highly skilled STEM professionals and the academic demand for those skills is not keeping up. Between 1992 and 2022, the number of STEM doctorates increased by 90 per cent and the number of faculty positions remained essentially flat. These graduates do find employment somewhere (e.g., Livermore, Pfizer). The following graphic shows an increasing trend of U.S.-trained life and health sciences PhDs finding employment in the private sector.

Figure 7.



Source: Langin (2019)

We think that these highly trained people with deep SME can help drive commercialization of the very technologies they have helped develop. They need the tools to do that.

To that end, we recommend that increased training in entrepreneurial skills be made available to faculty, post-docs and PhD students in STEM areas. Sansone et al. (2021) look at over 1,000 entrepreneurship courses offered at 90 U.S. universities from 2011 to 2014. They report that these courses increase the formation of USOs. Care must be taken to ensure that this training covers essential steps in commercialization. Sansone et al. (2021) also report that immersive and experiential learnings are more supportive of USO formation than is learning via standard lecture methods. We also recommend that relevant experts from various departments within the universities themselves are brought in to help form the training programs. Goethner and Wyrwich (2020) study business idea generation in German universities between 2007 and 2014 and report that spatial closeness between business faculties and faculties of natural science increases the generation of entrepreneurial ideas in the latter. Interdisciplinary interactions seem to foster knowledge flows.

Perhaps more important than training is a socialization to the idea of a non-academic career. Graduate student training within the various disciplines should highlight this new and growing career alternative. Most graduate students primarily interact with successful academics and see that career as the endgame. Programs that bring in people with PhDs who are successful non-academics will help graduate students see the alternative paths available to them. Such programs may also serve to socialize graduate supervisors to the idea that non-academic placements of students are not failures.

Even when a researcher decides on the USO path, the actual process for doing this is not always clear. Not all universities provide guidance on policies and procedures. The researcher and the TTO will need to enter an agreement transferring the IP from the university to the USO. The rules for such transfers are not always accessible via universities' TTO web portals. Some information on some web portals is outdated. The decision to start a USO is already loaded with natural uncertainty. Having a process that adds to the uncertainty adds to the costs the researcher faces.

Providing accessible and current information is not enough. The agreements that TTOs present to founders can be an obstacle to the creation of USOs. Researchers/founders are typically SMEs in fields that do not demand high levels of business acumen. The contracts offered by TTOs contain clauses relating to royalty rates, use rights and other business and legal issues that can leave very smart people at a loss. In addition, some contracts offer the researcher-founder options to choose between royalty payments to the university, letting the university own an equity stake, or some mix of the two. This menu of unfamiliar choices further increases the cost of forming USOs.

Getting the economic terms of the IP transfer to the USO correct is important to its success. Royalty schemes with high rates or long tails will be off-putting to potential equity investors who are essential to the development of the USO's business. University-friendly terms may make it seem like the university is getting the appropriate-sized slice of the pie. The problem is that terms that are overly friendly to the university lead to very small pies.

Before continuing with our recommendation for an instrument to transfer IP ownership from the university to a USO, we think that the preceding paragraphs provide an opportunity to make two points. First, earlier in this document we suggested that researchers receive more business education. Some critics of that idea suggest all that is required is to have people with business acumen work with the researcher-founder rather than try to educate the researcher-founder. The problem is that the researcher-founder requires business skills well before there is enough traction to interest a potential collaborator. Also, at the very early stages the uncertainty, information asymmetry and fear of IP leakage make researcher-founders unwilling to share key information that would be required to make informed decisions. Colocation of business skills and deep SME is, in our view, essential.

The second point has to do with the university's share of any commercialization benefits. One commentator on the issue recommends that we must try to avoid the mistakes of expensive subsidization of university research that benefits mostly faculty members when they license publicly funded inventions. The problem with this view is having a sharing rule where the benefits of innovation do not change the incentive to innovate but do change the incentive to commercialize. As pointed out earlier, attempts to get the university a fair share will get it larger slices of smaller pies. If the university focuses solely on the size of its slice of the pie, it may well stifle commercialization. When little or no commercialization occurs because of the university wanting too big of a slice, then the university is in a similar position to letting the researchers take a large slice. In the limit where the sharing rule stops commercialization, the university is in the same place it would be if it gave all of the commercialization benefits to the researchers.

Now, let us return to how the university may transfer IP to USOs. Our recommendation here is that universities create a Simplified Transfer of Research Intellectual Property (STRIP). The STRIP will state the percentage of the USO owned by the university and list the IP that is covered. Rather than include a percentage of equity, a STRIP could have a dollar amount of notional principal that converts into equity at a qualified financing. Basically, a STRIP could easily encompass a Simple Agreement for Future Equity (SAFE).[9] The benefit of incorporating a SAFE into a STRIP is that university is more likely to hold preferred shares in successful USOs.

We have heard suggestions that universities should include claw-back clauses in contracts transferring IP to researchers. Such clauses would include simple and readily verifiable development and commercialization milestones such as receiving a round of financing from

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9 The SAFE was developed by Y-Combinator. Technically, it is a variable-priced warrant, but for all intents and purposes it is a convertible note with a zero interest rate and no term to maturity.

other than friends and families, or evidence of paid pilots. Failure to meet those milestones would grant the university the right to return the IP to its own IP portfolio. The rationale for including claw-back provisions is that they protect the university from cases where the researcher/founder's skills are not the best available for developing the technology.

We recommend against claw-backs since we think their inclusion will create a recursive disincentive to USO founders. Imagine the USO founder is one day away from a paid pilot on the claw-back date. Does the university capture the value created? If yes, then one day prior to the claw-back, the founder has little incentive to exert effort. Now consider the same founder two days prior to the claw-back. Knowing that on the very next day she will have no incentive to exert herself, she will have little incentive to provide effort at this time. This will roll back to the very beginning.

Note that before a STRIP can be executed, the researcher will need to create a corporation for business research activities. This observation ties back to the need for enhanced business education for potential USO founders. Understanding the steps to USO creation makes taking them less costly.

The recommendations above go some way to lowering the cost of USO formation. Another major cost borne by faculty members who choose the USO path is career interruption. Starting a USO requires time and the publish-or-perish environment of academia does not treat those with time-consuming hobbies nicely. Doing both an academic job and founding a company is almost always a recipe for doing neither well.[10] And here we return to Figure 6. It showed the number of newly minted PhDs far outstripping the number of academic positions available. Broadening the education of post-secondary STEM students to include formal venture and commercialization training would increase the supply of potential founders.

As we mentioned in section 2.1, some researchers come up with innovations and want nothing to do with commercialization. Other researchers do and lack the tools. Still others do not even know such a path is available. It is for the latter two groups that we recommend programs to promote the recognition of commercial value and the business expertise required to successfully bring it to the technology market.

We leave to another document the thorny idea of including commercialization activities in the evaluation criteria for promotion and tenure. Here we simply propose that universities create mechanisms that allow academics a low-risk opportunity to pursue commercialization. An example of such a mechanism is a program available to faculty members at the University of Calgary. Section 18.7 of the faculty's collective agreement allows faculty members meeting certain criteria to take a three-year leave without pay to pursue alternate opportunities (University of Calgary 2022). As an alternative to lengthy leaves without pay, more liberal secondment policies could be adopted. Secondment of a researcher to her USO would allow for the faculty member to work part-time at her university duties.

We now turn to methods for creating regional agglomeration economies. As noted above, various Chinese provinces, despite developing local technology, are receptors for externally developed technology. It is also interesting to note that not every province with a high retention rate has a high attraction rate. This corresponds to the idea that technologies have a group of best receptors. What does this mean for creating a regional agglomeration economy?

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[10] We admit that there are exceptions to this idea. However, as a general proposition, constrained optimization typically does not result in global maximums.

Begin by asking what you do well and if you have any natural advantages. An example from the film industry may help. A past director of Calgary Economic Development said, "What really brings Hollywood to us, beyond our crew base and quality of crew and talent, is the quality of our vistas and backdrops" (Allen 2023). Kerr and Robert-Nicoud (2020) investigate the root of tech clusters and offer the following: "Our historical examples suggest that local officials instead may wish to facilitate the scaling of nascent industries that have taken root, even if due to random chance, rather than attempt to engineer a cluster from scratch."

An area needs to find out what types of businesses it can support and then support them. Trying to be all things to all startups is agglomerative in the sense that many startups are together. What is more important is to agglomerate along lines of related business activities so that there can be spillovers between live firms and recycling of skills from failed firms to new firms. This is not a recommendation to champion an area and tend to its success. It is a recommendation to recognize what is working and help it grow. This will create a set of core competencies embedded in an area's anchor firms. These anchor firms are the spine of the local agglomeration.[11]

There will be those who say the floundering ventures in an area need assistance. Dale Carnegie tells us that we "develop success from failures" and Thomas Edison claims to have never failed, but to have found thousands of ways that do not work. "Fail fast" is a dictum in the startup space and development policies should not stand in its way. Forestalling failure creates zombies rather than promoting the anchor firm or firms needed (Godfrey et al. 2020).

Before delving too deeply into the benefit of anchors, we want to make two clarifications. First, anchor firms are not "local champions" in the sense that they receive preferential treatment. Anchors develop endogenously. They are what a local economy does well. They will also shift in a dynamic economy. Yesterday's anchor firms must be allowed to fail.

Second, avoid overly heavy anchors. Chintz (1961) contrasts New York City with its diverse sets of firms to Pittsburgh, a city dominated by large firms in the primary metals industry. It provides several insights. First, anchor firms can affect the supply of labour to other firms. Rather than creating workers with relatively transferable skills, it can homogenize a workforce, making individuals less suited and less willing to take on other work. In particular, he posits that steady work in wage/salary earning positions dampens the supply of entrepreneurs. Chintz also argues that major players find it cost effective to internalize certain activities that if available through other parties would benefit the region. He uses the example of trucking services. If the dominant firm internalizes its delivery fleet, there is less likely a common carrier for smaller firms.

Despite these caveats, we maintain that anchor firms are important. Saralee Tiede (vice-president communications of the Austin Chamber of Commerce) notes that Dell "lured great talent" to Austin, expanding the number of engineers and entrepreneurs (Pimentel 2003). Agrawal and Cockburn (2003) report wide variation in the ability of local economies to convert local university research into local commercial innovation. They report that the presence of an "anchor tenant," a firm with absorptive capacity for the research coming out of a university, strengthens the relation between industrial R&D and university research. An example from that paper compares New York City and Los Angeles. Both areas have similar levels of university research in medical imaging. NYC had two anchor tenants in medical imaging and LA had none. The number of industrial patents in NYC was twice that of LA. Having local absorptive capacity is essential for commercializing technology locally.

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11 Spigel and Vinodrai (2021) provide an overview of recycling in the Waterloo, ON ecosystem.

Recent work by Hausman (2022) confirms the importance of complementarities between local receptors and universities' research strengths. She reports that following the 1980 Bayh-Dole Act, which gave U.S. universities property rights to innovations developed with federal funds, employment, payroll and wages grew faster in industries that were more closely related to the technological strengths of nearby universities. Hausman also shows spillover effects where the amount and importance of corporate innovation in areas related to university technologies also increases.

These anchor firms will demand and create talent that will generate positive externalities for other firms evolving in that and near spaces. These other evolving firms will also draw talent and resources, resulting in a virtuous cycle of development. Local policies like incubators and office parks may help things start. However, Egeln et al. (2004) report that USOs will relocate to be near customers or other clients in order to adjust their product offerings. Growing a hub around core competencies will also draw customers near and create more local gravity. To this end, Godfrey et al. (2020) recommend regions consider "micro-clusters" and not attempt to re-create any existing hub. Attempts to be good at broad areas like life sciences are unlikely to work. Instead, discover the narrow slice that you do well and become best in class there. For universities, the recommendation is to foster outstanding departments rather than strong colleges.

The idea of fostering strong departments and the noted benefits of complementarities between universities' technological strengths and local receptors suggest that universities should engage in selective specialization. To the extent a university wishes to enhance its commercialization activities, resource allocation decisions should consider which disciplines are likely to create successful opportunities. This analysis can be used to determine the relative growth rates of departments.

Another way to find out what you do well is to look at past successes. A group like the A100 is informative here. Members of the A100 are individuals who have scaled a tech-focused business in Western Canada. Look to the technologies they levered. More importantly, build on the A100's networks. If these individuals scaled and exited a business, the teams they used can be recycled. In addition to the founders, aggregating information about the business development staff, sales channel partners, designers, legal teams, etc., will provide information about where there is already a deep talent pool. This can be used to help determine what the local anchor is.

The advice in the last paragraph might be thought of as a call to more effectively recycle the local entrepreneurial talent. This recycling will also occur as individuals at anchor firms transfer to startups that are in near technology spaces. Individuals develop the tacit knowledge of entrepreneurship via learning by doing. Combined with deep SME, the tacit knowledge gained in cycles of entrepreneurial activity creates a stable base of human capital that will increase local gravity of talent.

There is one last group whose education will help create USOs: local potential angel investors. Individuals and families who have no experience investing in the startup space hold considerable amounts of wealth. If these potential angels were socialized to angel investing, they could contribute to the formation of capital needed to create firms. This will not be an easy task in areas where local investing has typically been concentrated in projects with more concrete parameters and valuation guidelines. It is also unlikely that the target market is keen on attending seminars. However, an outreach program to local high net-worth individuals with the offer of bespoke angel investing education programs can potentially unleash some of the capital needed to spur local USO activity.

Please note that the idea here is not to attempt to imbue these potential angels with the deep SME to navigate the asymmetric information problems in startup investing. Rather, it is to familiarize them with the various types of investment vehicles, the nature of uncertainty resolution and how to create a network of individuals who can aid them in any angel investing opportunities. Attention to the concept of diversification and the role of extreme returns in angel investing should also be highlighted. If people do not know how to build an angel portfolio, they most likely will not.

We end with a note of caution taken from Hobsbawm (1969, 40)[12]:

> It is often assumed that an economy of private enterprise has an automatic bias toward innovation, but this is not so. It has a bias only toward profit.

This quote reminds us to be aware that the pools of money set aside to promote innovative entrepreneurship will also attract agents seeking to profit from those programs rather than actually innovate. That is, large pools of money create incentives for innovative rent seekers. As such, care must be taken to ensure the resources are used appropriately.

The concepts of university tech commercialization, startup clusters and innovation hubs have created a growth industry of establishments, organizations and businesses offering ESS. ESS providers include incubators, accelerators, law firms, capital arrangers and pitch deck consultants. There are also professionals who prepare the forms for ventures to claim scientific research and experimental development (SR&ED) tax incentives and firms that factor the tax credits generated by the SR&ED program. Some ESS provide service of dubious value and merely separate budding entrepreneurs from resources they could use to grow their businesses. Others provide useful services and charge prices that do not overly tax the startup. The leakage of resources meant to help startups to businesses designed to capture those resources must be considered in any program design.

Consider the SR&ED credit system. SR&ED is the largest single source of Canadian federal government support for R&D, providing billions of dollars to thousands of claimants. Basically, Canadian-controlled corporations that meet certain criteria can apply for a refundable tax credit in the amount of all monies spent on basic and applied research and experimental development.[13] The CRA provides an advisory service to first-time claimants.

As mentioned earlier, many budding entrepreneurs lack business acumen. Correspondingly, an industry of SR&ED preparation specialists has evolved. The resource, SR&ED Education and Resources, estimates that SR&ED consultants charge from 10 per cent to 25 per cent.[14] Up to a quarter of the money designed to help spur technological advancement is being paid out to service providers who profit without innovating.

Another innovation is the SR&ED loan. Basically, a venture needing capital can pledge its SR&ED return as collateral for immediate access to capital.[15] Note, often the SR&ED consultant who prepares the filing doubles as the factor. The risk involved in the SR&ED factoring is reduced when this occurs. The typical rates on SR&ED loans range from one per cent to 1.5 per cent per month or 12 per cent to 18 per cent per annum. Based on the lag between filing for a SR&ED credit and receiving it, another six per cent to nine per cent of the credit can go to the service

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12 Hat tip, Baumol (1990).
13 We think a policy that provided research and development tax credits to any firm with its headquarters and technical operations primarily in Canada, regardless of the geography of control, would better promote agglomeration.
14 See also Canadian SR&ED (n.d.).
15 See, for example, Easly (n.d.), OKR Financial (n.d.) and Mandel (2021).

provider granting the SR&ED loan. Whether the SR&ED program created jobs in the technology sector is unclear. What is clear is that the program has created jobs for entrepreneurs in the ESS sector and up to 34 per cent of the money meant to spur research innovation is leaking from the program. This 34 per cent is perhaps a lower bound on the leakage as there are other members of the ESS sector who are collecting monies meant for innovative activities.

So, what is a regional government to do? Based on the discussion above, we make the following six recommendations:

1. Create a provincial office of SR&ED preparation for startups located in the province.
    a. Hire a staff of three to four accountants and charge a low fee; and
    b. Rather than create a program to give away millions of dollars, spend a few hundred thousand dollars to allow founders to keep millions of dollars.
2. Use whatever budgetary carrots and sticks are available to persuade universities to:
    a. Make changes to universities' TTOs:
        i. Organize system-wide TTOs into areas of excellence;
        ii. Understand what the core competencies are for each TTO, focus on those and use commercially available licensing catalogues for marketing the remaining licensable IP;
        iii. Help universities create simpler means of transferring IP to founders of USOs; and
        iv. Undertake a thorough governance review of university TTOs.
    b. Create programming inside universities to enhance commercialization skills of SMEs:
        i. Leverage the capacity of programs like Lab2Market (n.d.); and
        ii. Create commercialization educations programs as part of STEM graduate requirements.
    c. Nudge universities to engage in selective specialization:
        i. Provide incentives for tilting hiring to departments that create technologies with higher complementarities with the technology of local receptors.
3. Create a provincial-level refundable commercialization expense program. Funding for technology development is readily available. Subsidization of commercialization will get more commercialization:
    a. Make this available to all founders who want to begin commercialization efforts in the province. This will help the province attract technology.
4. Provide a well-curated portal listing funding and commercialization support opportunities. This should be indexed by costs and some measure of quality.
    a. Use this information to ensure lack of duplication and to prevent cannibalization.
5. Mandate registration/licensing of all fee-taking ESS in the province.
    a. Hair stylists face more scrutiny before they are allowed to cut hair than the ESS who are selling services whose value is far less measurable.
6. Educate local potential angel investors.

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About the Authors

Mark R. Huson is a Professor of Finance and the Dianne and Irving Kipnes Chair in Finance and Development University of Alberta. He is also the Academic Director at Creative Destruction Labs—Rockies.

He has published papers in the *Journal of Financial Economics*, *Journal of Finance*, *Journal of Corporate Finance*, *The Accounting Review*, and *The Journal of Operations Management*. Mark is a founding director of the Financial Research Association. He was on the editorial boards of *Contemporary Accounting Research* (2010-2013), *Canadian Journal of Administrative Sciences* (2012-2013), and served as an Associate Editor of the *Review of Financial Studies* (2013-2016).

Mark's startup experience includes Angel investing as a member the Central Texas Angel Network (CTAN) in Austin. Additionally he sat on the board of Greenspense, a Tel Aviv based start-up and is currently a board director at Pacylex an Edmonton based oncology start-up.

Randall Morck is the most cited economist in Canada, his research referenced more than 53,000 times in other researchers' work. From a blue-collar Alberta family, he received a scholarship to attend Yale University where he graduated summa cum laude with BSc in Honors Applied Mathematics and an M.A. in Economics. After earning a PhD in Economics from Harvard, in 1986 he joined the University of Alberta, which appointed him Stephen Jarislowsky Distinguished Professor of Finance. He returns to both his almae matres, most recently as Mackenzie King Visiting Professor at Harvard and as Schoen Visiting Professor at Yale. Prof. Morck is a Research Associate at the National Bureau of Economic Research in Cambridge Massachusetts and Senior Fellow at the Asian Bureau of Finance and Economics Research in Singapore. In 2018, he was awarded a Yangtse-River Professorship, the highest academic honor in China, where he is affiliated with the Wenlan School of Economics. In August 2023, the University of Montreal and HEC Montreal awarded him an honorary doctorate for contributions to corporate governance and other areas of finance research. He has advised governments, central banks, and multilateral institutions on these issues

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