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Spreading academic entrepreneurship: Made in Mexico

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Abstract This work presents REPITA (*Research-Ecosystem-People-Intellectual Property-Transfer-Alignment*), a prescriptive and repeatable model for successful technology-based academic entrepreneurship, synthesized from research of academic entrepreneurship in developing economy conditions. In this work, we identify three deficiencies in Mexico's entrepreneurship ecosystem: research skills, high technology, and technology transfer. We then present a solution that has been recognized by the Organization for Economic Co-operation and Development (OECD) for fueling high-tech university spin-offs with science and technology doctoral research. Lessons from 48 spin-off projects are synthesized in the newly proposed REPITA model, which prescribes connecting a basic research platform to applications, catalyzing the entrepreneurship ecosystem with resources and incentives, combining highly specialized people in entrepreneurial teams, setting generous and flexible intellectual property policies for the knowledge economy, transferring technology per entry and exit strategies, and aligning technology and business incubation. Finally, we propose a tool that presents academic entrepreneurship theories in an actionable format for university administrators and entrepreneurs. These results are not a theoretical framework on their own, but rather a real-world organizational model based on theory for impelling technology-based, academic spin-offs with economic impact. Taken together, this contribution may be useful to practitioners and provocative for researchers.

1. The rise of academic entrepreneurship

Although entrepreneurship is not the university's traditional raison d'être, it has become a priority for institutions seeking to generate revenues and

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elevate brand status. Academic entrepreneurship refers to university researchers commercializing university research through new business enterprises. State-of-the-art suggestions for boosting academic entrepreneurship via technology transfer include increasing faculty quality as well as faculty size, investing in patent protection, expanding industry relations, launching interdisciplinary research centers, and rewriting university incentives in favor of commercialization at the expense of scientific publication (Hsu, Shen, Yuan, & Chou, 2015). These actions cannot all be feasible within a university with a historical set of priorities and limited resources. Through the experience of dozens of academic startups in this decade, a Mexican university is defining a sustainable model for high-tech academic entrepreneurship that could teach other institutions a few lessons.

1.1. Mexico's academic entrepreneurship priority

Donald Trump isn't the only one talking about Mexico. In 2015, *Inc*. magazine called Mexico an "undiscovered opportunity for entrepreneurs" (Rampton, 2015) and, although it may be unexpected, academic entrepreneurship is a rising trend in Mexico, presenting opportunities to the country and the region. The Mexican National Council of Science and Technology, abbreviated to CONACYT by its Spanish initials, plays a role similar to the National Science Foundation (NSF) in the U.S. It coordinates an innovation program named FINNOVA that connects applied research with entrepreneurs and companies, helping to transfer technology between academics and businesses and assisting academic institutions in the creation of spin-offs. Preliminary research reports that 13% of Mexican university and research institute researchers have been or are involved in spin-off creation (Gutiérrez & Montemayor, 2012). Beyond these summaries, however, the practitioner's experience of Mexican academic entrepreneurship has not been studied and shared. What does the spread of academic entrepreneurship in Mexico have to teach about how universities can impel successful spin-offs that create returns to their scientific, social, and economic communities?

The lessons learned from a first-of-its-kind entrepreneurship experiment have been assimilated into a model called REPITA, which prescribes six actions:

1. *Research*: Structuring a basic research platform toward applications;
2. *Ecosystem*: Catalyzing the entrepreneurship ecosystem with resources and incentives;
3. *People*: Combining highly specialized people in entrepreneurial teams;
4. *Intellectual property*: Writing more generous and flexible intellectual property (IP) compensation policies for the knowledge economy;
5. *Transfer*: Transferring technology per entry and exit strategies that respect young businesses and profit the technology transfer office (TTO); and
6. *Alignment*: Aligning technology and business incubation.

Before arriving to the model, dozens of high-technology academic spin-offs were studied in an experimental entrepreneurship program called *incubation cells*, which was recognized by the Organization for Economic Co-operation and Development (OECD) for teaching "business competencies to doctoral students" (OECD, 2012). Tecnológico de Monterrey, the Mexican academic institution with the most patents filed and spin-offs created in recent history (Yeverino-Juarez, 2015), hosted this experiment. Lessons learned from the experiment are synthesized into the prescriptive REPITA model.

1.2. How does academic entrepreneurship work?

Universities have recently earned a primary role in the study of entrepreneurship as practitioners and theorists have asked how academic entrepreneurship works. One idea, the *resource-based framework* (Wernerfelt, 1984), was applied to university entrepreneurship by O'Shea, Allen, and Chevalier (2005). This framework suggests that the heterogeneity of each university's resources gives unique characteristics and opportunities to each of the university's spin-off activities. There are four resource categories that explain differences in university entrepreneurship: human, institutional, financial, and commercial resources. These resources help transfer innovations from university research to commercial markets.

Research supports these four resource categories. Hsu et al. (2015), as well as Powers and McDougall (2005), found human resources such as quantity and quality of researchers to be relevant for the successful production of spin-offs in universities and research centers. O'Shea, Allen, Mores, O'Gorman, and Roche (2007) and Valdez and Richardson (2013) determined that intangible institutional resources such as institutional history and culture impel entrepreneurship. Tangible institutional resources such as technology transfer offices are related strongly to spin-off success (O'Kane, Mangematin, Geoghegan, & Fitzgerald, 2015). The third category, financial resources, includes research and development (R&D) spending and investment capital, which can come from public or private sources and is correlated with a greater number of academic spin-offs (Rasmussen & Sørheim, 2012). Finally, within the framework, commercial resources often include incubators, although these are environments in which networks of finance, mentorship, and even customers mingle. Patent protection is another commercial resource that is often available and beneficial to university spin-offs (Hsu & Ziedonis, 2013). In short, the resource-based theory assumes that the supply of university resources is critical to the quantity and profitability of spin-offs.

The *capability-based framework* is another idea that has been applied to academic entrepreneurship. This framework emphasizes capabilities more than the mere supply of resources (Rasmussen & Borch, 2010). The capability-based framework is divided into three capabilities that facilitate academic spin-offs: opening new paths of action, balancing academic and commercial interests, and integrating new resources. The capability to open new paths of action is the first category in the framework, and it relates to the exploration of new business ideas within the university ecosystem. A university that can generate new ideas and open new paths of action will have more spin-offs. For example, patenting a discovery from a university lab may open a new path of action toward entrepreneurship, depending on factors including the target industry and the strength of a country's IP law (Woo, Jang, & Kim, 2015). Second is the capability to balance academic and commercial interests. Balance has to do with legitimizing both academic and commercial activities. Special entities such as university TTOs and incubators do a good job of striking this balance and fostering healthy spin-offs. Finally, the capability to integrate new resources capitalizes on networks in order to attract and offer external resources that complement internal university resources. According to the framework's developers, new resources are most often integrated through the personal networks of academic entrepreneurs, especially if they have a history of industry connections. Integrating new resources can be done with social capital or cultural capital and it is most likely to be successful when the two are combined (Light & Dana, 2013).

Summarily, resources and capabilities are two different ways of framing academic entrepreneurship. The resource-based view emphasizes supply and access to resources. The capability-based framework focuses on competency and agency. The resource-based theory has been applied to entrepreneurship research in Mexico (West, Bamford, & Marsden, 2008), where researchers have concluded that entrepreneurship can help grow and stabilize the country's economy as entrepreneurship provides a job-creating alternative to foreign direct investment. Just as in developed economies, an intangible resource—entrepreneurial culture—was key for entrepreneurs in Mexico; in fact, it was the most important resource.

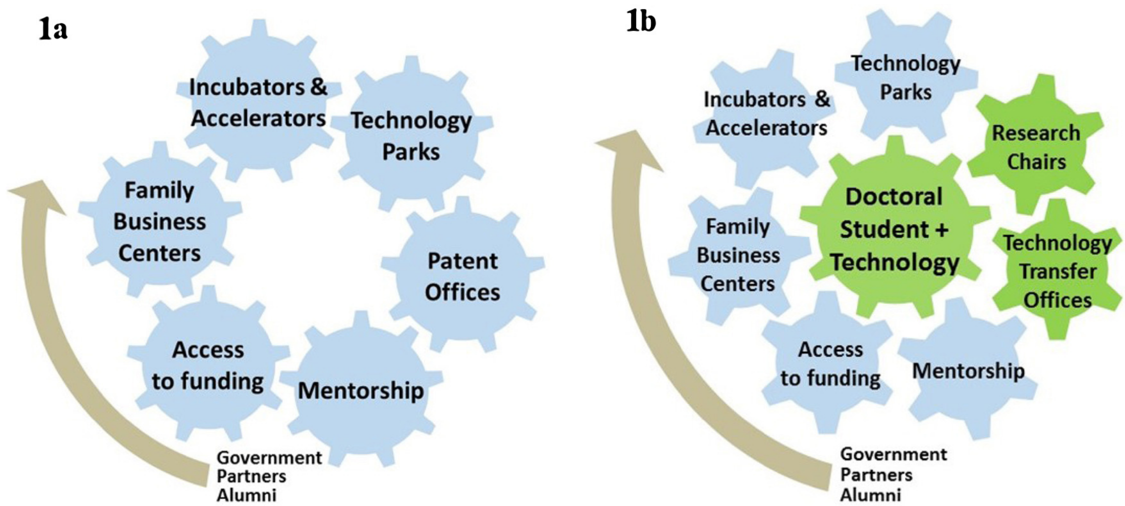
2. A live entrepreneurship experiment

2.1. Academic entrepreneurship that solves three problems

In the years preceding 2010, Tecnológico de Monterrey reviewed its expansive entrepreneurship ecosystem (Figure 1a). The ecosystem included patent offices, PIIT (one of Latin America's most important technology parks), business incubators, 32 campuses spread over the major Mexican cities (and therefore in contact with all sectors of the Mexican economy), and nearly 100,000 students and 9,000 faculty. Three gaps in the entrepreneurship ecosystem were identified: The ecosystem lacked mechanisms targeting graduate students with research skills, did not focus on technology-based entrepreneurship, and did not provide formal channels to transfer university-owned technology to spin-off companies. The university decided to create an experiment to introduce these three missing elements. Planning culminated in the definition of an experimental incubation cell program and the indicators by which it would be studied. The program was designed to introduce the missing elements to the ecosystem: graduate student research skills, technology-based entrepreneurship, and the transfer of university-owned technology IP to spin-offs.

An incubation cell is a group of researchers (professors and students) led by a PhD student for the purpose of creating a technology-based spin-off company aligned with doctoral research. The PhD student would be the leader in conceiving the business idea, developing the product or service prototype, and applying knowledge from the student's research. The incubation cell program

Figure 1. **Pre-existing entrepreneurship ecosystem (1a) and incubation cell program (1b)**



conceived of a science or technology doctoral student as an entrepreneur at the center of the ecosystem, simultaneously introducing graduate-level research experience, high-technology experience, and a channel for technology transfer into the ecosystem (Figure 1b).

A complementary ingredient was added to the entrepreneurship ecosystem as part of the incubation cell program, the university's *research chairs*. A research chair is a group of professors and students who develop and consolidate a line of research in a strategic knowledge area at the university, as described by Cantu-Ortiz, Bustani, Molina, and Moreira (2009). Research chairs were enacted in 2002 at the university, reflecting the larger trend of Mexican universities focusing on research as well as teaching (Gregorutti, 2010). The research chairs began successfully creating new technologies and the incubation cell program arose as a technology transfer process that naturally took advantage of the research chairs. A second complementary evolution took place regarding the patent offices in the ecosystem. Impelled by the development of new technologies, the previous patent offices evolved into TTOs dedicated to protecting intellectual property and finding business applications.

A proposal by a doctoral student to initiate an incubation cell had to be endorsed by the principal investigator of the research chair to which the student belonged. Next, an evaluation committee typically composed of 12 members from industry and academia assessed the proposal. The referees followed a predefined rubric with three main sections: profile of the entrepreneur, novelty of the technology and associated prototype, and competitors and potential markets. Once approved, the student and the technology would be enrolled in the university's business incubator.

Once admitted, the student's incubation cell became a part of the entrepreneurship ecosystem and received support from the institution. According to the program policy, incubation cell participants agreed to incubate a business in parallel with their doctoral studies in exchange for space in the university's incubator and seed funding from the university. According to the intellectual property policy, ownership of intellectual property generated by the incubation cell or research chair would be reserved to the university. The cells have a non-commercial agreement to develop the technology as well as the priority to eventually sign a commercial license and exploit the technology as a spin-off company. Key indicators for studying the program included spin-off generation and survival, patent applications, graduation rates, revenues, satisfaction with the TTO, and satisfaction with the incubator.

2.2. An entrepreneurship experiment

The first call for entrepreneurs occurred in 2010, and the accepted projects began incubation. The incubation cell program operated for 6 years until 2015. Cells had constant contact with the program directors and with ecosystem resources such as research labs, the TTO, the business incubator, and others. Cells had annual performance reviews with internal and external experts.

Table 1 summarizes the annual results of the program. In total, 48 projects applied to the incubation cell program between 2010 and 2014, and 39 entered as incubation cells. About 25 cells were active in each year from 2010—2013. University-wide

Table 1. Annual summary statistics of the incubation cell model

	2010	2011	2012	2013	2014	2015	Total
Proposals	31	2	8	6	1	0	48
Rejected	4	0	1	1	0	0	6
Accepted, never active	2	0	1	0	0	0	3
New cells	25	2	6	5	1	0	39
Abandoned	0	5	2	4	18	0	29
Reactivated	0	0	1	0	0	0	1
Active cells	25	22	27	28	11	11	124
IP applications	7	16	7	2	0	0	32
Companies constituted	0	4	9	1	2	0	16

changes to the research chair system reduced the number of cells to just 11 in 2014. These 11 cells continued operating as of August 2016 either in a pre-launch phase or as legally constituted spin-offs.

In total, 16 incubation cells legally constituted a technology-based spin-off company. Six of these companies are still in operation. Incubation cells filed for intellectual property protection 32 times during the 6 years of the program. The years with most intellectual property applications were 2010—2012, slightly preceding and coinciding with the years in which incubation cells constituted the most new businesses, 2011—2012.

These results were made possible by university investments. The university invested an average of $29,421 USD and a median of $23,271 USD in each incubation cell. These figures include subsidies or payments for intellectual property protection, legal constitution of the business, commercialization, incubator space and services, and other non-research services. The minimum amount invested in one cell was $3,239 over 1 year, and the maximum invested in one cell was $138,734 over 4 years. The average investment in one cell for 1 year was $11,081, and the median was $8,750. Right-skewed cost distributions result from some outlying expensive projects.

2.3. Lessons learned

In 2014, university-wide changes to the research chair system put a natural stop to the incubation cell experiment. In 2015, the university underwent another review of its entrepreneurship ecosystem with eyes toward improvement. Regarding key indicators, the university solicited the perspective of incubation cell participants, recorded quantitative metrics for benchmarking against other programs, and collected observations from program directors. Lessons distilled from this research are presented next.

2.3.1. Spin-off creation and survival may be improved

The university created more spin-offs than any other Mexican academic or research institution from 2011—2013 (Yeverino-Juarez, 2015). This was certainly a step toward achieving the university's goal of impelling academic tech-based spin-offs. Of 39 total cells, the six businesses still active at print of this article in 2017 represent a 15% active-business success rate. Among the 16 spin-offs that were ever legally constituted, the six remaining spin-offs represent a 38% success rate. Success rates are much lower than reported by Van Geenhuizen and Soetanto (2009), who reported 90% survival after 6 years among academic spin-offs founded between 1994 and 2003 at Delft University of Technology in the Netherlands. No exact point of comparison for academic spin-offs in Mexico exists. The Global Entrepreneurship Monitor (GEM) reports that 5.6% of all Mexican businesses closed in 2014, but the incubation cells are not typical Mexican businesses. Just 11% of Mexican businesses aged 42 months or younger are using technology less than 1 year old (Global Entrepreneurship Monitor, 2015). The incubation cells all used new technology in their businesses. The years with most spin-offs directly followed the years with most IP applications.

2.3.2. Patent generation expands

The university filed 396 total patents between 2004 and 2014 in Mexico and abroad. The institution was the greatest patent-generating Mexican university or research institute during this time. Projects participating in the incubation cells filed 32 patents in the 5 years between 2010 and 2014. In these 5 years of incubation cell operation, the institution filed 18 more patents than it had in the previous 6 years.

2.3.3. Technology transfer office faces new challenges

The principal task for incubation cell directors was to connect research results with entrepreneurship.

To do this, the university's TTOs were connected for the first time as a network across Tecnológico de Monterrey's 32 national campuses. This took advantage of elements already offered in the ecosystem like incubators and technology parks, which traditionally supported external projects rather than projects with intellectual property owned by the university. Transformations within the TTO lend credence to Weckowska's (2015) recent conclusion that top-down administration initiatives can produce innovation in university technology transfer offices.

A successful TTO must have legitimacy in the entrepreneurship and research communities (O'Kane et al., 2015). TTO personnel had to learn how to protect and license high-technology intellectual property to earn this legitimacy. To date, the TTO has commercially licensed new technology to three incubation cells. The other active cells continue developing their technologies with non-commercial rights.

As a result of the incubation cell program, the TTO grew by the standards of patents solicited, funds obtained, and employees specialized in commercialization. In the experience of the TTO, great technology was more critical to spin-off success than the student-founder's business polish. This echoed research from Brazil that found R&D a driver of the highest returns of all business activities to academic spin-offs (Freitas, Gonçalves, Cheng, & Muniz, 2013).

2.3.4. Being a PhD student and entrepreneur was a challenge

Even the most successful cell participants simultaneously pursuing PhD studies and entrepreneurship experienced a problem: There just wasn't enough time. The experiment overwhelmingly revealed that students struggled to develop a technology and a business and also graduate in 4—5 years. Some students asked for academic leave to solidify the business. Others completed their theses and then turned their attention to commercialization. Students often left their nascent businesses behind the moment they graduated. This was because the program offered support to students in critical ways not extended to alumni or employees.

2.3.5. Incubator needs focus

While the incubator was helpful for business training and legal support, the incubation cells needed an incubator focused on high technology. The incubator offered co-located office spaces to all of the cells, but this office space was used almost not at all. Comments from one cell participant were representative of this phenomenon: Researchers already have habitual workplaces in their laboratories that they find effective and convenient, and therefore they were not looking to take advantage of co-located office space.

2.3.6. Intellectual property and financial policies must change

A non-trivial outcome of the incubation cell program was the set of financial failures it identified. Spin-off activity in the incubation cells was governed by an IP policy established at the university in 2007. The incubation cells revealed that this policy had several shortcomings for an institute transferring technology from research to entrepreneurship. For example, although inventor ownership rights encourage more faculty entrepreneurship (Kenney & Patton, 2011), the 2007 policy stipulated that the technologies developed at the university belonged to the institution and that only 30% of patent royalties would be awarded to researcher-inventors. The policy did not consider potential conflicts of interest for professors who were both inventors of intellectual property and equity-holders in a new spin-off company. It also limited the university's flexibility to reap financial returns through technology transfer. The university, which is a nonprofit, is permitted to generate and offer services of research and to commercialize the results through licensing of intellectual property when this activity is aligned with the social objectives of the university. This means that the university could not hold equity in spin-off companies and could only recuperate its investment in the incubation cells through licensing fees.

The incubation cell experiment marks a before and after for the university. Although the university traditionally had incubators and technology parks, this was the first time it decided to create high-tech businesses by leveraging its own researchers and intellectual property. This is believed to be a unique design in all of Latin America and in all developing economies. The incubation cells gained the attention of universities in Colombia, Chile, Paraguay, and Peru. These universities had no programs of entrepreneurship or technology transfer as an outlet for research and wanted to create such programs. Representatives from these schools visited Tecnológico de Monterrey looking for the lessons presented here. TTO leaders spoke with them about the incubation cells and provided training and consultancy services in technology transfer and tech-based entrepreneurship. But would the model prove replicable?

2.4. One example of how these lessons are applied

Lessons learned from the incubation cells were applied in a new program for technology-based spin-offs at Tecnológico de Monterrey in 2016. The new design serves not only doctoral students but also all university researchers, both professors and students, wishing to spin off a technology-based company.

New arrangements were made between the university, the TTO, and the entrepreneurs. According to the new program, the university provides research and development funding to an inventor and retains rights to just 50% of the royalties (down from 70%) generated from intellectual property licenses. The TTO has made new financial arrangements that allow it to hold a share of equity in university spin-offs, and it negotiates for some percentage of equity in the spin-offs it assists. In the present plan, the TTO sells its shares in the spin-off during the second and third rounds of investment. Per the plan, sales will ideally be made to the founders of the spin-off. Finally, spin-offs are also required to make a financial contribution; each spin-off is responsible for securing at least $100,000 USD of its own funding by the end of incubation. The spin-off gains incubation, credibility, R&D, and networking from the three-way relationship, all of which help it become profitable.

As mentioned in the previous paragraph, IP compensation policies were adjusted. First, the new policy assigns 50% of royalties from patent licensing to the inventors and withholds only 50% for the university. Second, it opens mechanisms to make payments to the entire team of technology inventors, even those who are not students or employees of the institution. This especially will benefit alumni who started working on a technology as a student but obtained a patent and license agreement after graduation. This exact situation is relevant to many of the former incubation cell participants.

Whereas the incubation cells focused on the profile of the entrepreneur, the new program includes requirements for entrepreneurial teams. The team must meet three criteria. First, it must have an expert in the technology being transferred; this is generally the researcher-inventor. Second, it must have a businessperson with a minimum of 10 years of experience in the target industry. Third, it must have at least one co-investor from the target sector.

Finally, technology and business incubation are synchronized in a 36-month schedule. Before incubation begins, the market opportunity, the technology, and the profile of the inventor-entrepreneur are assessed by the university. If they are approved, incubation in the university incubator has three phases. Phase one consists of 6 months of incubation in which the entrepreneurial team must coalesce, the business model must be defined, and the technology must reach a pre-commercial prototype level. Phase two is technology and market validation; 18 months are allowed for this phase. In this phase, public or private funds must be obtained to create a pilot technology, which must be implemented through pre-sales or trials with the spin-off's first clients. Finally, phase three is market launch. One year is budgeted to find strategic co-investors from the industry who must provide at least $100,000 USD. With the introduction of this external support, the spin-off should be able to leave the incubator and begin independent operations.

The actions described above outline a new program of academic entrepreneurship at Tecnológico de Monterrey specifically tailored to its research and innovation context, which is described in Cantu-Ortiz (2015). The most important result of the incubation cells experiment, however, has been the synthesis of a repeatable academic entrepreneurship model that can be tailored to serve other universities. The model is called REPITA. It is a prescriptive model for successful academic entrepreneurship based on six elements: research, ecosystem, people, IP, transfer, and alignment.

3. A higher education evolution?

3.1. Next steps for spreading academic entrepreneurship

The REPITA model is deployed as a coherent set of actions that a university may take to establish successful academic entrepreneurship. Critically, these actions are feasible for universities without a history of entrepreneurship or an internationally recognized brand. Taking these steps, however, can position a university among the leaders in the spreading global phenomenon of academic entrepreneurship. REPITA prescribes actions regarding research, entrepreneurship ecosystems, people, IP, technology transfer, and alignment of technology and business.

3.1.1. Research: Stimulate research and structure it toward applications

The first step is to establish a base of cutting-edge investigation in which academics are inventing new technologies or ideas from research methodologies. Basic research infrastructure is essential and can be developed internally or in collaboration with universities with well-established laboratories. The base of investigation should be accompanied by some structures toward application. Involving student researchers both foments research and structures it toward applications. Students can cultivate research in terms of absolute quantity that an institution can produce. Students also structure research toward applications because the majority of them move into careers other than research, building networks across which research can flow.

3.1.2. Entrepreneurship ecosystem: Catalyze spin-offs by combining resources and incentives

A model of co-investment is based on the relative resources and incentives of the agents involved in the entrepreneurship ecosystem. A university has vast research resources and is interested in stable economic returns and the prestige associated with spin-off activity. It can provide research and development funding to inventors and retain some rights to the royalties generated from intellectual property licenses. Research funding is usually complemented by grants from national governments or international agencies that hope to see technological and social development. A TTO is capable of protecting IP and incubating a business, and by doing so it effectively invests in a spin-off. A TTO also is interested in some exposure to risk and entitled to large pay-offs in the event of a successful project. Finally, the new spin-off is the entity with the highest potential to create new value, both economic and social. The spin-off will draw resources from the ecosystem in order to realize this potential. In the interest of sustainability, spin-offs can be required to attract part of their own funding (especially from angel investors, venture capitalists, and other profit-seeking entities) to the ecosystem. It is not solely the university's responsibility to be the ecosystem's catalyst. Governments, companies, and non-profits should be included as catalysts as well.

3.1.3. IP: In a knowledge economy, intellectual property policies must be generous and flexible

IP policies that are both generous and flexible are best suited to academic entrepreneurship. Offering inventors generous shares of royalty revenue attracts top talent. It is inevitable, however, that knowledge will flow across university boundaries. Flexible payment mechanisms must be in place to reward faculty, students, alumni, and industry collaborators fairly.

3.1.4. People: Entrepreneurial teams should combine highly specialized skills

Academic entrepreneurship is difficult in part because the academic is highly specialized in his or her research domain. Building a team of a few highly specialized people is more feasible and robust than rounding out the academic's areas of expertise. Other key skills to combine in entrepreneurial teams include commercialization, finance, and operations.

3.1.5. Technology transfer: A TTO needs an entry strategy and an exit strategy

A TTO should know where to begin: providing research services, soliciting researcher-inventors, or waiting to be approached by researcher-inventors. Then, a TTO must know where to stop: protecting IP negotiating licenses, or assisting spin-offs. Preconceived entry and exit strategies help define the scope of the relationship between the TTO and spin-off, help the spin-off successfully mature, and increase the likelihood of positive financial returns for the TTO.

3.1.6. Alignment: Align technology and business incubation

Neither the technology nor the business can spin off alone. Successful co-development requires that the technology and business be configured to fit together and to fit in the external environment. Incubated separately, they may become rigid and incompatible. Incubated in synchrony, the two pieces align and strengthen each other, and the spin-off will have the foundation necessary to leave incubation and become a full-fledged company.

REPITA is a real-world prescriptive and repeatable model for impelling technology-based academic spin-offs. It should be subject to ongoing experimentation and improvement, as this will create the greatest social and economic impact.

3.2. A tool for getting started

Universities implementing REPITA need to understand, take advantage of, and contribute to their regional, national, and international context. A matrix tool (Table 2) is proposed for getting started. There is a growing amount of knowledge and experience in the world around academic entrepreneurship. Knowledge and experience are powerful drivers for change if they can be represented in an actionable way. Table 2 represents the resource-based framework (O'Shea et al., 2005; Wernerfelt, 1984) and the capability-based framework of academic entrepreneurship (Rasmussen & Borch, 2010) so that a university director or entrepreneur can

Table 2. Academic entrepreneurship cross-examined by resource-based and capability-based frameworks

	Open new paths of action	Balance academic & commercial interests	Integrate new resources
Human resources	• Research faculty	• Academic entrepreneurship model directors	• Social network
	• Other students		
Institutional resources	• Entrepreneurship Institute	• Technology transfer office	• Annual entrepreneurship conference
	• History and culture of entrepreneurship		
Financial resources	• Expenditure on IP protection	• Equity and licensing revenue streams	• Scholarships
			• Grant application support
			• Network of capital
Commercial resources	• Technology park	• Incubator	• Industry consulting
		• Institutional IP portfolio	• Research by contract

investigate what resources may be available and what those resources are capable of achieving. The tool can be filled with information according to regional, national, and international context. Then the six REPITA elements can be tailored to each institution's purposes.

4. Further experiments

Academic entrepreneurship is a phenomenon based on experimentation (Djokovic & Souitaris, 2008). This study presents at least two avenues for deeper investigation of academic entrepreneurship. First, this analysis did not have space to review the connection between REPITA and a new 'demand-side' academic entrepreneurship framework that considers the nature of university support in response to the demands of its spin-offs (Rasmussen & Wright, 2015). Second is the tension of entrepreneurship as a contingency or as a foundation of higher education. The original incubation cell program was contingent on the university's research chair system. Because the research chairs were redesigned in 2014, the incubation cells had to be redesigned as well. The new REPITA model seeks to embed entrepreneurship deeper into the university's fabric. Will entrepreneurship become a fundamental function of higher education? As academic entrepreneurship spreads around the world, one must not miss the opportunity to learn from cutting-edge research.

The incubation cell program linking doctoral research to a spin-off company was the first of its kind in Latin America or any developing economy. The result of the incubation cell experiment is not a theoretical framework on its own, but rather a real-world prescriptive and repeatable REPITA model for impelling technology-based academic spin-offs with economic impact. The REPITA model includes a basic research platform that leads to applications, a catalytic mix of resources and incentives in the entrepreneurship ecosystem, successful entrepreneurial teams that combine people with highly specialized skills, more generous and flexible IP compensation policies for the knowledge economy, technology transfer entry and exit strategies that respect young businesses and profit the TTO, and synchronized incubation that aligns technology and business development. We hope that academic entrepreneurship based on the REPITA model serves to generate further knowledge and experience in Mexico and around the world.

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