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Arizona's Bioscience Roadmap Progress Report Update

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Q&A session:

Mitch Horowitz, TEConomy Partners

Kevin Klowden, Milken Institute

Q: How do bio jobs here compare to states like Massachusetts and California?

Mitch Horowitz: We do not have specific comparisons to share today, but that will be available in our upcoming report for BIO on state biosciences development, which will cover the non-hospital biosciences sector.

What we can say is whether it's Massachusetts or California or New Jersey, large states that have been leaders in biosciences development don't always perform well. California in the 2000s did not have strong growth trends and then rigorously came back in recent years. Massachusetts has had more consistent gains over the past two decades in part due to their major investments through the Massachusetts Life Sciences Center. We can also tell you for sure, there are going to be few states that can match Arizona's growth rates, given how much greater it has performed compared to the overall national trends, even in the most recent two-year period and certainly since 2002. There are not many states that can rival that growth.

Q: The bioscience job numbers are outstanding, but we're in for an economic crunch in the months ahead. We're hearing that even hospitals are having to furlough workers across the nation. What does this data tell you about Arizona's ability to handle it?

Mitch Horowitz: No doubt that even the biosciences sector will not be immune from job losses due to the national economic shutdown with the coronavirus pandemic. In the short term, we may see significant employment declines in both hospital and non-hospital biosciences industries. But hopefully the biosciences will bounce back quickly since it tends to be a counter-cyclical industry sector reflecting the fact that patient demands for medical treatments are not dependent upon economic conditions.

This has been the pattern in Arizona in the past. In the Great Recession of 2008-2009, Arizona private sector employment fell 11.3% but actually rose by 6.7% for all biosciences, including hospitals (as measured from the employment peak in 2007). This suggests that the biosciences may offer a buffer to significant job losses in Arizona.

Q: What is included in Bio Distribution?

Mitch Horowitz: The bioscience-related distribution subsector coordinates the delivery of bioscience-related products spanning pharmaceuticals, medical devices and equipment, and ag-biotech products. The subsector leverages and deploys specialized technologies such as cold storage, highly regulated product monitoring, RFID technologies, and automated drug distribution systems. Nationally the leading companies include major corporations such as Cardinal Health, McKesson, and Monsanto/Bayer.

Q: What is behind the improvement in bioscience venture funding in Arizona? Do we know what has contributed to the growth in angel investing and venture capital? Do you expect the growth in venture capital to continue in 2020 (especially given the COVID-19 crisis)?

Mitch Horowitz: It appears that the improvement in venture capital funding is due to the growing pipeline of early-stage companies. As the presentation indicated from 2016-2019, 63% of the biosciences deals in Arizona have been in pre-seed/angel investor deals compared to 40.8% nationally. This has primed the pump for Arizona and now a number of these companies to get follow-on early stage formal venture capital, such as OncoMyx Therapeutics, Paradigm Cancer Diagnostic, and GT Medical Technologies, as well as later stage venture capital.

Without the uncertainties of the coronavirus pandemic, it would appear that Arizona is well-positioned for continued VC growth given the strong numbers of pre-seed/angel investor deals in recent years, the replenishment of the Angel Investment Tax Credit, the state's university technology transfer infrastructure, and the strong growth in research activity.

But these are very uncertain times. The most recent Venture Monitor, prepared by NVCA and PitchBook covering the first quarter of 2020, noted that "investment pace will likely slow down if shelter-in-place orders are still in effect once deals that were already in progress or in the pipeline are completed, since VC is a business that revolves around in-person meetings with founding teams before making an investment." In that same issue of the Venture Monitor, Brenda Santoro from Silicon Valley Bank responded to a question about what pandemic-related impacts life sciences and healthcare companies and investors are seeing by stating: "It appears investors are still deploying capital, but we expect we will continue to see a major flight to

quality over the coming months. We're also operating in a selective market where good companies will need to be realistic on valuation. The short of it is the worst is still ahead. And the biggest unknown driving all of this volatility is how long the U.S. will be shut down."

Q: We need to be careful when we are disclosing that fewer dollars are required for medical device growth opportunities. The state is outperforming the United States in this area, how do we stay on course for 2020 - 2025?

Mitch Horowitz: On the question about the cost for advancing innovations, everything is relative. Our comment on the lower cost for advancing medical device and health IT innovations is in comparison to the average cost needed for advancing a novel therapeutic, which is well above $1 billion on average. The question is correct that the absolute costs for advancing innovations in medical devices is still substantial and would be higher than many health IT innovations involving web applications.

In terms of the future of staying competitive in medical device innovations, what we're seeing is that medical devices are becoming more scientifically complex, involving bioscience advances in growth factors, nanotechnology, and other sophisticated technologies. To move forward — here's another interesting parallel about the importance of translational efforts and a role for having a strong hospital system— you need thought leaders in medical devices, and ways to get clinical insights about what's going to matter and what's effective. There's a great program nationally that has had a lot of impact at the university level—the Coulter Centers. They have proved that you systematically bring together engineers and clinicians and really advance innovations going forward. It's that kind of culture that continues to need to be bred in Arizona to be a leader in medical device innovations.

Q: Growth in IP generation (patents) is impressive, but you mentioned earlier that Tech Transfer could be lagging. Any ideas why ASU licensing has dropped in the past 3 years? How do we bridge this gap?

Mitch Horowitz: First, let us be clear that the data we are presenting on university technology transfer reflects the trends across all three research universities in the state—no individual institution has been analyzed and no specific conclusions about an individual university performance should be inferred.

Overall, Arizona in the 2018-2019 period continues to generate significant levels of technology transfer activities in the biosciences, including 129 licenses of technology executed and 32 new

bioscience startups from university IP. This is a significant level of commercialization activity to help fuel continued biosciences development in the state.

We would also not categorize the trends in technology transfer as "lagging" but more "mixed" with some measures up, some measures flat and some measures falling. More specifically:

- Patents are up
- Licenses and startups are holding up to prior levels
- Disclosures are slightly down and licensing income has fallen

We would not categorize the fall in licensing income as a serious concern at this time. Licensing income is not a perfect measure of success since the biggest wins often come from startups that take years to be realized. Plus, one-time events can drive licensing income up or down from year-to-year, so we need to see a longer time frame to comment on whether there is a concern here.

Licensing income also depends heavily upon the ability to advance commercialization of university inventions and having a high-functioning ecosystem for the success of startups. Many of the best research discoveries aren't ready for commercialization, especially in the biosciences. Almost every university tech-transfer office has learned that without having sources of proof-of-concept funding to validate commercial potential, it is very difficult to advance biosciences innovations. You need to make those proof-of-concept investments with the best market intelligence that you can get from networks of entrepreneurs and investors. It also takes more than just university technology transfer to really have success in how startups grow. That is a shared responsibility with all of the participants in a state and regional innovation ecosystem. Universities are often working to provide entrepreneurial bootcamps and access to entrepreneurs-in-residence to help get startups on the right footing, but the quality of angel and seed investors to help shape business planning and management teams is crucial as is having access to sources of formal venture capital.

Q: On the translational spectrum, what percentage of patents/licenses make it into clinical practice?

Mitch Horowitz: Unfortunately, there is not a fixed formula predicting success of life sciences innovations. Life science innovation must meet very rigorous testing for safety, efficacy, and comparative cost-effectiveness that can hold back even the most breakthrough discoveries from reaching patients. We do know that only 12% of investigative medicines entering clinical trials are ultimately approved by the FDA—less than half of the percentage approved a mere decade ago.

Looking to the future, with new scientific advances has come greater complexity and uncertainty as medical discovery tackles disease areas of increasing scientific challenge. There has also been growing complexity of clinical trials because of the rising sophistication of therapeutics, leading to an increasingly complex, uncertain, and costly R&D process.

Q: You measure impact through gauges such as startups, patents, grant dollars leveraged, etc. Can you speak to the types of impacts TRIF is having that can't be measured?

Kevin Klowden: There are several areas that TRIF shows benefits that are not easy to measure in data. These include the numerous success stories of startups and their supporting ecosystems that have thrived over the years due to TRIF. One of the reasons we profiled specific case studies in the report is to show clear success stories that are not easily quantifiable. In addition, many of the indirect economic benefits, such as the boosting of the broader bioscience ecosystem, attracting high-profiled skilled faculty to the universities, and the retention of skilled workers in the state have a direct relation to TRIF, even if this cannot easily be shown in the numbers.

Q: We just heard from TEConomy Partners how well Arizona's bioscience sector has been performing. Would we be hearing that if TRIF was reduced or never happened?

Kevin Klowden: TRIF, and the resulting ecosystem it funds are essential to Arizona's success in the bioscience sector. As we discussed previously, having a state try to succeed in attracting biotech and life science business either based on a low-cost structure isn't enough. The state needs strong universities, and robust tech transfer programs in order to build the strong ecosystem needed to not just attract but keep bioscience research and firms. Simply put, without TRIF, Arizona would not have been capable of doing so.

Q: Do other states typically have a program like TRIF in place?

Kevin Klowden: The specific structure of TRIF is unique to Arizona, but several other states have created alternate funding sources for tech transfer and innovation. California for example, passed a state proposition to fund stem cell research at its universities, which has some parallels to the TRIF model. However, California's model was much more area specific and time limited. Utah has established a Fund of Funds, to direct state money into technology investment funds which invest in Utah, particularly in areas of tech transfer and life sciences. This model has also proven highly successful, but its structure is partly necessitated by one of Utah's main research universities, BYU, being private rather than public.

Q: How do bio jobs in Arizona compare to other states?

Kevin Klowden: Arizona has been outperforming, at the very least, on a relative basis. One of the real advantages Arizona has had—and you can see that in the rising concentration of bioscience jobs in the state—is that it's a state that, unlike a lot of others that actively invested and chose to be a stronger center of life sciences activity, has done so and succeeded. A number of states that made efforts in this regard have had real trouble actually creating jobs within the state. One of the key things that's really important about Arizona is that it's a lower-cost state with universities who have actively been investing in the ecosystem, which means it's able to attract a number of jobs that might be driven out by California or Massachusetts because of the higher cost of operating. And also attractive to states who might not have a strong up-and-down ecosystem, who have done some flirtations with the life sciences but not nearly been as effective. That's actually been reflected in the data; it's one of the reasons that Arizona has been growing faster than the national average.

There are other states like Nevada, Oklahoma, Arkansas, Missouri, or Kansas where they have been pushing the low cost of doing business but do not have the commitment to the university research and the partnership between the universities and private sector.

Q: Growth in IP generation (patents) is impressive, but it was mentioned earlier that Tech Transfer could be lagging. How do we bridge this gap?

Kevin Klowden: There are a couple of important things that have to happen. The first is that patents are an intellectual process in terms of research. There is a skill and ability to be able to turn and translate research into patents. But turning it into executable licenses is a mix of a couple of things.

The first is luck. Some of the most successful licenses that have hit have turned out to have had applications well beyond that which was originally expected. A number of the various drugs over the years that have been effective in arthritis and broader medical application were cases where additional research determined further applications in many cases that were well beyond what people originally thought. The most notorious is Rogaine, which nobody expected to help with hair growth. But more directly in terms of actual process, a lot of that comes down to attracting professors who are effective at cooperating with the private sector to be able to work on taking patents and sharing them and working with companies, startups especially, who can capitalize on these various ideas and turn them into applications.

It requires funding, having an effective and robust venture capital ecosystem up and down, not only in terms of growing licenses once they have been translated in to the private sector, but also being able to get initial angel funding and then growth funding to be able to grow various licenses. Especially when dealing with the life sciences, where a lot of drug trials are very expensive and require funding at different levels and stages. And it requires patience, because the growth in translating IP into results in the private sector is one where you can have tremendous effort and it can still take multiple years before you can see results.