

**Title:** Innovation and the Regional Economy:

**Subtitle:** Implications for Wyoming

**TITLE SLIDE:** Thank you for the introduction. And thanks for opportunity to talk about a topic that I've been interested in for quite a while. In fact, my thesis work at Washington University had to do with precisely this topic of innovation and how innovation affects regional economic performance. *Disclaimer.*

## I. Motivation:

But before we get started, I think it's useful to consider why innovation, or the process of coming up with new products and services, is so important? Why do policymakers and people who study regional economies believe innovation is central to regional economic performance?

Well, one thing that is clear is that high rates of innovation are associated with some pretty good things.

1. The first **TABLE** (high productivity  $\Leftrightarrow$  high innovation rate) shows labor productivity and innovation rates in the 4 most productive and the 4 least productive OECD countries. It suggests high productivity is correlated with high rates of innovation.
2. **SLIDE** And if we look inside the U.S., we find that highly innovative industries pay higher wages.

And that highly innovative locations enjoy higher employment and wage growth.

And these are associated with other good things for a region, like job stability.

3. What we're going to do in the time we have remaining is to think about why innovation is associated with these good things.

**OUTLINE (A)** We'll begin by thinking in some detail about how innovation happens. We'll note who is doing innovation and that one of the important ways that innovators get ideas is from each other.

**OUTLINE (B)** We'll then move from thinking about how an individual innovates to how innovative activity benefits a region in general. This includes not only the idea that high wages are largely spent locally. But also that the very process of new-idea-generation makes other innovators in a region more productive.

Now, with this process in mind, of learning from others and learning from others nearby, we'll think about what I believe is the fundamental challenge for innovators in a place like Wyoming. **OUTLINE (C)** Namely, that sparse population is a disadvantage for innovators trying to learn from others.

With this framework in mind, we can think about the implications for what kind of innovative activity is likely to succeed in Wyoming.

And what you'll take away from this talk are what I would call 'best bets' for a sparsely populated place looking to enjoy, as much as possible, the benefits of the knowledge economy.

## II. **PIE CHART** When we think about how innovation happens,

A. I think the first thing that comes to mind is the research done in universities, government research labs, and non-profit institutions.

But what is interesting to note is that a large majority of research is actually funded by private industry. And these are exactly the high-value-adding dollars that many would love to see invested in their region.

B. Where do these researchers get their ideas? **SLIDE (A)**.

Well, some economists asked managers of research departments in private corporations this question.

1. Of course the first thing you might be thinking is at the top of the list – scientists and engineers are paid to come up with new ideas.

The really interesting thing to note, however, is that most of the responses amount to learning from others.

Moreover, most of these channels refer to ways of acquiring ideas that learning firms aren't paying for.

These are what we call knowledge spillovers – things like reverse-engineering another firm's products or hiring their employees.

2. Another interesting thing to note about these spillover channels is that a number of them may be more effective when firms are in close proximity to one another – for example, you're more likely to hire the employees of another innovating firm if they are located nearby. Or maybe you're more likely to send your engineers to technical meetings locally, where they'll interact with other engineers in your region.

III. **OUTLINE** So that's how firms innovate. But how does innovation affect regional economic performance?

A. **SLIDE** Well, first is the obvious direct effect on the demand side: High local income => high local demand.

B. Second, are some effects on the supply side.

1. More innovative activity in an area creates thicker markets for inputs to innovation. This can mean finding it easier to higher another scientist to finding it easier to buy high-tech computing support or repair lab equipment.
2. Another supply side effect, and the one we're highlighting today, is the effect that more innovative activity has on knowledge spillovers. More active researchers in an area mean more opportunities to run into new ideas. This can make researchers in a location more productive than they would otherwise be and make that location more attractive to firms looking for a place to do research.

But it's important to notice that these supply side effects don't benefit all locations equally. **CURVE** Some critical mass must be achieved before a region begins to really benefit from innovative activity.

The curve plots a county's annual patents per 10,000 inhabitants vs. total county population. What it shows is that, for counties with relatively low population, increases in population have no effect on the patent rate. So, a county of 50,000 people is twice as patent productive as a county with 25,000 people, simply because more people means more patents.

But an interesting thing happens around a county

population of 100,000 people, and this is what we've been talking about. At populations above 100,000 people, adding more people gives a region a greater-than-proportional increase in patents. So a county of 100,000 has about 10 patents per year while a county of 200,000 has about 40 patents per year.

IV. **OUTLINE** And this brings us to what I believe is the fundamental Challenge for Wyoming.

**TABLE** And that is Wyoming's relatively sparse population.

In fact, Wyoming is the most sparsely populated state in lower 48.

To put things in local context, the most populous county in Wyoming is Laramie, with something over 81,000 people. At an annual rate of population growth of 1%, the national average, that would put Laramie County on the cusp of this increasing returns to population region in about 20 years.

V. **OUTLINE** What is the implication of this sparse population for innovative activity?

A. **SLIDE (A)** The short answer is that sparsely populated states have to look for opportunities in industries where density is less important for innovation.

1. **SLIDE (B)** One potential opportunity for innovation is in resource and natural amenity related industries.

Researchers in these industries may prefer to locate near these natural advantages since it gives them more opportunities to discover problems and test out new ideas.

2. **SLIDE (C)** Another opportunity may be in mature industries. In industries where the technological state of the art is pretty well established, researchers may have a pretty good idea of what their next innovation lies. Because of this, they don't necessarily need to be in a large city for the opportunity to bump into other researchers and hope to learn a new idea. Compared to researchers in emerging industries, those in mature industries know who they need to talk to and can get the spillovers by picking up the phone or getting on a plane, without incurring the high cost of operating in a large city.

**MAPS** And in fact, these maps are illustrative of this phenomena.

The map on the left shows population by county. Green represents low population density. Red represents high population density.

The map on the right shows the technological maturity or 'age' of the mix of innovations that occurs in a county. Green counties patent disproportionately in mature industries. Red counties patent disproportionately in emerging industries.

The thing to notice is that patents in emerging industries seem to predominate in some large cities and on the coasts. While mature patent activity seems to avoid these areas and locate in the lower population areas through the center of the country.

- B. These two general observations, that sparsely populated places may have more success attracting innovators that complement their natural advantages or innovators in mature industries, has obvious implications for Wyoming.

**TABLE (A)** And if we look at Wyoming's recent patent activity, it supports these points and suggests where we future success may lie.

1. This table shows patent activity in Wyoming in the 1990's, relative to patent activity in the U.S. The first column lists the technological classes in which Wyoming was disproportionately more patent intensive as compared to the U.S. as a whole. For example, Wyoming had a relatively large proportion of its total patents in land vehicles used for dumping, a technical filed that complements your mining industry. Specifically, the fraction of Wyoming's total patents in these land vehicles was 41 times the nation's fraction of total patents in these types of land vehicles.

In contrast, consider semiconductor manufacturing. Such activity is unlikely to benefit from any particular natural advantage of a place. That is, because semiconductor manufacturing does not benefit by any particular natural advantage, you might think this activity would be just as likely to locate in one place as another. In fact, the share of Wyoming's patents in semiconductors is less than one fifth the share of total U.S. patents in semiconductors. Given natural advantages don't play any role in the location of this innovative activity, its appears to have avoided locating in your sparsely populated state.

2. **TABLE (B)** This next table presents the same list of technological classes, in which Wyoming is relatively highly innovative and not highly innovative. In this table we show the year in which patent activity in that technical class peaked, which we're using as a measure of the technological maturity of that class. What is interesting

here is that relatively mature technologies, as indicated by an earlier peak patent year, seem to predominate among Wyoming's high-intensity technologies. In contrast, low-intensity technologies in Wyoming might be characterized as immature or emerging, as indicated by a relatively recent peak patent year.

## VI. Concluding comments:

### A. SUMMARY OF CONCEPTS

1. Innovators learn from one another.
2. Knowledge spillovers enhanced by proximity.
3. Sparse population a disadvantage for knowledge spillovers

### B. BEST BETS

1. Expect more success in sectors that benefit from a regional comparative advantage.
2. Expect more success in sectors where technology is mature.
3. Investments that may pay off – transportation, communication, education – investments that mitigate distance.