# Unit 3 Pre-Class Warm-up

*Joanna Yu, Tuesday 4pm, Fall 2018*

## An Exercise in Operationalization

A large academic community studies the creation of new inventions using public data gained from patents. This is a challenging area to work in, partly because of the difficulty of operationalizing key variables. For example, researchers are interested in describing inventions that are truly groundbreaking, transformational, or radical and the factors that facilitate their creation. We may have difficulty in agreeing on a conceptual definition of radical, let alone an operational definition.

For an example of this type of work, the following passages are taken from Schoenmakers, W., Duysters, G., (2010), The Technological Origins of Radical Inventions, Research Policy 39, pp. 1051-1059.

> Inventions come in many different forms ranging from incremental or run-of-the-mill inventions, to radical or breakthrough inventions. Most inventions can be characterized as incremental inventions. Incremental inventions consist of minor improvements or plain adjustments to existing products or technology. Their individual impact on the technological system is usually limited. Radical inventions on the other hand are generally considered as being a risky departure away from existing practice (Hage, 1980). Radical inventions exhibit key characteristics that are inherently different from existing products or technologies. They often lie at the hart of changes in technological paradigms (Nelson and Winter, 1982), thereby creating new technological systems and sometimes even new industries. Although incremental inventions might be a principal source of measured productivity growth, without the original radical invention they would not have been possible. Radical inventions are thus considered to be a crucial basis for a sequence of subsequent developments around this original invention (Mokyr, 1990)...
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> We are particularly interested in how an invention can be a catalyst for the development of subsequent inventions. We especially want to focus on those inventions that can be considered radical or breakthrough. Therefore we focus our attention to those inventions that serve as a basis for many successive inventions...
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> Patent data is the single most dominant indicator in invention studies. For a patent to be granted it must be novel, non-trivial, and useful. If a patent meets these requirements, a legal title will be created containing information on for instance the name of the inventing firm and also on the technological antecedents of the knowledge, the patent citations. In the European Patent Office (EPO) system, the patent applicant can include citations to prior patents (and prior technological and scientific literature), but ultimately it is the patent examiner from the patent office who determines what citations will be included in a patent (Michel and Bettels, 2001). Patent citations reveal the so-called "prior art" of the newly developed patent. Citations to other patents, the so-called backward citations, indicate on what preceding knowledge the new patent is based. They provide a kind of patent family tree. The citations from other patents to a patent, the so-called forward citations, on the other hand are an indication for the importance of the patent...
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> Since we expect, in line with Ahuja and Lampert (2001) and Dahlin and Behrens (2005), that radical inventions are a rather rare phenomenon, we selected only the most highly cited patents as our group of radical patents. The highest cited radical patent received 54 citations and the least cited 20 citations.We put our cut-off value at 20 citations based on the beforementioned expectation that truly radical inventions will rather be an uncommon occurrence, and we observed that many patents have 19 or less citations, whereas only very few have more than 20 citations... We ended up with a group of 96 radical patents. For the construction of the non-radical inventions we randomly selected 96 patents from the group of patents with less than 20 forward citations. For both groups we collected the necessary variables using, besides EPO, Worldscope. We ended

up with 74 patents in the radical group and 83 patents in our non-radical group for whom we had sufficient information to perform the analysis...

As a first independent variable we use the number of times a patent is citing other patents (COP). Some scholars assert that radical patents are based on completely new knowledge; knowledge that was not available in the market before, while others especially point at the recombination of beforehand-unconnected knowledge as a source of radical inventions. For scholars in favour of the first viewpoint the assumption is, that, if a relatively large amount of citations for a new technology is to scientific literature, than this is an indication of novelty (Carpenter et al., 1981), since the new technology in that case is than not based on already existing technologies, but instead on science itself (Dahlin and Behrens, 2005)...

Looking at the first variable (COP) we see that the group of radical patents cites more patents than the group of non-radical patents, 2.5541 compared to 1.2651. This variable is also significant (see Table 2). Our first hypothesis is thus rejected. Radical patents are apparently even more reliant on the recombination of already existing knowledge than non-radical patents...

In contrast to the conventional wisdom that radical inventions are based less on existing knowledge, we find that they are to a higher degree based on existing knowledge than non-radical inventions. For radical inventions already existing knowledge seems of paramount importance. Radical inventions are also to a higher degree based on emergent technologies, and especially on a combination of mature and emergent technologies than non-radical inventions.

## Discussion Questions:

1. Schoenmakers and Duysters are particularly interested in radical inventions. Explain what their conceptual definition is and how it is related to their operational definition.

   Their conceptual definition is that radical inventions should be a rare phenomenon and serve as a basis for many successive inventions. Their operational definition of a radical invention is to that the patent must be cited many times and the number of citations must be distinctly different from the number of citations for non-radical inventions.

2. In your opinion, does the author's operational definition of radical invention have validity? (does it have face validity? construct validity?)

   I feel the author's operational definition has face validity but construct validity seems weak. For face validity, operationalizing the concept by looking at the number of forward citations associated with a patent could help see the importance of the patent. But the author's definition of radical invention may not be valid. The author takes a simplistic approach to identifying which inventions are considered radical. An invention is considered either radical or not radical. But there may be different degrees of radicalness or it can even be a spectrum.

3. If you believe there is a discrepancy between the author's operational definition of radical invention and the intended concept, how could this affect their conclusions? What factors, other than whether an invention is radical, could be driving their results?

   If the operational definition of radical invention is incorrect, the whole analysis would not lead to the intended result and conclusion would be false. The independent variable used could also drive their results since that's what their analysis is based on.

4. In what other ways could you operationalize the concept of radical invention?

   In addition to patent citations, I could also operationalize the concept by looking at how many article and research papers cite that particular invention. If it's a revolutionary breakthrough, there should be a lot of citations.