Patent Quality, Intellectual Property Rights, and Technology Transfer in the Solar Sector: All in the Family?

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Overview

The importance of green technologies is increasing; the Durban Climate Conference and COP 21, the U.N. Climate Conference, highlighted the concern with facilitating the transfer of climate-change-mitigating technologies. In addition, legally binding agreements have committed countries to reducing CO_2-casuing emissions. When it comes to solar technology, prices have been falling, and the market has been expanding. Global patenting in green technologies in general increased 20% per year between 1997 and 2008. For solar specifically, investments rose 30% between 2013 and 2014, while solar photovoltaic (PV) capacity increased 25% between 2014 and 2015. The size of the solar PV market is 10 times larger today than it was a decade ago. Out of this context, important questions emerge: Is intellectual property rights (IPR) protection an important component in facilitating technology transfer in this sector? Are higher-quality patents more likely to be filed abroad? It turns out, the answer depends on how "patent flows" are defined.

I use two different methods to measure patent flows: patent equivalents and extended patent families. The former means that the same patent document has been filed in more than one country. The latter comprises "all the documents sharing—directly or indirectly—at least one priority [patent]" (Espacenet, 2016). Patent equivalents compare patent-to-patent, so researchers can follow a trail of a small piece of technology globally, from patent office to patent office. However, products rarely contain only one patent; if the intent is to track the transfer of a complete invention, equivalents may not be the best method, and could result in overcounting of technologies. Extended patent families, meanwhile, compare technology-to-technology to track a completed invention worldwide. This present some challenges: First, families are defined differently office to office. Second, indirect relationships can determine family membership, so the patents in the family may not actually be related; therefore, researchers may not actually be tracking one technology or invention.

Methods

Based on the theoretical and econometric framework of Gallini et al. (2206), I use a negative binomial specification to measure how IPR protection and quality affect patent flows from the U.S. to 22 other countries. The dependent variable, p_{ijt}, is the number of patents files from country I (the U.S.) in country j in year t. I have two variables of interest: 1) *qual*, a weighted proxy for aggregate quality of patents filed in country j from the U.S. in year t. *Qual* is equal to the total number of citations received by all patents from U.S. filed in country j in year t divided by the total number of patents filed in country j in year t; and 2) *ipr*, the Ginarte & Park index (1997), which measures "how strongly patent rights will be protected" in a given country. Theory would predict a positive effect for both variables. In addition, I add several control variables for the host country (country j): economy size, human capital, distance to country i, bilateral trade flows, shared language, environmental policies, and weather. I measure p_{ijt} as for equivalents and extended patent families.

Results

Summary statistics reveal immediate difference between the patent equivalent and extended families analyses. For the equivalents, p_{ijt}, the average number of solar patents filed from the U.S. in country j in year t, is about 12; for the extended families, the average of p_{ijt} is about 25, a difference of more than 100%. The standard deviation of p_{ijt} in the extended analysis is also larger by more than 100%: 25 compared with 52. The average quality measure for equivalents is about 4.5, while for extended families the average is a little more than 6. In this case, the standard deviation for the extended families analysis is much larger than that of the equivalents analysis (7 vs. 51). These differences are consistent with the definitions previously discussed: Patent equivalents, or patent-to-patent analysis, provide a much narrower definition of what constitutes a patent flow, while extended patent families cover not just equivalents but also those patents that are both directly and indirectly related. Therefore, it is not surprising and

indeed expected that in the extended families analysis, we would see higher average counts, leading to more patents to be cited, leading to a higher quality measure on average.

Examining first the equivalents analysis, we see 1) that IPR protection has no effect on facilitating green technology transfer, contrary to what theory predicts, and 2) that higher quality solar patents are more likely to be filed abroad, consistent with theory. In the extended families analysis, we see that 1) IPR protection does facilitate the transfer of environmental technology, and 2) higher quality patents may be filed more often abroad, but only in countries with more sunshine on average.

Conclusions

What accounts for these different results? We might expect that because the extended family dataset has more patents on average, and a much larger average quality measure than the equivalents data that the quality variable would yield a statistically significant result in that data set. However, extended families data contain a significant amount of "noise" that most likely affects the results: In large patent families, only a few patents account for a large majority of citations, and only a few families in the aggregate country quality measure account for a majority of citations. In other words, even though the total number of citations and patents filed is, on average, much larger, the quality measure (ration of patent citations/patents filed) is in reality much smaller. When the analysis is re-run without the large outliers in quality measures, the results do not change. Ergo, controlling for "noise" does not seem to explain the different results. However, the equivalents analysis may not be better because over-counting could inflate citations and bias the results.

Future work could help resolve these differences: The same analysis could be conducted for other groups of countries, not just the 22 in this study. Researchers could also compare individual patents contained in each data set, which was beyond the scope of this study. Future works could also use "expert-validated families based on novel technical content" (Martínez, 2011) to more clearly define technologies and their content. Finally, the gold standard would be to use firm-level data from solar companies, but this may not be available and/or reliable.

The question of equivalents vs. extended patent families is of vital important to current and future policies designed to increase access to climate-change-mitigating technologies. Results presented here should give patent researchers pause, and encourage us all to consider more carefully how we define and use our data.

References

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