

Patents and Industry Dynamics in Photovoltaics: a Negative Dependence?

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There is a rich history of patent data being used in technological change measures that originated before World War II. Patent statistics cannot indicate innovativeness of countries or companies – there are many limitations to the applicability of this method. Nevertheless, patent data analysis provides rich information on technological situation in industries. Whether the number of patents and patent citations, as a measure of technological progress, makes any positive contribution to the industry dynamics is a topic of lively academic debate with important practical consequences. This study explores the aforesaid issue in photovoltaics (PV)¹ – an industry which broke even only 2-3 years ago due to substantial government subsidy programmes. The main tools of the analysis are:

- Modeling statistical dependence between patent portfolios of 29 leading companies, which account for 95,5 % of the total industry output, and their volumes of production during 1999-2004 and
- Tracing the knowledge flow between different institutions relating to PV on the basis of patent citations statistics for patents granted during 1976-2000.

To this end two sets of data have been brought together: all patents concerning PV granted by the USPTO between 1976 and 2004 (together with relevant patent citations) and PV News which provides information on the PV production by company between 1999 and 2004.

The findings of the study are threefold.

1) There is a negative inverse relationship between the total number of patents granted to a company before 2004 (*pat*) and its output during 1999-2004 (*pv*):

$$pv = \begin{cases} 8,029 * pat^{-0,679}, & d = 0 \\ 47,85 * pat^{-0,702}, & d = 1 \end{cases}, \quad R^2=0,677, \quad \text{where } d \text{ takes the value } 0 \text{ for dedicated}$$

companies and 1 for subsidiaries of corporations. If the patent portfolio of a company is growing, its output is reducing; for subsidiaries of corporations this reduction is sharper than for dedicated manufacturers, because manufacturers with only one field of activity are not so flexible as regards activity diversification. Uncompetitiveness of photovoltaics makes companies with patents in this sphere seek opportunities of application of their technologies in other industries. The best example is *Canon* selling in 2000 its share in the *United Solar Systems* to the Belgian steel company *Bekaert*, which wanted to use knowledge gained from solar cell technology for its copy machines.

2) Patent citations analysis indicates that technological progress in photovoltaics is much concerned with technological developments in such industries like semiconductors and thin films. PV manufacturers cite heavily leaders in these spheres and get more and more feedback from them. On the one hand this new trend is positive for PV because it indicates the importance of its patents. On the other hand it shows uncompetitiveness of the industry – PV patents are more valued in other industries than in PV itself.

3) Price uncompetitiveness of PV remains the main problem of the industry stifling its progress. Not innovations but government subsidies drive the PV market presently. Companies concentrate their efforts not on technological improvements but on the competition for the government support.

¹ PV – a technology that uses solar cells to convert energy from the sun into electricity