The technological contribution to cleaner energy of the world's largest firms: what tell us patent data.

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1. Aims of the contribution

It becomes clear that only clean public R&D investment, procurement, infrastructure could not achieve a drastic reduction of green house gas emissions. It is needed a real commitment of from private sector for producing new clean energy technology or adopting new cleaner equipments (Veugelers, 2012). In our communication we contribute to the literature in dealing with the eco-innovation determinants. We delineate the scale, the variety and the drivers of eco-innovation at the firm level. Many studies because using mainly CIS2008 can get information about if a firm is eco-innovator or not but do not assess the true size of its investment in green technologies production. By contrast data on patenting is very suitable to our goal. They enable us to accurately know the amount of innovations produce in cleaner energy technological fields.

2. Methodology and the data set

We run statistical treatments onto a rich patenting data set.

This research uses patent information extracted from the Patstat database (2011) which includes all patents applied for across the world in one of the 80 patent offices. It selects priority patent applications. i.e. the very first patent application for a novelty without any patent office restriction. We basically use a database of the consolidated portfolios of patents applied for by 2000 firms with the highest investments in R&D in 2008. This list of firms provided by the Industrial R&D Investment Scoreboard 2008 (IPTS) was further enriched with a selection of firms from Computsat and EPO, WIPO. The final database includes 2800 large firms that applied for 5.12 millions priority patents between 1986 and 2005 (58 % of the total number of priority patents applied for across the world). We work on a subset of 946 companies investigated on two time periods : 1994-96 (706 524 patents) and 2003-05 (882 895 patents). We get

49.4% of priority patents. The paper by Laurens et al. (2013) provides information on this sample.

The European Patent Office (EPO) has built up its own system of patent classification (ECLA) (160 000 codes) and created in 2010 a new patent class (Y02) that collects all technologies which control, reduce or prevent GHG emissions of anthropogenic origin as set forth by the Kyoto Protocol. Y02 class tags technologies for adaptation or mitigation to climate change in terms of buildings (Y02B), energy (Y02E), transportation (Y02T) and capture, storage sequestration or disposal of GHG (Y02C). In April 2011 around 639 500 patents were tagged YO2E. Our patent sample in cleaner energy is set up as follows: 11 445 patents for 1994-96 (1.62 % of all firm patents), 20 273 patents for 2003-05 (2.30 % of all firm patents).

3. The main findings

a. The patents related to clean energy are very highly unevenly distributed. They are concentrated in one technological field namely « electrical machinery, apparatus… ». For instance in the second time period under observation the two third are in this field. "Semi conductors" and "engine, pumps, turbines" are the two followers but very far behind. The fact there is a huge sector producer of new climate-friendly energy technologies confirm and illustrate the view by Mowery et al. (2008). In other terms in this techno-industrial domain the innovator-developer is not always the adopter-user. In this context matters the "supplier-dominated innovation trajectory" (according to the taxonomy by Pavitt). As a consequence we are in a frame in which national system of innovation has its own importance. In particular learning by interacting is an important tool for improving technologies matching strongly needs of the users.
b. The amount of patents related to clean energy is very low in technological sectors as Food chemistry, Pharmaceuticals, digital communication.
c. The distribution of patenting related to clean energy new technologies by countries is equally uneven. Japan gets the lion share with 83 %. It is an effect of the making of our data set that gives an important weight to Asian patentors. The European countries go behind. The USA holds the second position but the volume of this patenting is weak with respect to the size of their overall patenting. China records a dramatic increase between the two periods.
d. Once we take into account the uneven distribution of patenting by technological field it is not amazing that the *firm* share of patents related to clean energy are very high in « electrical machinery, apparatus… ». Clean energy patenting accounts for near 20 % of the overall amount of patenting in this field. This share is equally high in "engine, pumps, turbines" (especially in 1994-96) and in Materials and metallurgy (especially in 2003-05) and "environmental technology" (in 2003-05). In general this share is low for many technological fields (between 0.1 to 0.4).

e. We also look at how the share of clean energy patenting varies across countries. Japan has a high score but Norway reaches a higher share and in dramatic increase between the two time periods. The share of the USA is notably low (1.1).
f. The firm share of clean energy patents shows an increasing relation with the overall patenting firm size. To put it simply the proportion of clean energy patent increases with the technological activity firm size. Lastly among the ranked list of the first 30 firm we find 12 firms from Japan, 5 from France, 4 from Germany and the USA.
g. From the logit models we estimate the probability a firm becomes clean energy innovator. We find a positive effect of two variables: the size of the firm technological activity and the scale of firm technological variety. Competition and technological concentration in the dominant technological field have no effect at all on the probability to innovate in clean energy technologies. For the second period we put in the model a variable indicating if the firm was innovator in clean energy technology in the first time period. It has a positive significant coefficient witnessing an effect of innovation persistence. None of our dummy for countries effect is significant.
h. We now are currently building a model for the *intensity* of firm production of new cleaner energy technologies. We will use as a benchmark the study by Stucki and Woerter (2012) that provides relevant variables. The estimations are in progress.