Scientometrics (2011) 86:125–132
DOI 10.1007/s11192-010-0271-z

Impact evaluation of the voluntary early retirement policy on research and technology outputs of the faculties of science in Morocco

Hamid Bouabid · Mohamed Dalimi · Zayer ElMajid

Received: 15 February 2010 / Published online: 22 August 2010

Abstract Scientometric indicators or science metrics, conventional and derived ones, are used in ex-post evaluating of a government policy with impact on research system. Publications, citations, h-index, Glänzel model, and patents are applied in both micro and meso levels. This provides useful insight into the impact of the voluntary early retirement policy on research and technological outputs of the faculties of science in Morocco and consequently on the overall Morocco's research system. The use of these metrics showed that the effect of the initiative was quite limited by affecting an average of 8% of the professor staffs of these institutions. Furthermore, each professor benefiting from this initiative had produced an average of 3.7 publications indexed in *SCI* in all his (her) career. The few number of the publications attributed to these professors had been gradually decreasing even 6 years before the initiative. No specific scientific field had intensively been struck. The findings also support that these professors were in general more 'author' than 'inventor'. Inventor-professor institutions were likely more affected by the initiative. By means of these metrics, even if the initiative had not contributed to rejuvenate the professor-staffs of the faculties of science in Morocco, would nevertheless be a *stimulus* of their research system with respect to their scientometric indicators.

Keywords Public policy · Metrics · Research and technology outputs · Evaluation · Morocco

Introduction

Voluntary Early retirement, was a government policy launched in 2005 to encourage early retirement in the public sector by giving substantial subsidies and enjoy the whole

H. Bouabid · M. Dalimi · Z. ElMajid
Directorate of Technology, Ministry of Higher Education and Scientific Research,
29, Avenue Alger, Hassan, Rabat, Morocco

H. Bouabid (✉)
University Ibn Tofail, B.P. 133, 14000 Kenitra, Morocco
e-mail: h.bouabid@hotmail.com

retirement allocations. It is a very exceptional and singular policy in the public administration of Morocco since its independence. The objective was mainly to make sustainable the wages bill in the total budget and to reduce the overstaffing, but also to contribute in rejuvenating the personnel of the public administration including that of the universities.

According to a study of the World Bank (2006), the policy '*achieved most of its quantitative and financial objectives. …….. Other objectives have been only partially achieved*'.

This policy has been very controversially commented particularly by the scientific community as this policy occurred in a critical time when scientific production of Morocco had showed stagnation between 2001 and 2004 following a steady increase. Furthermore, it had affected the national top-ranked authors: 2 out of the top ten researchers in term of publications (Bouabid and Martin 2009).

This evaluation is a bibliometric-based approach and focused on the faculties of science because 55% of the total professors in science and techniques (including medical sciences) at the universities belong to the faculties of sciences.

Conventional metrics are used since their origin after the World War II and have then evolved to include derived and composite metrics which are almost unanimously useful and accurate in performing research-evaluation of either public policies (Jimenez-Contreras et al. 2003; Van Leeuwen et al. 2001), institutions (Bourke and Butler 1998; Charlton and Andras 2007), programs (Narin 1987; Hicks et al. 2004; Granadino et al. 2005), fields (Martin and Irvine 1983; Katz 2000; Vilibic 2009) or researchers themselves (Hirsch 2005; Czarnitzki et al. 2007; Bouabid and Martin 2009; Ventura and Mombru 2006).

This evaluation outlined the usefulness and accuracy of scientometric in providing clear insight for decision makers into the impact of earlier retirement government policy on the Moroccan faculties of science research-system. The scientometric indicators used here provided real evidences in mapping *ad vitam aeternam* the extent to which the policy of earlier retirement impacted research outputs of the faculties of science in Morocco and consequently the overall Morocco's scientific production. It also responds how was research activity of those professors benefiting from this policy even before it had occurred.

Methodology

Charlton and Andras (2007) argued that a research metric should have qualities such as simplicity, transparency, objectivity, replicability, precision and sensitivity. This is exactly the objective of this evaluation which is conducted at a micro-level since the metrics are calculated for each professor and are then aggregated to a meso-level: the group under observation and the institution.

We should emphasize that the main and only purpose of this evaluation was the research activities and patenting and did not include educational and expertise activities of these professors which we believe were as important and valuable as their research activities.

Undoubtly, the research output metrics are quantitatively transparent and clear and significantly allow independent external assessment without influencing involvement of those being assessed unlike the peer-review approach. The four scientometric indicators used were built in a micro-level (for each professor) and then aggregated to a meso-level (for the group of the professors or the institution).

Publication counts are the first indicator that represents the cumulative publications for each professor until 2008 inclusively. The second indicator is related to quality of research-outputs of each one. This indicator is citation counts using an open 'time-window'. In other words, the counts are the citations earned by the publications from the publishing year until 2008 inclusive. The third indicator which denotes the *h-index* is used in the Glänzel's model (2006) to complete this quality analysis part.

All the publications are counted on an open time window basis, provided they are indexed in that database. The first publication of these professors was in 1973. Consequently, the total number of counted publications comprised those made between 1973 and 2008 inclusive.

For technology indicator we count the patent applications made by the professors. This is the fourth indicator. All patents are counted under the only threshold of the name of the professor ignoring whether it is a 'university owned' patent or a 'university invented' patent, even if in Morocco till now the most patents are university invented patent than university owned patent.

To build up these indicators we have used the Science Citation Index (*SCI*) database of the Web of Knowledge®. For the patent counts, the database of the Moroccan Office for the Industrial Property was used.

Results and analysis

All the faculties of science were concerned but differently by this policy. With 262 professors left within this initiative, it represented an average of 8% of the total professor staffs (3,279 professors) of these 11 institutions (Fig. 1). Rather, the number of professors seems to be proportional to the size of the institution (Fig. 1).

The female professors represented almost 27% of the total professors of the group under observation.

On another hand, even if the initiative aimed at rejuvenating the professor staffs, we find out that the age-class 50 and more had even increased just after the initiative. One year after the initiative the number professors aged 50 and more represented 38% of total professor staff against 28.5% just before the initiative.

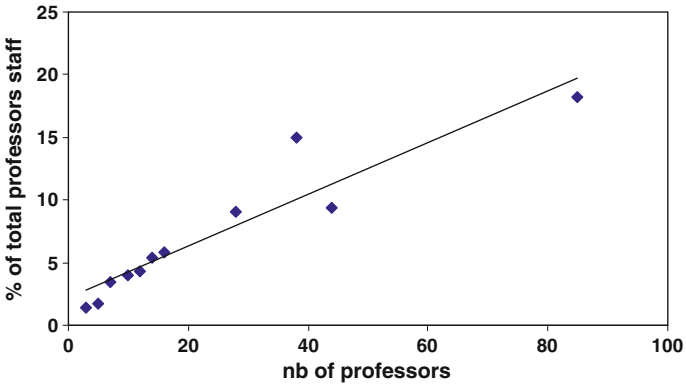

Fig. 1 Number of voluntary early retirement professors and their percentage with respect to total professors staff according to the institution ($R^2 = 87.5\%$)

Publication and citation analysis

The gross productivity of this group, which means the number of publications to the total number of professors in this group, was 3.7 publications in *SCI* per professor in all his (her) career. The net productivity, which represents the total number of publications to the total number of active professors in this group (having at least 1 publication), is 8.8 publications in *SCI* per active professor in all his (her) career. The difference between the net and the gross productivities results from the fact that almost 58% of professors of the group under observation did not have any publication in *SCI* of the Web of Knowledge; whereas only 5 professors produced more than 40 publications each and just one professor earned 101 publications.

Chemistry was the dominated field within the contribution of these professors. With 40% of total publications, chemistry preceded physics: 38%, biology: 14%, mathematics and computer sciences: 6% and geology: 2%, of total publications of these professors. The field breakdown of the publishing contribution of this group followed broadly the general field-weighted publications at the national level (Bouabid and Martin 2009) where the physics and chemistry shared respectively 30 and 22% of the total number of publications followed by mathematics and computer with 10% and biology with 9%.

In Fig. 2 we plot the total the number of publications done by professors who benefit from the initiative and its percentage to the national publications (TNP) for Morocco in sciences and techniques (*SCI* classification). The difference is observed until 2005 in order to measure the real contribution of these professors to the total scientific production of Morocco every year previously to the initiative.

The Fig. 2 shows very few publications attributed to these professors since the percentage of their publications did not exceed 8% of the total national publications for Morocco in *SCI*, which was less than a quantum of 85 publications per year in best case.

At this meso-level, all else being constant, the professors tended to publish less even years before the initiative. Their contribution was gradually decreasing from almost 8% of the TNP 6 years before the initiative had happened to less than 5% in 2005.

The average citations earned by the publications of the group under observation was 5.1 citations per publication (Table 1) which we believe is less important regarding that the time window was open from publication year to 2008 inclusive. In the analysis conducted

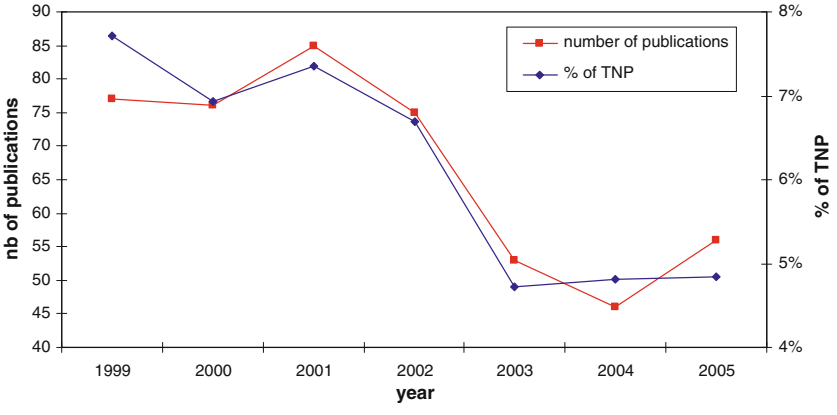

Fig. 2 Number of publications done by professors and its percentage to the total national publications for Morocco in *SCI*

Table 1 Breakdown of the professors's publications, citations according to institution

Institution	Number of professors	Total publications	Total citations	Publications/professor		Citations/publication	
				Number	Rank	Number	Rank
Rabat	85	321	1552	3.8	5	4.8	4
Marrakech	44	137	805	3.1	6	5.9	3
Meknes	16	114	788	7.1	2	6.9	1
Kenitra	10	91	557	9.1	1	6.1	2
Oujda	12	80	468	6.7	3	5.9	3
Casablanca	38	79	242	2.1	9	3.1	7
Fes	28	78	294	2.8	7	3.8	6
Mohammedia	14	59	228	4.2	4	3.9	5
El Jadida	5	11	25	2.2	8	2.3	9
Tetouan	7	6	15	0.9	10	2.5	8
Agadir	3	1	0	0.3	11	0.0	10
Total	262	977	4974	3.7		5.1	

by Bouabid and Martin (2009) the average citations per publication was 3.0 for the *SCI* total publications of Morocco considering only a 5 years time window including publication year.

At a meso-level, we tried to measure how were the faculties been impacted by the initiative and also lost in terms of productivity and scientific quality if any. The faculties having top ranks in terms of productivity were also found to be top ranked in term of citations (Table 1). Accordingly, there is a correlation between gross productivity and quality measured by mean citations per publication. Thus the faculties of Kenitra, Meknes and Oujda were then the most affected by the initiative in terms of both the mean publications per professor and the mean citations per publication.

The citations rate for female professors was found to be higher (5.7) than that of their peer male professors (5.0) adversely to net productivity which was 6.3 publications for female professors and 9.4 for male professors.

Composite metric analysis

It is admitted that the h-index introduced by Hirsch (2005) is one of the recent composite science metric that is used in evaluating individual and groups performance and quality outputs. The robustness of the h-index has since been confirmed (e.g. Bornmann and Daniel 2005; Vanclay 2006), although it is cautioned about applying it to small groups or individuals (Van Raan 2006) and in interdisciplinary comparisons (Hirsch 2005). H-index is a now part of the Web of Knowledge as a very common and useful indicator that is systematically calculated through its databases.

In this evaluation, h-index is not used on its own but through the Glänzel's model (2006) to complete this quality analysis part. Using the empirical relation he suggested, we calculated the relation between the h-index (h) and the composite variable of number of publications (n) and the mean citation rate per paper (x): $h = cn^{1/3}x^{2/3}$ where c is a positive constant. The calculated relation is drawn in Fig. 3.

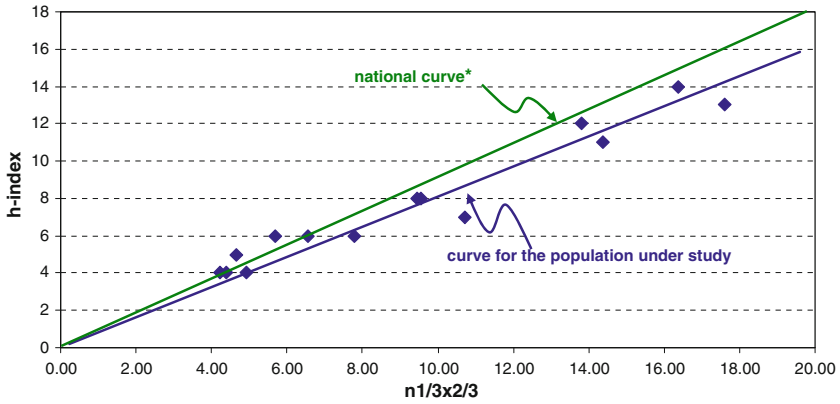

Fig. 3 Glänzel model for the high publishing professors of the group under study (with publications ≥20): $c = 0.81$ and $R^2 = 93\%$

For the group under observation, the c constant is found to be equal to 0.81 which is lower than 0.92 obtained by Bouabid and Martin (2009) at a national level considering just 10 years (1997–2006) of publications timespan and 5 years citation time-window. Csajbok et al. (2007) had found c equal to 0.932 for a sample of 40 countries including 27 EU (UK is treated as four separate statistical entities), Croatia, Turkey, Norway, Switzerland, Australia, Canada, India, Japan, China, and USA.

Patenting analysis

The evaluation would not be fairly complete without including technological outputs of theses professors along with their research outputs. In analysing the co-activity of each of them we found that the majority were more 'author' than 'inventor'. In fact, just 9 out of 262 are inventor-professors owning 44 patents. Table 2 shows however that even if there is a few number of inventor-professors, their average productivity is higher (10.5) than that of their peer non-inventor-professors (3.3) which is also the case of the mean citations per publication.

This conclusion is fully in line with the findings that patenting activity is generally positively correlated to publication activity and its quality drawn by several researches such as those of Agrawal and Henderson (2002) for the study on knowledge transfer from MIT, Breschi et al. (2007) for evaluating Italian university system, Rosenberg (1998) for analysing chemical engineering in USA and Europe, Meyer (2006) for exploring co-activity in nano-science and technology, Van Looy et al. (2006) for analysing mutual

Table 2 Average productivity and average mean citation for inventor and non-inventor professors

	Number	Number of publications	Number of pub/professor	Number of citations	Number of cit/pub
Inventor-professors	9	94	10.5	614	6.5
Non-inventor-professors	253	883	3.3	4360	4.9
Total	262	977	3.7	4974	5.1

effects between publishing and inventing at the Leuven university, and recently Czarnitzki et al. (2007) for assessing co-activity of German professors.

As a result, the inventor-professors institutions were likely more impacted by the initiative. The faculties of Kenitra came first (with 41% of the total patents) followed by the faculty of science of Rabat (with 39% of total patents).

Concluding remarks

The present evaluation provides *ad vitam aeternam* accurate data and a useful insight into the impact of the voluntary early retirement policy on research and technological outputs of the faculties of science in Morocco and consequently on the overall Morocco's research system. Conventional scientometric indicators: publication counts, citations and composite indicators: h-index and Glänzel model and patent counts are used to quantitatively portray the extent of this policy on the research system and to override some speculations pulled in since.

The study concluded the initiative had limited effect on the faculties of science with a turn over of only an average of 8% within the professor staffs of these institutions and the number of professors seems to be proportional to the size of the institution. Additionally, the field distribution of the production of these professors should raise no worry. Indeed, no specific scientific field had intensively been struck as the field breakdown of this production followed broadly the general scientific field-weighted production at the national level.

The productivity and its quality of the group of professors benefiting from this initiative were not as much as the national averages; with more than half of professors having no publication in the *SCI* and that the few active professors were more authors than inventors. A further conclusion concerns the gradual decrease of the scientific production of these professors even several years before the initiative occurred.

By means of these metrics, even if the initiative had not contributed to rejuvenate the professor-staffs of the faculties of science in Morocco, was nevertheless well distributed among these institutions and would be a *stimulus* of their research system with respect to their scientometric indicators.

Acknowledgments The authors thank M. Bousmina, D. Aboutajeddeine and T. Bounahmidi, for their valuable and helpful comments.

References

Agrawal, A., & Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science, 48*(1), 44–60.

Bornmann, L., & Daniel, H.-D. (2005). Does the h-index for ranking of scientists really work? *Scientometrics, 65*(3), 391–392.

Bouabid, H., & Martin, B. R. (2009). Evaluation of Moroccan research using a bibliometric-based approach: Investigation of the validity of the h-index. *Scientometrics, 78*(2), 203–217.

Bourke, P., & Butler, L. (1998). Institutions and the map of science: Matching university departments and fields of research. *Research Policy, 26*(6), 711–718.

Breschi, S., Lissoni, F., & Montobbio, F. (2007). The scientific productivity of academic inventors: New evidence from Italian data. *Economics of Innovation and New Technology, 16*(2), 101–118.

Charlton, B. G., & Andras, P. (2007). Evaluating universities using simple scientometric research-output metrics: Total citation counts per university for a retrospective seven-year rolling sample. *Science and Public Policy, 34*(8), 555–563.

Csajbok, E., Berhidi, A., Vasas, L., & Schubert, A. (2007). Hirsch-index for countries based on essential science indicators data. *Scientometrics, 73*(1), 91–117.

Czarnitzki, D., Glänzel, W., & Hussinger, K. (2007). Patent and publication activities of German professors: An empirical assessment of their co-activity. *Research Evaluation, 16*(4), 311–319.

Glänzel, W. (2006). On the h-index—A mathematical approach to a new measure of publication activity and citation impact. *Scientometrics, 67*(2), 315–321.

Granadino, B., Plaza, L. M., & Vidal, C. (2005). Analysis of Spanish scientific output following the joint action program (Acciones Integradas) of the Ministry of Science and Technology (MCYT). *Research Evaluation, 14*(2), 97–102.

Hicks, D., Tomizawa, H., Saitoh, Y., & Kobayashi, S. (2004). Bibliometric techniques in the evaluation of federally funded research in the USA. *Research Evaluation, 13*(2), 68–78.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences, 102*(26), 16569–16572.

Jimenez-Contreras, E., Anegon, F. D., & Lopez-Cozar, E. D. (2003). The evolution of research activity in Spain—The impact of the National Commission for the Evaluation of Research Activity (CNEAI). *Research Policy, 32*(1), 123–142.

Katz, J. S. (2000). Scale-independent indicators and research evaluation. *Science and Public Policy, 27*(1), 23–36.

Martin, B. R., & Irvine, J. (1983). Assessing basic research: Some partial indicators of scientific progress in radio astronomy. *Research Policy, 12*, 65–69.

Meyer, M. (2006). Are patenting scientists the better scholars? An exploratory comparison of inventor-authors with their noninventing peers in nano-science and technology. *Research Policy, 35*(10), 1646–1662.

Narin, F. (1987). Bibliometric techniques in the evaluation of research programs. *Science and Public Policy, 14*(2), 104–106.

Rosenberg, N. (1998). Chemical engineering as a general purpose technology. In E. Helpman (Ed.), *General purpose technologies and economic growth* (pp. 167–192). Cambridge: MIT Press.

The World Bank. (2006). MENA Regional Governance Case Study: Morocco Voluntary Retirement Program.

Vanclay, J. K. (2006). On the robustness of h-index. *Journal of the American Society for Information Science and Technology, 58*(10), 1547–1550.

Van Leeuwen, T. N., Van der Wurff, L. J., & Van Raan, A. F. J. (2001). The use of combined bibliometric methods in research funding policy. *Research Evaluation, 10*(3), 195–201.

Van Looy, B., Callaert, J., & Debackere, K. (2006). Publication and patent behaviour of academic researchers: Conflicting, reinforcing or merely co-existing? *Research Policy, 35*(4), 596–609.

Van Raan, A. F. J. (2006). Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups. *Scientometrics, 67*(3), 491–502.

Ventura, O. N., & Mombru, A. W. (2006). Use of bibliometric information to assist research policy making. A comparison of publication and citation profiles of Full and Associate Professors at a School of Chemistry in Uruguay. *Scientometrics, 69*(2), 287–313.

Vilibic, I. (2009). Bibliometric analysis of the adriatic-related oceanography and meteorology publications. *Geofizika, 26*(2), 229–243.