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Performance of Indonesian R&D institutions: Influence of type of institutions and their funding source on R&D productivity

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ABSTRACT

This study compares and analyzes the performance of Indonesian R&D institutions based on scientific as well as technological productivity. The effects of collective determinants such as type of R&D institutions and their funding source as well as size on productivity are considered in the formulation of policy recommendations for the development of R&D institutions in Indonesia. Based on their funding source, our findings indicate that R&D institutions that are self-sufficient in funding display better performance than government-funded R&D institutions. In accordance with their mandate, State-Owned R&D institutions are the most productive R&D institutions, followed by Ministerial R&D institutions and non-Ministerial R&D institutions, especially when considering technological productivity. Similar to previous findings, it was found that the size of an R&D institution has a negative effect on productivity.

1. Introduction

Research and development (R&D) conducted at universities (Rosenberg and Nelson, 1994 [35], Furman and MacGarvie, 2007 [14], Miyata, 2000 [24], Santoro and Chakrabarti, 2002 [38], Laursen and Salter, 2004 [19]) and public research institutions (PRIs) (Salter and Martin, 2001 [37]) is a crucially important driver of innovation, economic progress and social welfare (Mazzoleni and Nelson, 2007 [22], Papon, 1998 [31]). Both in the literature (OECD, 1997 [30]) and in the political and public debates, there are increasing recognitions of the role of universities and PRIs as strategic actors in knowledge creation and diffusion. Universities' scientific production especially concerns basic research, but the results that are generated have not only long-term effects but produce spillovers that have short- and medium-term effects on industrial innovation (Daraio and Henk, 2011, Salter and Martin, 2001 [37]).

The transfer, exploitation and commercialization of public research results are critical areas of science, technology and innovation policy. Efforts to ring-fence public research in the context of fiscal austerity in many developed countries – as well as competition from new players in Asia – have increased pressures on universities, public research institutions and governments to increase the economic outputs and effect of investments in public research (OECD, 2012 [29]). Though knowledge and research generated by the public research system is diffused through a variety of channels – mobility of academic staff, scientific publications, conferences, contract research with industry and the licensing of university inventions – much of the policy focus in OECD countries has centered on promoting knowledge transfer via a dual and rather linear model of commercialization (OECD, 2012 [29], Lockett et al., 2005 [21]).

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The R&D institutions In Indonesia, as in other developing countries (Ynalvez and Shrum, 2011 [48], Brambila and Veloso, 2007 [5], Chmainade et al., 2012 [9]), generally have many problems and externalities. Public R&D institutions are generally managed under the idea of "business-as-usual" for a public institution in general, without any attention given to the special qualifications of a research institute with distinctive requirements. Under the current Indonesian government budgeting mechanism, the public research institutions have no strong motivation to cooperate with outsiders to support technology development in industry. Thus, a weak linkage between R&D institutions on the supply side with industries on the demand side occurs. Quick changes of industrial technology development are difficult for R&D institutions because of their human resources weaknesses. The operational system for public research institutions does not provide much opportunity to build linkages with the private sectors. The incentives system that supports these linkages is weak; there are no national industrial policies related to government procurement that supports domestic industry (Thee, 1998 [42], Lall, 1998 [20]). Indonesia's Vice President, Budiono has offered criticism that science and technology (S&T) in Indonesia is not yet optimally utilized for national development. In addition, he stated that R&D output is limited to scientific publications and prototypes, and there is weakness in national science and technology (S&T) development planning (Budiono, 2013 [6]). Moreover, there are overlapping on research themes and focus on reduced synergy between R&D institutions especially in the public research institutes. As a consequence, the innovation rank indicator of Indonesia (33rd) remains lower than Malaysia (25th) and Singapore (9th), but nevertheless, it remains higher than Thailand (66th) by 33 levels (WEF, 2013 [46]). The quality rank of Indonesian scientific research institutions has been reported to be better than that of Thailand. However from 2008 to 2012 this rank decreased significantly by 17 levels, from 39th place (2008) to 46th (2012). The scientific productivity of Indonesian researchers is known to be low at the individual and institutional level compared with other ASEAN countries (Lakitan et al., 2012 [18]).

This paper addresses the performance of R&D institutions in Indonesia and analyzes the determinants that affect their R&D productivity. Focused on collective determinants, this study explores the effects of institutions type and their funding sources on the scientific and technological productivity of these R&D institutions in developing countries such as Indonesia. The nature of outcomes may be strongly influenced by the funding structure of the institution. Carayol (2003) [8] demonstrated that the reputation and internal organization of the laboratory might profoundly influence the nature of contractual funding provided by the firms. Policy recommendations formulated from this paper are a next step objective with the aim of increasing the performance of R&D institutions in Indonesia. The right direction and accurate formulation of the problems are essential and critical phases in order to avoid mismatches in formulating solution through policy recommendation (Chmainade et al., 2012 [9]).

This study compares and analyzes the performance of Indonesian R&D institutions based on scientific productivity as well as technological productivity. The effects of institution determinants such as: type of R&D institutions and their funding source on R&D productivities are considered in the formulation of policy recommendations for the development of R&D institutions in Indonesia. This paper also introduces 'scientific and technological efficiency' as well as the 'scientific and technological cost index' which are defined as a standard for output cost unit for producing one scientific publication as well as a technological product (service), respectively.

2. R&D institutions and productivity

The R&D productivity of research institutions has been studied by many authors and is known generally to involve to type two of factors: individual factors such as age, gender, type of positions occupied by scholars, scientific disciplines, training, etc; and institutional factors such as the average age and the positions of colleagues, the quality of institutions and colleagues, non-permanent researchers, size institution, funding, scientific collaboration, etc. (Carayol and Matt, 2006 [7], Brambila and Veloso, 2007 [5], Ynalvez and Shrum, 2011 [48]).

2.1. Individual effects

Many authors had studied the impact of age on scientific productivity as reviewed by Carayol and Matt (2006) [7]. Some authors have found that scientist's major findings occur in a single peak curve in their 30s or 40s. In case of developing countries (Brambila and Veloso, 2007 [5]), this is a confirmed a quadratic relationship between age and the number of published papers. However, publishing peaks when researchers are approximately 53 years old, 5–10 years later than prior studies. Overall, the results suggest that age does not have a substantial influence on research output and impact in the case of Mexican researchers. However, some authors have demonstrated that the high productivity of researchers occurs in a two-peak (around 30–40 and around 50 years of age) productivity curve. In most fields, researchers productions tend to increase in the early career period, reach a peak and then decrease. Variables such as researcher positions are possible suggested explanations. Scholars progressively turn toward research administration tasks as they get older, and their productivity declines.

Gender effects have also been studied by many authors. In the case of developing countries, the results suggest that there is not a large gender difference in scientific output (Brambila and Veloso, 2007 [5]). Mexican female scientists is not overrepresented among the non-publishers, and they produce only slightly fewer papers (0.07 papers) than men on average per year. The proportion of female scientists varies greatly among areas of knowledge. The areas with greater representation are the health sciences with 39%, followed by the social sciences and humanities with 38%. Although only 12% of engineers are women, the results suggest that women in this area are slightly more productive than men. The largest gap is found in the health sciences