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The Impact of Bayh-Dole Act on Knowledge Transfer in the States and a Study on Applicability in Turkey

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***Abstract*—**This study aims to contribute to efforts of Turkey to increase research and development to overcome mid-income level trap by discussing regulations on patenting and licensing. Knowledge and technology transfer from universities to business world is attached great significance to increase innovation. Through literature survey, it is observed that the States accomplished to boost the economy and increase welfare by the Bayh-Dole Act enacted in 1980. Thus, this good practice is imitated by other nations to make technological developments. The Act allows universities to acquire patent right in research programs funded by government to increase technology transfer from universities whilst motivating real sector to use research pools in the universities. An act similar with Bayh-Dole could be beneficial to Turkey since efforts in Turkey are to promote research, development and innovation. Towards this end, the impact of Bayh-Dole Act on the patent system for universities in the Sates is deliberately examined, applicability in Turkey is discussed. However, it is conceded that success rate of applying Bayh-Dole Act in Turkey would be low once Turkey mainly differs from the States regarding social, economic and cultural traits.

***Keywords*—**Bayh-Dole act, knowledge transfer, license, patent, spin-off.

I. Introduction

AMERICAN higher education system is one of the biggest contributor to economic development following the Second World War. In particular, the Bayh-Dole Act (hereinafter referred to as "the Act" or BDA), came in to effect in 1980, has the utmost effect on this contribution [1], [2].

Patents were awarded to federal agencies that provided fund to universities until 1960. Universities were forced to follow a challenging procedure to acquire a patent for the product funded by the government [2]. During 1960s and 1970s, federal agencies applied flexible policies on patenting procedures for universities. Patents were made available by applying federal agencies or supervisor body regulating patenting procedures. However, there were no written rules or a regulated process for universities' research and development [1]. Moreover, crises in 1970s and 1980s unraveled the requirement for the research programs. This resulted in BDA dated back to 1980. By the Act, patenting and licensing procedures for the research funded by federal agencies were laid out [1], [2]. The Act aims to promote technology transfer from universities to real sector.

The journey in the States is very similar to Turkey's recent efforts to promote research, development and innovation to overcome middle-income trap. Thus, it is considered significant to discuss the process in the States and adapt lessons-learned to Turkey's experience. Hence, this paper aims to provide a clear vision for policy makers in Turkey in compliance with Turkish social, economic and scientific infrastructure as well as Turkey's (vision 2023). To this end, paper is structured as four sections. First section is on BDA and experience in the States. The second section discusses the effects of the Act. The third and the forth ones research and shed some light on the applicability of the Act in Turkey. Finally, some recommendations may be found in the conclusion.

II. Developments Following the Act

A. Patenting

BDA is a significant initiative for American technology policy and a significant actor to promote competitiveness of American economy. The Economist describes BDA as "the most inspiring act of the last fifty years" [3]. BDA is a reform to facilitate and speed technology acceptance and transfer. BDA provides universities to make research, acquire patent and license, and transfer technology to business world [4].

Following the Act, some universities such as MIT, Stanford University, University of California, and Wisconsin University started to acquire patents [1]. The Act resulted in an increase in the number of patents. The number peaked from 390 in 1980 to 1662 in 1993, with a growth rate of 316%. Patents of enterprises increased at a rate of %48 at the same period [5]. Fig. 1 shows the research patent universities acquired between 1925 and 1995. Momentum gained after 1980 may be clearly seen in the figure.

B. Technology Transfer Offices

BDA provides opportunity to establish technology transfer offices (TTO) that sell outputs of research and management [6]. We may here state that BDA attracts universities, which would like to transform their tacit knowledge to concrete outputs (Fig. 1 shows number of patents and licenses universities in the US over the years). We observe that few universities have activities on patenting and licensing till 1990's. The number of activities starts to increase in 1970's; upwards tendency went on and doubled following BDA was introduced. All universities revised their policies, restructured TTO and delegated patenting and licensing to TTO once

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technology was produced [7]. 300 TTO were established and more than 4500 firms benefited patents of universities [8].

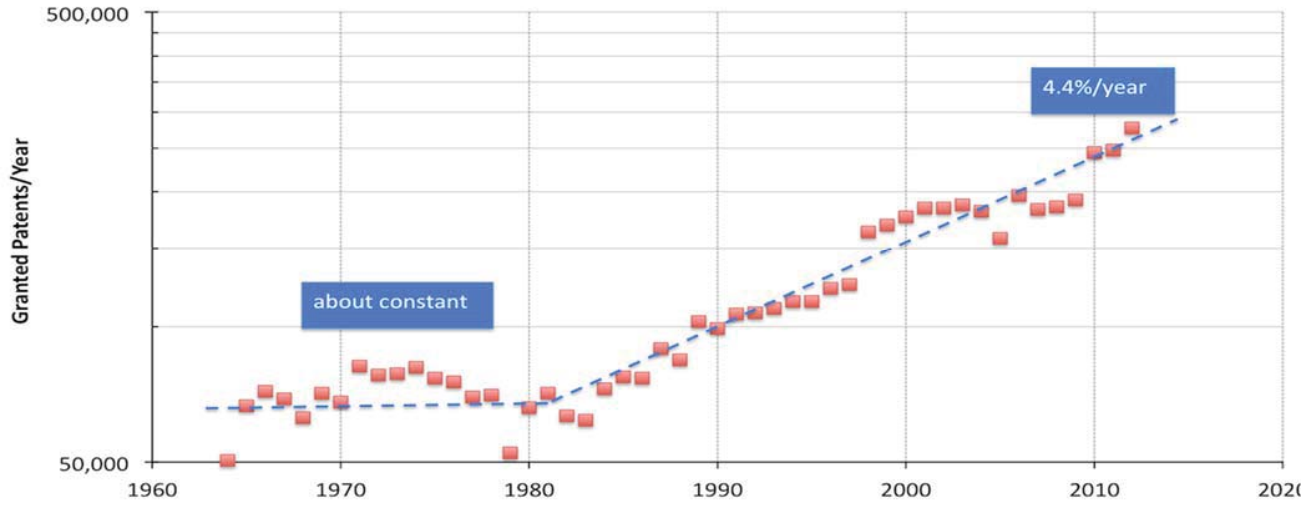

Fig. 1 Number of Patents [9]

C. Licensing

Licensing is a budgetary item for universities to create revenues from indigenously developed technology. Talking with the numbers, we may refer to Association of University Technology Managers (AUTM) that licensing income of universities is reported about 200 million dollars [10]. License income as well as other core measures of technology transfer activities between 1991 and 2008 is indicated in Fig. 2. Another issue here is that a small portion of universities takes large piece of license income. To be more concrete, one tenth of universities have 60% of total license income. To this end, it is not wrong to say that many universities do not make money by patenting and licensing [11].

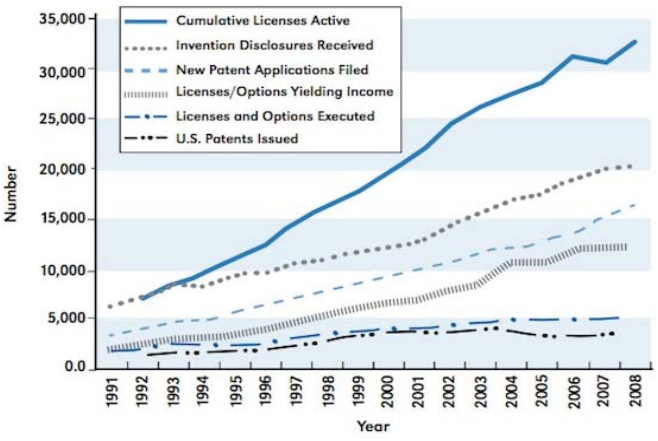

Fig. 2 Change in Core Measures of Technology Transfer Activities, 1991-2008 [12]

III. Discussion on the Act

BDA is considered as a trigger to commercialization of university knowledge production. However, some advocates that growth trend started before the Act and it only speeded up the process. On the other hand, we also see that some European countries like Austria, Denmark, Germany and Norway enacted bills similar to BDA. Nonetheless OECD notes that acceptance of similar acts in Europe does not show the same success rate as the US [13]. Movery et al. [7] examined the effects of BDA on Colombia, Stanford and California universities. According to research, although Colombia University engaged in patenting after the Act, it is one of those who earn licensing and royalty income. Three universities abovementioned concentrate their patenting activities on biomedical sector because federal government gives financial support to biomedical researches as an official development policy. This indicates that some other factors as well as BDA affect disclosure, patenting and licensing activities in universities. It is true that BDA provides input for economic system. However, commercialization requires more research, development (R&D) and investment. Firms are motivated to involve in university collaboration and transfer knowledge from university, resulting in allocating finance in R&D. On the other side, to our best knowledge, some critics are made to BDA.

- BDA leads to lower quality in university R&D.
- BDA asks universities to make researches in applied sciences rather than basic sciences.
- BDA has negative effect on technology transfer to emerging markets.
- BDA restricts technology transfer on society.
- BDA negatively affects dispersion of patents on occupations.

This section discusses the effects of BDA listed above.

A. Quality of Patenting at University

Henderson et al. [6] are the first to research negative effect of BDA on patenting quality. They evaluated patenting quality in two categories: significance and commonality where

significance shows the reference rate of the patent and commonality is related to the fields of the patent's references. Researchers advocate that increase in number of significance and commonality is not in compliance with that of commercialization, and therefore national science and technology development is negatively affected. They conclude that although the number of patents increases, patenting quality decreases by the introduction of BDA.

Movery et al. [14] also investigate patenting quality and extend Henderson's study [6] till 1999. In contrast to former study, they concede that BDA has a trivial effect on patenting quality even significance and commonality of patents of the universities following BDA are lower than those of the ones active before BDA [3]. However, it is hardly to infer that universities produce patents in lower quality after the introduction of the Act. We all know that it will take newly started universities some time to improve patenting and licensing management.

B. Basic and Applied Sciences

BDA is heavily criticized that it diverts universities through applied sciences instead of basic sciences. It is advocated that support given by the Act will negatively affect national and international life quality [15]. Resources are also reallocated on behalf of applied sciences. As a consequence of license income, resource allocated to basic R&D would decrease in comparison to total assets whilst resource allocated to R&D increase. On the other side, Rafferty [16] made a research to investigate the effect of BDA on basic science by means of the data of 500 universities for the period 1953-2002 (Please refer to Fig. 3). He demonstrates that basic science research does not show a decline following the Act. On the contrary, it has a decline trend in 1960's and 1970's. Therefore, we may concede that BDA does not lead to a decline in basic R&D.

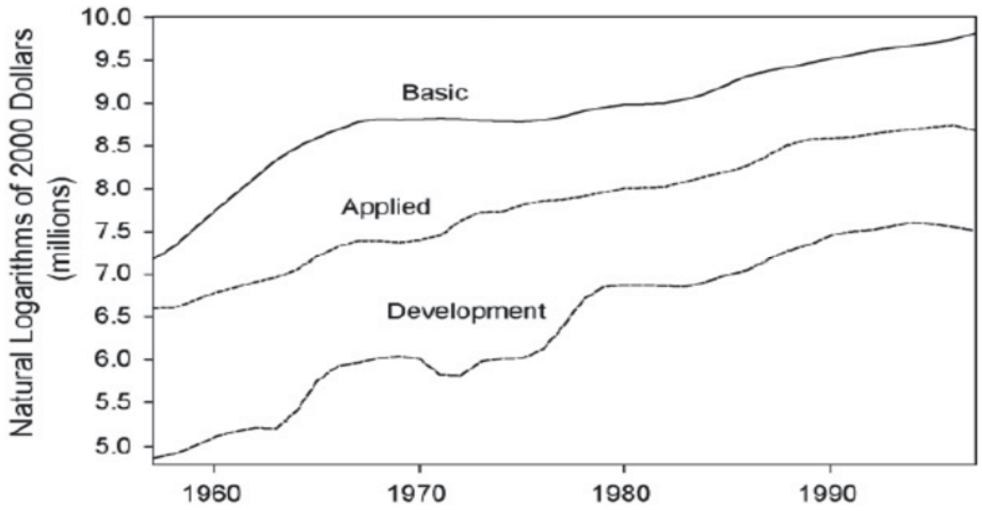

Fig. 3 R&D Expenditures for Universities (Natural logarithms of 2000 dollars) [16]

C. International Technology Transfer

Many nations in Europe and Asia intend to enact a bill like BDA [14]. Cambridge University, for instance, is an individual example employed a system like the Act in 2005. Emerging markets such as China, Brazil, and South Africa introduced new patent bills for public research [8]. On the other hand, Pineda [15] states that BDA impedes network among universities by transforming labs into business environment. Universities start not to share and transfer knowledge produced in the labs. Unwillingness of knowledge sharing negatively affects access to technology of emerging markets.

D. Technology Transfer through Society

Main criticism on BDA concentrates on societal effects. While government supplies finance to universities for knowledge and technology production, BDA focuses on commercialization disregarding society. We may infer that BDA leads to restrictions of attainability and commonality of knowledge and technology employed by universities and academia in scientific research. This means use of knowledge is reserved to the firms having licensing capability. Once BDA empowers universities rather than federal agencies for patenting, large firms take much more advantage because of financial and technical capacity. Here we ask the mission of the universities and investigate whether public funds are used as designed.

IV. Applicability of the Act in Turkey

Rights of employees' regarding inventions are regulated with a decree law on Protection of Patent Rights (Issue nu. 551). Employees' inventions are classified into two categories: free inventions and in-service inventions (Item nu.17,19). Unless invention is classified as in-service, the rights are reserved to employee. Employee may be either a worker or an officer. However, policymaker regards the work academicians' as a free invention [18]. Then lecturers in universities absolutely hold all rights related to their work

[19]. Professors individually may apply for a patent on their own work. However, universities ask for a rational portion in compliance with contribution when invention is commercialized [20].

In order to evaluate the applicability of an act similar to BDA in Turkey, it is deemed necessary to identify academic levels and patenting in universities. To this end, we see an increase in academic research (Fig. 4). The number of publications rose from 1.154 in 1990 to 27.276 in 2014. With this figures, Turkey ranked 18 in the world while 41 in 1990. It is not wrong to say that Turkey made a steady progress regarding academic work.

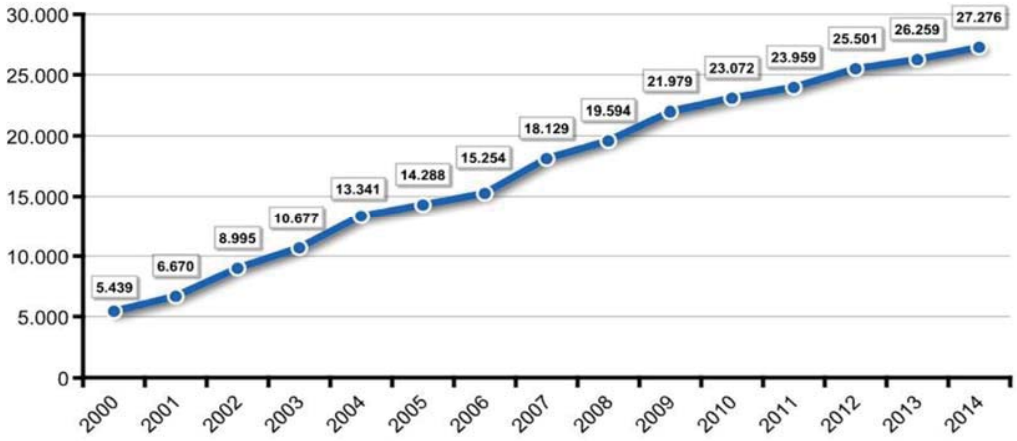

Fig. 4 Publications in Turkey (2003-2013) [21]

Patenting follows the same upward pattern as academic publications. Fig. 5 indicates the increase in patent applications and patenting between 2002 and 2009. The number of domestic patent applications rose from 414 to 2588 where that of domestic patenting rose from 73 to 456. We may infer that after 2005 there is a jump in domestic patenting. On the other hand, when we compare with publications, it is clearly observed that number of patenting is very low. We may concede that Turkey is not successful at transferring knowledge and technology into industry and commercializing academic work.

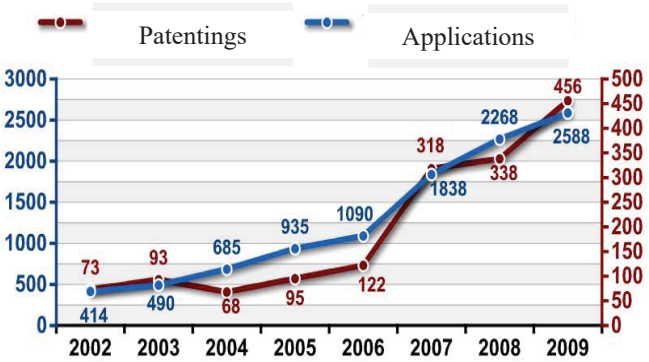

Fig. 5 Domestic Patent Applications and Number of Patenting [22]

V. Some Comments on Critics on the Act Regarding Turkey

Number of applications and patenting is very low in comparison with academic publications. We may infer that Turkey fails at transferring academic research to industry. We may also concede that applied research is mostly lacking in Turkey due to weakness in collaboration among industry, government, and university. Furthermore, there is no equal opportunity among universities. Schooling rate in higher education is high, i.e. %60, since 2004 in Turkey. However, universities are not at the same educational level and do not have similar capacities for knowledge production and transfer. This situation also affects society where university is located. Therefore, industry and society is developed in particular cities, namely Ankara, İstanbul, and İzmir with their periphery.

In order to speed transfers up, patenting and licensing are to be motivated. An act similar to BDA is likely to boost industry by licenses and patents. It is also a useful tool for an easy transition from basic to applied research. However, it may restrict knowledge and technology transfer to emerging markets as well as from developed nations. In particular, academic cooperation may be deteriorated because of weakness in joint research, researcher exchange programs, and commercialization. It may also affect knowledge transfer form renown universities to newly established ones, leading to weak education and research as well as undeveloped society. One more negative effect would be on the concentration of enterprises that might have maximized license incomes. This makes sense with regard to short-term economic and political targets whereas long-term economy and societal welfare.

VI. Conclusion

BDA led to great developments in patenting in the States. After 1980, an increase is seen in number of patents, number of universities involved in research and license income of universities. Universities acquired freedom in patenting and licensing. The main motivator was the direct increase in knowledge and technology transfer and the indirect increase in economic and societal welfare. However, BDA results in

commercialization risk that universities disregard societal effects and focus on commercialization. License income oriented research is considered a risk to restrict main activities of the Act. Thus, researchers and academicians are highly recommended to study how to overcome constraints on knowledge and technology transfer and radiation resulted from BDA. Although there are also some critics on quality of patenting, studies show that no decline is experienced in the quality of patents.

To this end, BDA is a role-model for other countries to transfer knowledge and technology to industry. Hence, this study discusses the applicability of BDA in Turkey. Although number of academic research in Turkey has recently increased, we could not see the same pattern in knowledge and technology production and transfer from universities to industry. Therefore, we concede that an act similar to BDA is deemed necessary to boost economic growth by R&D and innovation.

Success rate of adoption of the same act is very low due to different societal, economic, and cultural needs. However, an act which overcomes critics on BDA and regards Turkey-specific needs may be more reasonable in compliance with economic growth and societal welfare. Thus, we strongly recommend the policy makers to study hard on lessons-learned and examine good practices to tailor BDA to Turkey.

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