Technological Forecasting & Social Change 82 (2014) 6–22

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Developing human capital and research capacity: Science policies promoting brain gain

Manuel Heitor *[,1], Hugo Horta, Joana Mendonça [2]

Center for Innovation, Technology and Policy Research, Instituto Superior Técnico, Technical University of Lisbon, Lisbon, Portugal

ARTICLE INFO

Article history:
Received 29 October 2012
Received in revised form 18 June 2013
Accepted 9 July 2013
Available online 14 August 2013

Keywords:
Science policy
Brain gain
Human capital
Advanced training
Research system
Higher education system and reform

ABSTRACT

Science policies emphasizing the advanced qualification of human resources, together with democratizing access to science and internationalizing the science base, are shown to help build the conditions needed to drive brain gain over time.

Exploring a new set of data for the period 1970–2010 in Portugal, this paper focuses on the analysis of flows of doctorates, with the ultimate goal of helping to promote the absorptive capacity that emerging regions and countries worldwide need to acquire to *learn* how to use science for economic and social development. It shows a notable process of brain gain by the end of this period and, above all, it provides a dynamic approach to the cumulative process of building knowledge-based societies. The results show the need to consider the co-evolution of brain gain, brain drain and brain circulation over time and space. In addition, they suggest the importance of certain major counter-intuitive policy instruments to facilitate the co-evolution of human capital formation and research capacity building. In the case of Portugal, these instruments have included a centralized program of research grants, research careers independent of traditional academic career tracks, and a diversified system of funding research units and institutions based on research assessments through international peer reviews.

1. Introduction

The main argument of this paper is the need to focus science policies in developing regions on the process of building advanced human capital, which requires stable public strategies over time, together with adaptable and resilient research institutions.

Critical mass is vital for the creation and dissemination of knowledge, and attaining that critical mass is of utmost importance for both developed and developing countries, and is particularly relevant for emerging regions worldwide [1–3]. The key role for policy-makers and governments in regions where major investments in science and higher education are being made is to select priority actions and make appropriate decisions as to where and how to start the process.

Our evidence and lessons learned show that achieving this ultimate goal requires science policies and strategies aimed at advanced human capital in a context in which alliances and partnerships between research organizations and higher education institutions, as well as between them and corporations, are of particular importance. Nevertheless, the main public policy issue relates to the conditions for fostering brain gain. This has become a politically sensitive issue worldwide and a critical one in developing and emerging regions [4].

It is against this background that our ultimate goal is to help understand the dynamics of brain gain, brain drain and brain circulation over time and space in order to deepen our current knowledge of policies that can drive brain gain in emerging regions worldwide [5,6]. This is important because brain gain depends on a cumulative process that is associated

* Corresponding author.
E-mail addresses: mheitor@ist.ut.pt (M. Heitor), hugo.horta@ist.ut.pt (H. Horta), joana.mendonca@ist.utl.pt (J. Mendonça).

[1] On leave during 2011–12 at Harvard University, Science Technology and Public Policy Program, at the Kennedy School. Secretary of State for Science, Technology and Higher Education in the Portuguese Government, 2005–2011.

[2] Previously at the Observatory for Science and Technology; Statistical Office, Ministry of Science and Education, Portugal.

0040-1625/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.techfore.2013.07.008

with efforts to build knowledge-based societies [7]. In this context, our research hypothesis underlines that aspects of time and space and processes associated with the co-evolution of human capital formation and institutional building help promote the absorptive capacity that regions and countries need to acquire in order to *learn* how to use science for economic and social development.

It is clear that public policies to attract and retain talented people have mostly been focused on favorable immigration strategies [8]. We acknowledge the importance of such policies, but focus our argument on the need to promote science policies based on building advanced human capital and the internationalization of the science base.

Two further issues drove our research work and should be emphasized, as follows. First, innovation must be considered together with competence building and advanced training of individual skills through the complex interactions between formal and informal qualifications. This requires broadening the social basis for knowledge activities, including higher education enrolment, as well as strengthening the top of the research system to foster knowledge production at the highest level. It is well-known that the world's most developed regions (such as Japan and the US) have high rates of researchers per 1000 workforce, and are striving to increase these rates even further [9].

Second, strengthening experimentation in international knowledge networks necessarily involves flows of people. It is the organized cooperation among networks of knowledge workers, together with different arrays of users, that will help diffuse innovation in the design of products and services. But establishing these innovating communities requires the systematic development of routines of collaboration on the basis of formal education programs, sophisticated research projects, and a diversified and non-structured array of informal networking processes. This requires public policies, particularly science policies, to foster "brain circulation" between leading institutions worldwide.

As this point, we should remember that scientific progress is a source of development and that tertiary education institutions play a critical role in this process [10]. The investment of public resources in the context of rigorous international assessments leads to new knowledge, better advanced training of new human resources for society, and new ideas and processes, which increasingly result in innovation, modernization of institutions, improved quality of life, economic productivity and better employment opportunities [11].

Consequently, our goals require the renovation and expansion of the social basis for scientific and technological development. This calls for strong commitment not only from the scientific and technical professions and from public and private research organizations, but also from students and from the general population. The growing appropriation of scientific and technological culture by society was one of the central aspects of the analysis by Heitor [12] and here we explore that central principle, making use of a new set of data.

It should be noted that any analysis of this subject needs to be context-sensitive, taking into account changes in the mobility of talent and corresponding perceptions. The literature on the topic is itself in transformation, from the apparently one-way, inherently competitive and mutually exclusive mobility of the highly skilled (as understood as brain drain in both the internationalist and nationalistic views of Johnson [13] and Grubel and Scott [14]) to brain circulation [15]. In this framework, this paper is not intended to provide any type of recipe. Rather, it discusses lessons learned based on a historical analysis and under the assumption that science is contextualized [16]. As a result, we consider that knowledge diffusion processes are context-sensitive and should be oriented towards inclusive learning [17].

We base our analysis on a set of data on flows of doctorates in Portugal over the period 1970–2010. Portugal represents an interesting case study since continuous investment in science and technology in a small south-western European region has resulted in significant progress after some four decades of lagging behind [18]. In addition, a thorough legal reform of the Portuguese tertiary education system has been successfully completed [18,19] and there has been a uniquely large increase in public investment in science and technology [20].

The rest of this paper is divided into five parts. The following section describes the new set of data used for our analysis of Portugal in the period 1970–2010, together with the research methodology. Section 3 presents data up to 2010, the evidence on the achievement of brain gain after four decades of investing in the science base. Section 4 analyzes the evolution over time of relatively unstable science policies over those four decades, and Section 5 discusses structural factors that determine research capacity. In both sections, we use the number of doctorates as the main proxy for our analysis. The paper concludes with our main summarizing remarks and lessons learned in terms of the need for science policies in many different regions of the world to focus on advanced human capital formation and research capacity.

2. Methodology and data

The data used in this paper were made available by the services of the Ministry of Science, Technology and Higher Education responsible for gathering and publishing statistics [21]. They include identification of the professional situation of all doctorate holders whose studies were awarded at, or recognized by, Portuguese universities over the last four decades, as well as those working in Portugal in 2009. This identification was based on analysis of microdata from various sources of statistical and administrative information, on the basis of which all doctorate holders and their corresponding professional situation in 2009 were identified.

These doctorate holders can be divided into three groups, namely: 1) PhDs whose doctorates were awarded by Portuguese universities; 2) PhDs who gained their doctorate abroad and requested recognition, equivalence or registration of their degree in Portugal; 3) PhDs who gained their doctorate abroad and did not officially register their degree in Portugal.

The identities of the PhDs in each of these groups and data on their mobility and professional situation came from different information sources, gathered directly or administratively, as follows:

i) the official annual R&D survey of all entities that carry out research and development (governmental, higher education, private not-for-profit institutions and companies), including information on all their individual researchers;