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Enhancement of research and development in Portugal: stimulation for innovation and the economy

Katherine Walters

ENHANCEMENT OF RESEARCH AND DEVELOPMENT IN PORTUGAL: STIMULATION FOR INNOVATION AND THE ECONOMY

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Introduction

Science and technology (S&T)–based innovation in any country is enabled when a delicate balance is established between knowledge growth and commercial industry. According to Professor Margarida Chagas Lopes of the University of Lisbon's School of Economics and Management, this balance is found when an economic market suited for highly educated research scientists and production engineers exists that parallels a comparable education system. Creating a system with high standards for education, research and development (R&D), and innovation is essential for a country to be successful economically. It is knowledge flowing throughout the positive feedback cycle of education to R&D to the production of innovation that will aid Portugal to prosper after the economic turmoil (Chagas Lopes, pp. 5–7).

In this article I explore the characteristics of Portugal's S&T innovation efforts following the end of the António Salazar regime (1974) until the present day. Through this analysis, I uncover the interconnections between the economy, knowledge flow, and R&D over time. Examining the 2010 financial crisis, I identify policies enacted due to the economy that negatively affected innovation. I find that these policies and cutbacks have had a negative effect on the national growth in innovation and investment in R&D. Based on these findings, I propose suggestions for improving knowledge flow and R&D to increase innovation, in terms of both new technology and process efficiency improvements, to create a commercially competitive field to drive economic growth, using biotechnology as a successful representative sector.

Background

At the emergence from a four-decade-long dictatorship in 1974, Portugal's education level and innovative mindset were relatively weak. Political and institutional pressures present at the onset of democracy pushed Portugal to elevate innovation and scientific development to a level on par with that of other European Union countries (Chagas Lopes, p. 2). In what would become a transformative era, Portugal undertook numerous structural changes aimed at becoming more competitive in the global marketplace.

Increasing innovation within Portugal's S&T sector was a key component of these efforts. In fact, the efforts began prior to the 1974 revolution with the establishment of the National Council for Scientific and Technological Research (JNICT) in 1967 to stimulate domestic technology innovation (Carvalho and Corchuelo, p. 118). After the revolution, the new national government consistently sought to improve R&D infrastructure throughout the remainder of the twentieth century through the first decade of the twenty-first century. These efforts I discuss in detail later; but, in short, the R&D infrastructure alterations enabled Portugal's S&T sector to flourish through academic training and research within universities.

Increased financial support for education and R&D led to positive growth in their respective indicators. For example, investment in higher education led to an increase in the rate of tertiary degree attainment among 25–64 year olds in 2011 to almost double what it had been in 2000 ("Education at a Glance 2013," p. 1). Also, Portugal's R&D intensity, measured by the gross expenditure on R&D as a percentage of GDP, was 0.73 percent in 2000 but increased to 1.66 percent in 2009 (Overall Review…, p. 1). This positive growth in R&D, during the otherwise stagnant economy, reflects the strong academic foundation established to improve knowledge flow (Figueiredo).

Portugal's general economic stagnation during the first years of the new century was compounded by the world financial crisis of 2008; the country was left with an accumulation of macro-economic imbalances. Considering its relatively late focus on knowledge creation and innovation, the effects of the economic crisis were more difficult for Portugal than for other countries with a more developed background in technology and knowledge, for it lacked a strong scientific and institutional infrastructure (Chagas Lopes, p. 1). The "toughest austerity budget in almost 30 years" (Lourtie, p. 22) resulted in deep cuts in public funding, including awards for post-doctoral fellowships and funding for research centers. Additionally, investment from the private sector decreased, with business expenditures on R&D (BERD) declining steadily from 2009 to 2011 (Carvalho and Corchuelo, p. 125). These reductions, although perhaps economically inevitable under the circumstances, have set back the nation's long-term S&T strategy (Levy, October 2014).

Since the 2014 "complete exit" from the austerity adjustment program, Portugal has had a chance to regroup and support S&T education and R&D. At the time of this writing, the Portuguese population is faring well in regard to the amount of doctoral graduates awarded, and the research and innovation system has been characterized by a high growth potential in the private sector. However, the number of job opportunities in knowledge-intensive careers remains low, with innovation potential unrealized. This fact, in conjunction with the general structure of the country's industrial economy, is cause for concern and indicative of an area in need of improvement.

In a country known for risk aversion (see the article by Erin Burton in this issue), the most vital questions to ask are, What efforts can be made to increase economic growth? and Where should investments be made in terms of the S&T sector to aid growth in the future? The Portuguese innovation system currently is characterized by low levels of research performance in industry, with the majority of research activities associated with academia (Santos Pereira, p. 452). Greater competitiveness of Portugal's commercial sector is needed and can be enhanced through the promotion of S&T-based investment in R&D as a first step toward economic recovery.

Science, Technology, and the Portuguese Economy

History of Investment in Knowledge Flow

During Salazar's regime, the development of S&T in Portugal was limited. Although some funding was provided for the creation of research institutions, the funded research often matched political interests (Gaspar et al., p. 74). In point of fact, members of the scientific community who publicly disagreed with the regime's policy for research suffered political persecution (Gaspar et al., p. 87).

The end of the regime in 1974 marked the beginning of the end of a scientifically repressed era. According to Professor Chagas Lopes, during and immediately after the era of dictatorship, "education was solely for the elite, illiteracy took a long time to eradicate, inequality was in evidence in schooling, and educational structures remained rigid and steeped in inertia" (p. 2). Given the lack of knowledge flow at the time, newly elected government officials voiced the need for a "fundamental shift" in order to bring about recovery ("Portugal Shakes Off Its Past"). The government, therefore, established initiatives to increase the country's effectiveness in education, R&D, and innovation, thereby improving the potential for S&T-based economic growth in Portugal.

Education was first to reap the benefits of new initiatives. Following the creation of a new Constitution in 1976, there were profound reforms in support of the elimination of illiteracy, the option of special education, and the safeguarding of the autonomy of the universities (Solsten). For a time after the revolution, education was highly politicized due to inherited bureaucratic habits and administrative processes from the past (Chagas Lopes, p. 2). By the 1980s, however, as Portuguese politics stabilized, the education system also became more structured, additional emphasis was placed on research, and efforts were made to raise the effectiveness of the country's tertiary schooling closer to that of Europe generally (Solsten). Consolidation of the higher education system was made possible due to the relatively stable political and economic environment in the 1980s. Growth was seen in the public university network both in the number of universities created and the size of the facilities (File, p. 13). Tertiary education advancements continued into the late 1990s and early 2000s. The government offered tax incentives for Ph.D. students who committed to entering the technological workforce to encourage enrollment, such as a 25 percent tax rebate for employee contracts (Louët, p. 276). Another program, launched in 1997, included a three-year government commitment to help fund half of the salaries of industry workers who held Ph.D. degrees (Dickson). With the help of the added incentives from the government, the number of Ph.D. candidates increased at an average rate of 10 percent per year from 1990 to 2000 for all areas of study (Louët, p. 277). Moreover, in the ten years from 1998 to 2008, the number of scientific publications increased from 1,418 to 4,156 articles, an increase of 293 percent ("Scientific and Technical Journal Articles in Portugal"). The commitment of the Portuguese government to improve S&T through investment enabled impressive growth in high-level academia, and the system continued to increase the numbers of qualified researchers. These researchers excelled through several levels, including Ph.D.s, postdoctorates, and even second postdoctorates through scholarships from the Fundação para a Ciência e Tecnologia (Foundation for Science and Technology [FCT]). Collectively, these indicators reflected a positive growth in education (Levy, October 2014).

R&D also saw improvements after the revolution. The succeeding three decades were marked by the establishment of new government agencies and policies focused on advancements in S&T. For instance, the JNICT introduced the first Integrated Plan for Scientific and Technological Development, clarifying science policy for research, which included the promotion of university-industry projects and encouraged state laboratories to take on research together with firms (History of the…). Science policy mechanisms were further strengthened during this period by an increase in the diversity of sources for funding, and by reinforcing networking through the

creation of the Law on Scientific Research and Technological Development (History of the…). This law addressed the numerous angles of S&T policy (Carvalho and Corchuelo, p. 118). Furthermore, R&D concerns were elevated to higher governmental concern in 1995 with the creation of the Ministry of Science, Technology, and Higher Education ("Portugal Shakes…"), in contrast to the existing council level of emphasis. This Ministry-level creation was a response to the need for a deep institutional renewal and was intended to stimulate the country's underdeveloped S&T sector. The Ministry then in 1997 reorganized the JNICT into the FCT, as it is known today, as the public institute and main funding agency in Portugal for research. These R&D infrastructure arrangements framed Portugal's S&T sector from the late 1980s through the early 1990s, reinforcing S&T as a governmental priority.

Attempts to create interest within industry for R&D to aid in innovation began in the early 2000s. Acknowledging the fact that the country's industries put little emphasis on S&T development ("Portugal Shakes…") and the fact that Portugal was neither a global player nor a technology leader, there was a need for focused attention on innovative activities for the improvement of products and processes (Molero, p. 232). Business firms that were considered technologically innovative and advanced were often the "modern" industries, although some technology advancements were made in the traditional, more labor-intensive firms (Molero, p. 232). When assessing the technological capability of different businesses in Portugal, those ranked highest were categorized as such due to technology upgrading of equipment rather than product innovation, indicating that advances in the education phase of knowledge flow had not translated well to applications within the country's industries.

To help identify the main issues preventing new technological development within Portuguese firms, inputs and performance indicators were monitored (Molero, p. 230). There also was an increase in corporate R&D investment. In order to promulgate research, Portugal attempted to ease entry to the marketplace through the On the Spot Firm program. This 2005 program sought to remove the barriers, considered among the highest in Western Europe, facing entrepreneurs in Portugal. The removal of barriers considered an obstruction for the small and medium-sized enterprises (SMEs) enabled growth in these smaller business firms across the country, and start-ups increased by approximately 17 percent in the short run (Branstetter et al., pp. 806–30).

Overall, growth in the S&T sector was seen between 1995 and 2009. Knowledge flow improvements looked promising, with the number of companies with one or more employees holding a tertiary degree increasing from 14 percent to 28 percent. When comparing total R&D expenditure by sectors of performance, up until 2005, the business enterprise sector was the major contributor, larger than the government sector, the higher education sector, and the private non-profit sector ("Portugal Overcomes…," p. 2). Unfortunately, however, the onset of economic turmoil in 2010 and the resulting adjustment program wreaked havoc on the still fledgling S&T sector.

Effect of Financial Crisis in 2010

The year 2010 marked the beginning of tough austerity measures. In hopes of reconstructing its economy to obtain sustainable growth and promote job creation, Portugal's responsiveness to structural reform recommendations was ranked among the best when compared to other restructuring countries (OECD, p. 3). Nonetheless, Portugal's total of €738 billion in public and private debt (Minder) led to a number of budgetary cuts, including reductions in education and R&D.

The austerity measures directly affected the education system in several detrimental ways. For instance, according to André Levy, a research fellow in the Eco-ethology Research Unit at the Higher Institute of Applied Psychology, there were decreases in the number of awards by the FCT for Ph.D. and postdoctoral fellowships. He claims there was a 40 percent reduction from 2012 to 2013 and a decrease in fellowship funding of 16.5 percent in 2014 compared with 2013 (Levy, February 2014). Additionally, Professor Chagas

Lopes (p. 18) noted that unemployment and job instability for citizens holding advanced science degrees, including the M.S. and Ph.D., have consistently increased, adding even further stress regarding job security. Although effects of austerity on the education system are to be expected, the goals for higher education in Portugal, set in 2010 by Europe 2020, are not reflecting the reality of the situation. The attainment of such goals is unlikely. Currently the higher education goals are still considered a reach (Chagas Lopes, p. 20).

It is important to note that the decreases in available governmental educational funds have a further direct effect on R&D because a majority of the research currently conducted in Portugal is done in public universities or corporate research units with strong ties to universities. Funding for science generally comes from the FCT, with little research done at private universities or in the industry sector. Even after a clean exit was made from the bailouts in 2014, economic cuts are still being implemented with dramatic implications for the development of S&T. In a personal interview with André Levy, he mentioned the hardships faced in 2014 as a researcher attempting to gain funding for projects. For example, the FCT and the European Science Foundation re-evaluated research units, causing many research institutions to reorganize existing research plans in attempts to qualify for the new funding standards. Unfortunately, more than half of the existing research units will "receive no funding or so little their demise is almost guaranteed" (Levy, October 2014).

This decrease in educational awards was compounded by reductions in R&D funding. Although Portugal defined ambitious R&D goals in 2010, including the target minimum set for 3 percent of GDP investment in R&D (Chagas Lopes, p. 14), the crisis further worsened the conditions for achieving scientific advancement. Not only was a decline seen in R&D investment and in public funds since 2011 (OECD Science…, p. 364) but also numerous policies for R&D were considered inadequate and insufficient (Chagas Lopes, p. 18). Businesses suffered from decreased sales and cumulative losses, and therefore many either delayed or cancelled outright future R&D investment plans and limited potential partnerships with other institutions, thereby directly slowing the integrative knowledge flow (Chagas Lopes, p. 20).

Research budget reductions occurred at three levels, including budget cuts for direct funding for people, specific research projects, and research units (Levy, October 2014). The decreases in investment are estimated to have serious long-term implications. Indeed, the effects are already being seen by people who have first-hand experience and knowledge of Portugal's financing of science, especially during the bailout. At the onset of the austerity there was a glaring reduction in the number of scholarships awarded (Levy, October 2014). Allowing for lag time, the full extent of austerity on R&D in the scientific field will be seen soon. While those currently in the scientific field in Portugal are working hard to continue making strides to publish research and gain future funding, the country is losing many of its highly qualified young people, who are forced to leave because of the lack of jobs. This loss of investment in human capital jeopardizes the growth of Portugal's knowledge-based economy. Portugal's proportion of highly educated emigrants was the fifth highest proportion in Europe in 2011 ("World Migration in Figures," p. 6), and the continued inability of the Portuguese people to receive scholarships subsequently will further emigration, causing damage that will be evident for years to come (Levy, October 2014).

The negative effect of the difficult economic times has led to a reduced investment in education, R&D, and innovation. Such drastic reductions in research-related funding will have both social and economic effects. There needs to be a consistent flow of knowledge, through R&D to innovative industry settings; but due to austerity, there are missing links when comparing supply with demand (Chagas Lopes, p. 8). Solutions to help repair the links include reducing unemployment of the highly educated and preventing mass emigration of well-educated citizens through sustainable investment and political policies enactment.

Innovation as a Solution

It is imperative for Portugal to utilize its resources to boost productivity and global competitiveness and combat the reductions in support for S&T. Although both public and business investments in R&D and innovation have suffered since 2009 (OECD, p. 31), Portugal's potential for innovation is still high due to its prior investment in education. For example, in 2014 Portugal's public research sector performed highly in the category of S&T articles published in leading international journals (OECD, p. 31). Leveraging the relatively strong public education sector, Portugal has the opportunity to change its economic fortunes through innovation sparked by advancing knowledge flow. A call for action is appropriate, one that acknowledges corporate R&D investment as weak and expands government support of R&D beyond the universities into industry. Just as Portugal did in the early 2000s for the education sector, investment is necessary to motivate businesses to accept R&D as their own responsibility.

Portugal used to focus its innovation on support of the improvement of products and processes originally developed outside the country (Molero, p. 230) rather than developing new products and services of its own. However, Portugal's industry currently has the ability to take innovation to a new level, if provided with appropriate incentives. Considering the absence of resources and the unwillingness of the private sector (Chagas Lopes, p. 9), this investment must first come from the government. Through direct investment geared to ensure the creation and sustainability of a wide base of innovation, government incentives offered for private industry will enhance innovation, for those willing to take the risk. According to Professor Chagas Lopes, well-organized and maintainable government intervention is necessary to help increase the caliber of human resources and ensure their placement within the industrial job market (p. 9). Through such support there would be increases in the returns of investment of knowledge and skills to industry (Fernandes et al).

The Organisation for Economic Cooperation and Development (OECD) suggests that competitive behavior in Portugal's industries and professional services can be improved and the return on R&D investments, both from past and future investments, heightened through a fostering of innovation and a push for entrepreneurship (OECD Science.... p. 364). Although strengthening business innovation will be a major challenge for the country, earlier investments in S&T education provide the necessary level of a highly skilled R&D workforce. Past government-funded investment in education now needs to be aligned with industrial R&D opportunities coordinated with potential market opportunities. Further investment will aid the research scientists looking for work to find useful careers, while industry will prosper by utilizing the highly educated in R&D opportunities (Schwab, p. 30). If investments in these fields are not made soon, current emigration levels will only worsen. To decrease the amount of brain drain Portugal is experiencing, government action is needed to secure careers for the highly educated and to promote entrepreneurship. Combatting the dangers of excessive professional emigration and fostering economic sustainability will be made through linking high education training strengths to industry opportunities with the greatest potential for productive innovation.

Systematic and Structured Investment Suggestions

Portugal's ranking for innovation within the EU-27 over the past ten years has increased significantly; however, there has been little in the way of added value or job creation (Chagas Lopes, p. 12). Thus, it is important to ensure that investment is dispensed in areas where human capital exists, demand is high, and relevance to industry is apparent. Aligning past academic degree support with large industrial sectors that can most profitably benefit from advances in R&D will be the important first step.

At the time of this writing, Portugal's industrial focus has been on manufacturing or improving existing product line technology because of lower-cost production rates compared with other countries. Although this market contributes to the economy, a more developed R&D-based industrial sector can

help the economy flourish further. Portugal's industrial sectors that can benefit from enhanced R&D include companies in both traditional and nontraditional sectors: textiles, wine, footwear, ceramics, paper, wind energy, wood, and cork.

Business sector makeup must be taken into account when considering R&D infrastructure and innovation potential. SMEs comprise a large percentage of Portugal's business sector, which complicates expansions of R&D. Considering the limited resources of individual SMEs for investment in R&D, there is a need for government funding of research positions in support of innovation, which educated and qualified workers can fill. Beyond the individual level, R&D infrastructure could be planned collectively to develop wider access to resources through the establishment of S&T parks and enterprise incubators (Chagas Lopes, p. 6). Prospects for collaborative partnerships exist among SMEs, utilizing their highly skilled employees to drive growth by fostering partnerships and allowing for acquisitions in which investors can gain access to new markets (Alves, p. 2).

Another area within Portugal's R&D infrastructure that must be improved involves how data about research and innovation are collected, quantified, stored, and made available. Among the specific problems is a need for greater standardization and for enhanced specificity. Currently such information is often categorized with broad definitions that make it difficult to comprehend and analyze correctly how much progress has been made in specific industries or contexts. For example, data can be quantified based on a measure of the proportion of sales caused by innovation. Because the specifications of innovation are not stated, any and all types of process and product improvement are potentially included; therefore, the values measured may be inflated based on the broadness of the category (Molero, p. 229). Quantifying success with more defined metrics will enable a better rubric for understanding advances in, as well as constraints to, innovation sparked by education contribution and research support.

Lastly, an area with a strong need for improvement to help enable innovation includes changes to governmental and industrial policies. Although many qualified employees currently work in public universities, it is time for the industrial sectors to create additional job opportunities. Because of the lack of private sector R&D, it is up to the government to motivate businesses to participate more actively. Policies geared to ensure the creation and sustainability of a wide base of innovation might include creating research parks, as mentioned previously, or providing financial incentives (Chagas Lopes, p. 6). In light of the positive effects that occurred in 2005 with the On the Spot Firm program, the government might similarly incentivize companies to include R&D facilities on site. Furthermore, as with tax incentives for students entering Ph.D. programs (Louët), the government could consider applying similar measures for companies dedicated to establishing their own R&D facilities. In fact, Portugal has already moved in this direction. According to Carlos Lobo, an Ernst and Young Tax Leader Advisor, "Start-ups may effectively pay no tax during the first years of activity by offsetting the tax credits derived from investment projects. SMEs also have available notional interest deductions and reinvestment of profits reliefs" (p. 32). These incentives, along with other provisions, are intended to facilitate the development of existing companies' R&D to promote innovation.

Case Study: Biotechnology

In order to create jobs for qualified researchers, enhance R&D, and drive innovation, the suggestions (discussed previously) can be applied to numerous sectors within the industries of Portugal. Biotechnology, the application of a combination of biological systems and technical elements to make or modify products or processes, is one sector that flourishes with improved investment in R&D. According to the National Innovation Plan (2005), biotechnology was identified as one of six priority areas that contribute to the creation of innovation platforms ("Industrial Biotechnology in Portugal," p. 3) and since then, this area of study has grown.

Expanded education in biological science and engineering areas has led to profound changes in scientific capabilities, which

in turn have enhanced the biotechnology industry. Much of the effort has focused on research at the university level through the creation of research centers in the life sciences. In addition, private funding has supported independent research institutes, including a donation from one of the richest men in Portugal's history, the late António de Sommer Champalimaud. His donation went to the creation of the Champalimaud Centre for the Unkown, an international biomedicine research facility. Other effects of increased education in the sciences and the availability of numerous Ph.D.-trained researchers include the strengthened reputation of Portuguese research, as is evident through a gradual change in companies' investments. Companies once focused on production and manufacturing are becoming more interested in knowledge production, a change that will enhance the current economic situation (Portela, p. 39).

One example of increased corporate biotechnology R&D can be found within the pharmaceutical industry. Bial, the largest of five pharmaceutical companies in Portugal, instituted an R&D program in the early 1990s, which has resulted in the company ranked second among all Portuguese companies to invest in R&D (Portela, p. 39). As a result of this investment, Bial was able to create and distribute the first Portuguese-based medicine, Zebinix, an anti-epileptic treatment, to be sold in other countries including the United States. Additionally, Bial was successful at securing the first license for Parkinson's disease in the Japanese market (Portela, p. 39).

Pharmaceuticals are not the only industry that can grow from increases in R&D in biotechnology. Such R&D is also applicable to agricultural and other health and medical applications. Noting Portugal's main exports, I believe that agricultural businesses, including wine production, olive oil production, forestry and paper, and cork, can gain greatly from biotechnology research. Investment in the agriculture and the food industry sectors' BERD with a 3.5-fold increase between 2002 and 2007 ("A New Landscape…," p. 12) has aided in successful applications of biotechnology. Additionally, health technology was able to grow greatly through biotechnology research. For example, technology-based start-ups increased the number of new firms in the medical devices sector by 6 percent from 2002 to 2007 ("A New Landscape…," p. 12). Also, the nonprofit Health Cluster Portugal was founded in 2008 to help consolidate R&D infrastructure and was successful in creating alliances between more than 1,000 scientific research entities (Portela, p. 39). These investments and developments, along with university training and changes in R&D infrastructure, enabled biotechnology to flourish in the first decade of the 2000s. This groundwork, even when faced with economic turmoil and austerity, enabled Portugal's biotechnology businesses to develop strongly, indicating biotechnology's high economic potential (Portela, p. 39). The positive growth of exports of health-related goods and services seen in Portugal during the hard economic times suggests that knowledge flow was successful in the biotechnology field.

Although this increased investment in biotechnology has led to great improvements, more can be done. Solutions need to be developed for ways to integrate biotechnology-related research to industry. Continuing support for people through supportive investment, development of taxing policies, and the creation of more research facilities will foster innovation. Ensuring knowledge flow will help Portugal become more competitive and innovative in the biotechnology sector. However, the changes made to date with respect to biotechnology have resulted in a greater range of products, advancements in technology, and more exports based on a heightened attractiveness of Portuguese production (Portela, p. 39). Following a similar protocol for other areas of R&D will enable future growth in numerous Portuguese industry sectors.

Conclusion

Evidence of positive knowledge flow synergy clearly points to human resources as the most essential factor in technology growth, because technology is only as good as the people who understand it. Graduates who received degrees in S&T at the start of the century can now aid in the return of economic stability, using resources dedicated for the improvement of S&T within the business

and industrial sectors. Despite remaining weaknesses, advances have been made in recent years that have fostered significant improvements (OECD STI Country Profiles). To continue fostering innovation, a systematic and sustainable approach must be set in place. It is important that Portugal create an action plan to promote further innovation.

This action plan should include, first of all, government investment in industrial S&T areas where educated people can work, products and services demand is high, and the market is relatively stable and resistant to effects of a fluctuating economy. These investments may be made through an increase in funding allocated for R&D projects, with decisions made through a resource allocation board, like the FCT, but focused on industry applications. Additional actions that Portugal's government may want to consider include tax incentive policies for companies that accomplish a set number of R&D projects and tax breaks for private individuals who are willing to donate to S&T fields. The establishment of a program to help with recent graduate placement in industry positions can help combat the brain drain of Portugal's highly educated. The government may also consider creating a fund meant solely for joint R&D projects to foster more university and industry R&D collaboration. To promote entrepreneurship, the government may want to evaluate current barriers to entry to the marketplace and to consider developing more research parks to combat SMEs' limited resources and thereby foster collaboration. Lastly, an established methodology for data collection when defining innovation through R&D would help monitor the trends and growth in the industry. To combat recent reductions in support for S&T, both in terms of education and support of R&D due to economic turmoil, it is important for Portugal to utilize a significant portion of its resources to boost productivity and global competitiveness. Current objectives set by the 2010 publication, Europe 2020, include a goal of 3 percent of GDP to be invested in R&D (Chagas Lopes, p. 14). Although the actual percentage decreased from 2009 (1.58 percent) to 2013 (1.36 percent) during austerity ("Progress towards 2020 Targets"), these suggestions for policies and investment strategies, if actively pursued and sufficiently funded, will go a long way toward reversing the detrimental effects of austerity measures, help to achieve the defined goal, and promote knowledge flow for growth in innovation and economic well-being.

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