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viewpoint

Integrating new countries into the European Research Area

Croatian reflections on joining the European Union

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The post-Cold War era is witnessing more European nations joining the European Union (EU). This influx of new members necessitates, *inter alia*, a re-examination of the policies that guide their integration into the common European Research Area (ERA). The basic premise of these policies is—or should be—axiomatic for Europe's further development: the continent cannot afford scientific illiteracy or underdevelopment in any region. The reasons are self-evident: at a minimum, scientific research is needed to nurture scientific literacy as the basis for technological progress and to increase general literacy; at most, it is a force that enriches, humanizes and ennobles. Consequently, claims that scientific research is too expensive for countries with emerging economies, or that these countries are unlikely to make major contributions to the scientific and technological progress of Europe, are no longer relevant. The pertinent question, then, is how to maximize its creative potential across the entire ERA.

An important obstacle to this process is the historic legacy that still affects Eastern European countries. In the twentieth century, the whole continent suffered from the self-inflicted wounds of two world wars, and the effects of the Nazi and Communist ideologies. After the Second World War, most Western European countries experienced rapid democratic, economic and scientific growth, but Eastern Europe struggled under Communist totalitarianism. One legacy of Communism is its economic failure, and the consequent trailing behind the West of scientific infrastructure and educational systems. The damage is larger still, as it reaches the core of society, particularly through the loss of the middle class and elites. Croatia, for example, lost large segments of its middle class—Jews, Croats and others—during the Second World War and the Communist purges that took place immediately thereafter. Thus, in less than a decade, the social fabric of Croatia was profoundly changed (Bejaković *et al*, 1990; Gelo, 1987; Gelo *et al*, 2005).

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This loss of the middle class continued when the former Yugoslavia opened its borders in the late 1950s to allow emigration. Large numbers of educated workers, including scientists and physicians, subsequently moved to Western Europe and North America. The Homeland War from 1991 to 1995 brought Croatia back into the Western orbit—true to its character and history—but did not stop this exodus. The loss of human potential is apparent at all levels of leadership, including education, science and technology (Kaase *et al*, 2002). It will take time and the right environment before a new generation of leaders in these fields emerges. Our thesis is that the integration of Croatia and other Eastern European countries into the ERA is a prerequisite for creating an environment that is conducive to nurturing leadership in science and education.

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Inadequate funding and diminished competition in Eastern Europe during Communism widened the scientific gap with democratic nations, even in countries—such as the former Czechoslovakia or the eastern part of Germany—that were industrially developed when they entered the Second World War. In these and other Communist countries, science was stripped of its elite status (Salzburg Seminar, 2000). Ideological concepts—such as socialist self-management, as in the former Yugoslavia—further hampered the ability of the scientific meritocracy to set research priorities, and to establish criteria for the allocation of resources and scientific promotions. As a result, the new and aspiring members of the EU suffer to different degrees from outdated scientific infrastructure, inadequate mechanisms for evaluating research projects and allocating research funds, poor internal and external competitiveness in science, lack of a critical mass of quality researchers, insufficient efforts to create and maintain national centres of scientific excellence, and, consequently, an often inadequate ability to provide up-to-date scientific education (Becker *et al*, 2002; Hankiss, 2002; Sztompka, 2002; Tamas, 2002).

In 2003, Croatia allocated 1.14% of its gross domestic product (GDP) to science—0.9% came from public sources and the rest came from the private sector—compared with an average of 1.6% in countries belonging to the Organisation for Economic Co-operation and Development. This level of funding leaves science at the relative periphery of society, and leaves scientists with inadequate resources and unattractive financial compensation for their work. Thus marginalized, science loses its impact, prestige and significance (Becker *et al*, 2002; Hankiss, 2002; Sztompka, 2002; Tamas, 2002).

The weakness of science in post-Communist countries has been partly blamed on the fact that the lion's share of research funding comes from public, rather than private, sources. The source of the funds, however, is less relevant than the mechanism of their allocation. In Croatia, funds have been *de facto* allocated per capita, often with insufficient regard for the quality of the project. In addition, political interests have been a problem when allocating grants and infrastructure. One underlying reason is that almost all scientists—except for the few employed by industry—are tenured public servants on a government payroll. This makes dismissal for inadequate performance legally, socially and politically difficult. Consequently, even a scientific leadership operating in the best interests of the country cannot ensure that the best researchers are promoted and awarded.

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Fig 1 | Schematic map of Croatia showing the main centres of higher education.

Croatia (Fig 1) is a country of about 4.5 million inhabitants, of which some 6,500 hold a Ph.D. in science or the humanities and are currently employed—that is, not retired. These figures, however, can be deceptive, as the number of productive scientists is markedly smaller. Between 1991 and 1996, as many as 1,160 Croatian scientists did not publish anything—the least productive being those aged 54–62 years (Klaić & Klaić, 2004). In subsequent years, only about 50% of scientists published at least one paper in an international journal. Fewer than 2,000 individuals with a Ph.D. qualify as active scientists according to the general criteria of productivity, which are still less restrictive than, for example, the criteria for obtaining peer-reviewed funding in Western Europe or North America. Thus, when applying the criteria of productivity, the official number of scientists must be scaled down by a factor of three.

With the introduction of the market economy, the role of the private sector in integrating new EU members into the ERA has come under scrutiny. This has been prompted by the growing realization that current and projected levels of public funding will not be enough to sustain the desired growth of science and science-based education across the ERA for the foreseeable future. Thus, private funding of science and education is increasingly important.

In the absence of significant private philanthropic foundations, alternative and/or complementary funding must come from industry. Generally, companies fund clearly defined research projects—including those in basic science—that have a potential for profit. In industrially developed countries, a large fraction of scientific and commercially successful innovations stem from industrial research. The argument for encouraging the business sector to participate in supporting public research is further buttressed by the diminishing distinction between pure and applied science. The narrowing gap between discovery and application therefore encourages more direct investment from business into science (de Solla Price, 1982; Mayr, 1982).

> Scientists from the new EU member countries have high expectations for their colleagues in the West and, in particular, for international scientific organizations

There have been various attempts to design models of effective research funding that could guide political decision-making. One such model, which is known as the endogenous growth theory, predicts that the profit from investment in science increases exponentially with the amount of investment (Aghion & Howitt, 1998; Weil, 2005). Despite the appeal of such mechanistic models, their predictive power is qualitative at best. The ability to turn discoveries into profits depends on many more factors than discovery alone. In addition, discovery is unpredictable, and often depends on unique and individual circumstances. This leaves policy-makers with the self-evident truth that the more science they fund, the better off they are in the long run. Fortunately, the success of science-based industries in countries such as Israel, Ireland and Finland, and, more recently, in the Far East, is evidence enough to silence even the most vociferous critics.

To attain the level of scientific productivity found in Western Europe, new and aspiring member states must increase both public and private spending on research, while also making use of available EU resources, such as the Framework Programmes. To receive funding from these programmes, the challenge for new EU members is to become sufficiently competitive in terms of scientific quality; however, the rest of the EU faces the same challenge. If the goal is—as stated above—to reap the maximum benefit from Europe's scientific talent, the EU must help to bring the lagging countries up to a standard where they can successfully compete for funds with more scientifically advanced nations. In other words, European politics, the economy, research institutions and individuals must help their colleagues in the new member countries to reach the European standard. Within this context, any concerns about a short-term loss of investment—as it will take time for the new EU members to catch up—are as myopic as they are detrimental.

In general, a country's scientific output is proportional to its economic strength (de Solla Price, 1982; European Commission, 2005; Mayr, 1982). Countries that invest 2% or more of their GDP in science maintain a high level of scientific production (European Commission, 2004a). To reach this level, the new member states must increase their investments in research to at least 3–4% of their GDP for some time before seeing results. It is worth emphasizing, though, that no amount of money can replace a system with clear lines of responsibility, and honest and competitive evaluation, in which careers are built on the basis of scientific merit. It will take time both to gain from such an investment and to build a system of evaluation, promotion and allocation of funds that rewards the best and most productive scientists. Are there ways to catalyse this process, and to help the new and aspiring member nations to reach the desired standards swiftly?

Fig 2 | The statue of Ruđer Bošković (1711–1787) by Ivan Meštrović located on the grounds of the Institute in Zagreb that bears his name. Among the many accomplishments of Bošković, who was a Jesuit philosopher, scientist, engineer, astronomer, diplomat and poet, is a theory that encompasses attractive and repelling forces between material points, and thus anticipates nuclear forces. Bošković is credited with the idea of the force field, a contribution to the development of the Legendre principle of least squares, as well as a design to repair St Peter's Dome in Rome, Italy, and many others. He was a member of many learned societies, including the Royal Society of London, the St Petersburg Academy and the French Academie Royale des Sciences. He founded the astronomical observatory in Brera near Milan, Italy, and was the Director of the Optique Militaire de la Marine Royale de France.

New member states require different degrees of local and international intervention in different segments of the scientific realm. First and foremost, a renewal of human potential is required at all levels. This is a generational process that runs alongside the overall social renewal to build up a new middle class and elites. In this regard, promising students and young scientists deserve considerably more support than they have received so far. In Croatia, a frequent obstacle to scientific careers is the difficulty of relocating, which is partly due to the scarcity of affordable starter homes. Consequently, many young professionals continue to live with their families while trying to solve the housing problem. Compounded by the unfavourable career prospects in science compared with other fields, there has been a concomitant decline of interest in science and a continuing brain drain.

To mitigate some of these difficulties, Croatia has introduced scholarships to support the best 10% of its students. These young people can receive three years of financial support while studying for their M.Sc. and an additional four years of support for their Ph.D. studies. The best and most motivated can enjoy another three years of support for postdoctoral studies abroad. Although we hope that this mechanism will help to rejuvenate the youngest cadre of Croatian scientists, we are facing a more serious problem at the level of senior scientists. There are few leaders with sufficient scientific credentials, international experience, and an understanding of business and philanthropies, who can formulate visions that are bold and realistic at the same time.

In the past decade, Croatia adopted its National Scientific Research Programme, and a science and technology policy for the period until 2010. The policy calls for new funding instruments and research programmes, as well as new rules and procedures for the allocation of research grants. In October 2005, Croatia signed an agreement on full scientific cooperation with the EU, which opens the way for Croatian biomedical scientists to participate in the EU Framework Programmes, but also confronts them with the aforementioned competitive challenge. However, raising the new member states to the scientific standard of Western countries is a task not only for the EU but also for scientific organizations, which must seize this unique opportunity and support their colleagues in Croatia and other accession countries as they enter this competitive environment.

The Croatian National Scientific Research Programme will also stimulate the concentration of domestic resources and investments into centres of excellence, and complex research programmes (Čavlek & Švarc, 2002). The scientific authorities in Croatia welcome and provide an opportunity for foreign scientists to participate in these programmes, particularly as reviewers. In this way, they could further strengthen the limited number of

Fig 3 | Rovinj in Istria is the site of the Ruđer Bošković Institute Centre for Marine Research. Dating from the late nineteenth century, the centre was part of the Zoological Station of the Berlin Aquarium. During the turbulent twentieth century, the institution was administered by the Kaiser-Wilhelm-Gesellshaft, Reale Comitato Talasografico Italiano, and the Yugoslav (now Croatian) Academy of Sciences and Arts in Zagreb. © Milan Babić. With permission from the Croatian National Tourist Board.

existing centres of excellence, such as the Ruđer Bošković Institute in Zagreb (Figs 2,3). These institutions are home to the most successful Croatian scientists, who make up about 1% of Croatia's scientific workforce, and are often better than the global average in terms of their productivity and the impact of their work.

There is no easy way out of this conundrum, but bringing in international leadership experience to Croatian scientific institutions is an important first step. Particularly valuable is the establishment of international advisory bodies to review local institutions, programmes and their leaders. Although such bodies can have important roles in areas that are devoid of a critical leadership mass, legal restrictions often preclude them being endowed with responsibilities that are typical of boards of trustees, such as the appointment of senior scientists. Hopefully, the alignment of our national labour laws and practices with those of the EU will mitigate this problem to some extent.

What can the new and aspiring EU members do to foster scientific growth? The ongoing integration of the ERA offers enormous opportunities for collaboration and cross-fertilization between the more and the less scientifically developed parts of Europe. These opportunities include the following: participation in international, or preferably European, evaluation processes for scientists, research projects and research institutions; further development of higher education in line with the 1999 Bologna Declaration (EUA, 2001; European Commission, 2004b; European Ministers of Higher Education, 2001; Haug & Tauch, 2001; Reichert & Tauch, 2003); nurturing scientific leadership through exchange programmes for mid-level and senior scientists; stimulating the return of expatriate scientists; educating young scientists at leading institutions, such as the European Molecular Biology Laboratory (Heidelberg, Germany); and establishing internationally relevant centres of excellence.

This is a massive undertaking. Scientists from the new EU member countries have high expectations for their colleagues in the West and, in particular, for international scientific organizations. Despite being positioned outside the general EU politics, these organizations can become an effective instrument of European scientific policies. Together, we must foster the better use of existing mechanisms and the creation of new mechanisms as circumstances demand, to put the vast human and material resources of a united Europe into the service of European science and society. In integrating European science, we are empowered by the magnitude of this historic opportunity—perhaps akin to the Renaissance—to contribute to the creation of a new European culture and identity across the whole continent.

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