Problems of Inequality in Science, Technology, and Innovation Policy

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Executive Summary

National leaders in science, technology, and innovation policies face two kinds of challenges of inequality: the competitive challenge of closing gaps in economic performance, and the social cohesion challenge of sharing the benefits of economic growth broadly. This paper describes the relationship between the two; articulates how the social cohesion challenge is currently being addressed in policies at national, European, and international levels; and suggests how those efforts might be strengthened.

A dominant concept in science, technology, and innovation (STI) policy is the Knowledge Economy, which focuses on science-based industries and turning knowledge into profit. Narrow high-tech focussed frames load the dice in favour of those particular advanced knowledge economies which are best placed to succeed in these particular industries, and restrict the range of policy options and strategies for coping in the knowledge economy. Emphasizing diversity and divergence may open up for policies predicated on specific systemic qualities and assets that are not easily identified in single and/or aggregated benchmarks, nor effectively addressed through trans-systemic transfer of best practices. Innovation has become increasingly market based. A shift has taken place in the relative roles of public and private R&D performers and funding sources, to the detriment of the public. The creation of "level" playing fields in areas like intellectual property policy may cement the competitive advantage of the already strong players of the game.

The social cohesion approach focuses on reducing inequalities in order to spread the benefits and costs of technological advance more evenly, creating win-win situations. We take reducing inequality to be a step towards "social inclusion" and "social cohesion," a general policy goal in many countries. At national level, human resource policies are often aimed at reducing inequalities in capacity, through programs that recruit women or members of under-represented ethnic minorities into science and engineering careers or by building institutional capacity in disadvantaged communities. Innovation policies generally respond primarily to the competitiveness agenda, but can also be directed in pro-poor ways by putting jobs front and center and focusing on pro-poor technologies. Research and regulatory policies often become re-distributional through the active participation of civil society groups. At European level, a tension exists between concentrating STI resources for competitiveness and spreading them around the region to achieve cohesion. At international level, while intellectual property laws are creating advantages for countries with strong STI capabilities already, there are many organizations, including the development banks, United Nations, foundations, and non-governmental organizations, that put significant effort into directing innovation toward human needs, empowering women, and activating communities to solve their own problems actively and demand accountability from the public sector.

We conclude that there is an emerging social cohesion agenda in science, technology, and innovation policy, but that there is ample room to expand its scope and sharpen its policy and program tools. Our research over the next few years will explore the concepts and pathways more deeply, to inform that growing agenda.

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1 Introduction

The practice of science, technology, and innovation (STI) policy is worldwide. Ministers of Science, Industry, Health, Agriculture, Education, and Defense are all involved. Heads of major public research laboratories participate, along with university leaders, managers in private firms, regional development authorities, and a wide range of non-governmental groups. Government decision makers in science and technology intensive issues spread even more widely, for example through trade, international affairs, and transportation agencies, as well as the judiciary. These functions exist in countries from the smallest to the largest, and from the least to the most affluent.

The way these people approach the STI aspects of their jobs is shaped by many factors, including their education and training; what others in their positions have done, before them and in parallel with them; and the challenges posed by the specific environments of their institutions.

Often those challenges include inequalities among nations, institutions, and regions. The leaders are almost always expected to be doing something about those inequalities, usually increasing performance to close a gap, or in the few cases of those currently at the top, increasing performance to maintain the gap. We might call these the competitive challenges of STI policy. But at the same time, leaders in the world of science and technology are challenged by internal inequalities: between rich and poor, men and women, dominant and disadvantaged ethnic and religious groups. The barriers and gaps between these groups limit the effectiveness of efforts to become more competitive, because each one of them leaves talent on the wrong side of opportunity and saps the energy of the nation, institution, or region. Reducing these gaps – the challenge of social cohesion -- becomes part and parcel of the job of improving performance.

Current concepts in STI policy and management offer many insights into the competitive challenges, but fewer into the social cohesion challenges, and almost none into the interaction between the two. The goal of this paper is to describe where these various inequalities fit in current practice in this area and to point to places where more attention should be devoted to them, not just for the sake of equity, justice, and social cohesion, but also for efficiency and effectiveness.

The paper will concentrate on national, European, and international policymaking. In the first section of the paper, we argue that too narrow a focus on high technology, research and development (R&D), and strong intellectual property protection – a set of strategies we will call "the competitiveness agenda" – favors incumbents over challengers broadly, not just between firms and countries but also across all the divides. A broader conception of innovation, which we will call "the social cohesion agenda," points to more sources of growth and prosperity, but has not been put into practice as widely as the competitiveness approach. In the second section of the paper, we point to places in STI policy at national, European, and international levels where the Social cohesion approach is already in operation or could take root.

2 The Knowledge Economy Policy Paradigm

> *Whatever else in the world we know survives to the year 2000, [the disparity between rich and poor] won't. Once the trick of getting rich is known, as it now is, the world can't survive half rich and half poor. It's just not on.* [1]

While the optimism of this half-decade old statement of hope and unconditional confidence in the power of science and technology in overcoming poverty and inequality has been unfulfilled, it resonates again strongly with current beliefs that science and technology *is* "the trick of getting rich", and will have to play essential roles in efforts to alleviate poverty and unacceptable inequalities. Many subscribe to the assumption that growth and development in developing countries and regions are contingent on the building up of qualified manpower and acquisition of technological capacity to exploit effectively S&T for economic growth and social development. In the hindsight of 50 years with limited and uneven achievements, it is, however, impossible to embrace the unqualified optimism of the quote that S&T is in itself a guarantee that poverty and extreme inequality will inevitably, sooner or later, be abolished. If S&T have brought these goals within reach, we have during these decades learned in many ways that the availability of science and technology as such is not a sufficient condition for success. It is as much the *ways* they are used which determine to what extent they may generate wealth, overcome underdevelopment and alleviates poverty.

2.1 Main features of the paradigm

The concept of the knowledge based economy has achieved extensive success as both explanatory and normative framework for explaining success in the contemporary economy as primarily dependent on investments in knowledge and technology. The achievements of some particularly successful countries such as the USA, a number of European countries, Japan and other Asian catch-up economies provide models and guidelines for others to emulate. To be able to catch up with the developed world, poorer and less developed countries are advised to invest in R&D, technology and knowledge.

Both national governments and various international bodies such as the European Union, the World Bank, the IMF, the OECD and others now subscribe to the notion of a 'knowledge economy'. Over the last decade, a general conviction has emerged and taken hold that this notion should frame and guide policy development of policies for growth and development, in developed as well as in less developed nations. By defining knowledge as an increasingly important 'strategic resource' in modern societies, developing effective policies for education, scientific research and technological development and R&D, are seen to become increasingly important. The progress of societies and the success of their economies will hence depend essentially on their capability to develop and implement effective policies for the production, distribution and application of knowledge. Such policies for knowledge are also generally reconceptualised as and embedded in broader policy frameworks for knowledge-based or knowledge-driven *innovation*, since the effective harnessing of the socio-economic benefits of knowledge is seen to depend essentially on specific capacity and competence

[1] Snow, C.P. (1959) *The Two Cultures*.

to *translate* knowledge into products and services that are novel, useful and commercially viable.

The notion of knowledge economy is predicated on a definitional hierarchy of types of knowledge, within which advanced, research-based scientific and technological knowledge is placed at the apex. The knowledge-based economy is defined by the "fusion of science, technology and the economy" (Daniel Bell), through which science and science-based technologies have become immediate sources of innovation and growth: "Scientific research, technological development and innovation are at the heart of the knowledge-based economy".[2] It is innovation based on advanced scientific and technological research which sustains the accelerating rates of innovation and technical change which characterize advanced economies.

The ever-increasing role of innovation based on advanced scientific and technological research has created "new rules of the game" [3], and learning to master and play by these rules determines the divide between those who will become winners and losers, pioneers and laggards in the epochal transitions that are underway. Key parts of that game include the implementation of policies to:

> (1) … support, develop capacity and harvest the commercial benefits of research and development (R&D), in particular in high-technology fields (ICT, biotechnology, nanotechnology) which drive development in research-intensive industries and services, seen to be the most fast-growing and profitable in the emergent knowledge economy;
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> (2) … support the commodification of knowledge, i.e., the transformation of knowledge into immediate economic entities (patents etc) by which knowledge becomes value that can be privately appropriated and an "intangible" capital asset in its own right. The significance of this is particularly evident in the rise of a specific type of knowledge-based firm which has considerable levels of knowledge and intangible economic assets in-house, but few or no saleable products at the time when financing is required. The extension and stronger protection of property rights over intellectual assets − patents, trademarks, designs, copyright – has thus become a hallmark of the knowledge economy.
>
> (3) … stimulate the increase of private R&D, facilitate public-private partnership, and access to public R&D by private firms.

While different versions and definitions of the knowledge economy and society circulate, they have within STI policy contexts achieved stability and coherence through the development and use of a core set of standard indicators of performance and progress in terms of developing into "knowledge economies". This set includes, as developed and disseminated by in particular the OECD [4] and the EU, indicators such as public and private investment in R&D; the R&D intensity of nations (R&D as proportion of GDP), and industries (R&D as proportion of sales); high tech export; output and employment in

[2] European Commission (2004) Science and technology, the key to Europe's future – Guidelines for future European Union policy to support research, (COM(2004) 353 final), p.2.
[3] UNESCO (2005) *UNESCO Science Report 2005*.
[4] See in particular, Godin, B (2005) Measurement and Statistics on Science and Technology: 1920 to the Present, London: Routledge.

high- and medium-tech industries; patents, trademarks and designs; proportion of population with secondary and tertiary education; number of S&T graduates; new products to the market and the firms; level of ICT expenditures and several other ICT-related indicators (broadband penetration etc). These indicators shape and constrain policy formation by providing a set of common standard terms, concepts and measures of performance that are easily translated into policy objectives and targets.

The development of STI policies through general dissemination of these conceptual frameworks and model policy solutions does, however, raise a number of questions. Policy development for the knowledge economy is often understood as a process of dissemination, imitation and convergence, often framed in the apolitical terms of (policy) "learning". This may erase tensions and preclude alternative options that must rather be exposed and addressed at a fundamental level for the development of effective STI policies with social or distributional objectives at their core to become possible. One specific and pervasive aspect of the dominant frameworks is how policies framed in terms of competitiveness invariably emphasize "excellence", concentration and critical mass, pushing back the complementary and equally essential roles in innovation of distribution, diffusion and spillover. These latter dimensions are not only key determinants of innovative performance, but also of specific importance if concerns with inclusion and participation, with wide distribution and general sharing of the benefits of innovation, would become integral to STI policy.

We will review three main issues aspects of prevalent policy notions about the knowledge economy which pertain to our concern with the role of distributional objectives in STI policies. These are, *first*, the issue of the general applicability of the prevalent knowledge economy paradigm: it is not evident that policies that have effectively pursued by some of the now most advanced countries and regions are equally applicable for countries and regions which start out from a lower level of development. *Secondly*, the paradigm may be seen to marginalise and immunize itself to distributional concerns and objectives: while it is recognized that STI policies pursued by advanced countries have undeniably in many cases proven highly effective in terms of their economies' overall growth and productivity, that progress has in some cases been achieved at the cost of rising inequalities in the social distribution of wealth, within the economy in question and/or between that economy and other economies. And *thirdly*, within the increasingly competitive game of global economy, the framework has facilitated the development of stratagems by which the already successful have increased their chances of retaining and consolidating their hegemony against aspiring competitors.

2.2 The general applicability of the paradigm

2.2.1 From high-tech to pervasive learning

Under the auspices of, in particular, the OECD and the EU, mainstream policy conceptions of the 'knowledge economy' have been developed and disseminated which have framed STI policy-making in developed economies and societies for a number of years. Their key ideas, arguments and indicators have thus been developed in response to the opportunities, needs and conditions of already well-developed knowledge economies. It is, however, far from given a priori that policy objectives and priorities, benchmarks and 'best practice' models which may be appropriate for well-developed economies and

effective for ensuring their continued success, are adequate and appropriate for economies and societies beyond the North. [5]

A number of standard indicators emphasize the salience in this framework of the most R&D intensive manufacturing industries. These industries epitomize the knowledge economy: they are extremely R&D intensive; scientific knowledge and research are immediate sources and drivers of innovation; they are fast growing and highly profitable. However, while high-tech manufacturing industries account for a growing share of value added in advanced economies (in particular in the US), they do still not account for more than four percent of GDP, even in the US [6]. Innovation in so-called low- and medium-tech industries remains essential to overall competitiveness and growth in all economies – and will remain so in the foreseeable future. While sophisticated knowledge and advanced technology may be essential in these industries, this is incompletely captured by R&D and high-tech indicators. A narrow focus on R&D intensive, high-tech industries may thus be seen to build on a skewed representation of the overall basis of economic growth and employment. A less high-tech-focused notion of STI policy may be seen to emerge, as the roles of Finland and the US as best performers in the knowledge economy are increasingly being matched by the strong performance of, e.g., Denmark, where growth is largely based on strong innovation performance in low- and medium-tech industries.

The high-tech bias of dominant knowledge economy framings of STI policies may thus also be seen to sustain a narrow conception of how *knowledge* underpins innovation in the "knowledge economy". While knowledge in an immense variety of forms arguably does play increasingly important roles in the modern economy, it does so in the whole economy, drawing on widely diverse forms of knowledge, not only, nor primarily, in R&D-intensive and directly science-based industries. Modern, innovative economies may be knowledge-intensive and based in a more generalised sense than suggested by high-tech biased conceptions of innovation. A broader perspective has, e.g., been proposed, phrased in terms of the pervasive role in the economy of "learning", i.e., the creative and productive recombination of a large number of forms of knowledge, both tacit and formal, experience- and research-based. [7] Thus, the economical role of knowledge is not exclusively based on formal, research-based knowledge ("STI knowledge"), but includes also a wide variety of forms of tacit, experience-based, 'doing-using-interacting' ("DUI knowledge") knowledge. While innovations originating in science-based forms of knowledge are highly important and common, in particular in such R&D intensive industries as pharmaceuticals and ICT, the innovative deployment of STI knowledge is dependent on and embedded in DUI-based forms of knowledge.

While too strongly R&D-biased innovation policies may be inadequate for many developed economies, in particular small and/or resource-based economies where low-

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[5] See, e.g., Joakum Arendt: Building science, technology and innovation policies, http://www.scidev.net/dossiers/index.cfm?fuseaction=policybrief&policy=62&section=363&dossier=13 , and http://www.scidev.net/dossiers/index.cfm?fuseaction=dossierfulltext&Dossier=13

[6] Hirsch-Kreinsen, H, D Jacobson, Steffan Laestadius (eds) (2005) Low-tech Innovation in the Knowledge Economy, Peter Lang: Frankfurt a M.

[7] Lundvall, B-Å (2005) *National innovation systems – analytical concept and development tool*, MS, <http://www.druid.dk/ocs/viewabstract.php?id=603&cf=3>, accessed Sept 2006.

and medium-tech industries pre-dominate, this is *a fortiori* the case for developing economies: "A narrow innovation system concept focusing on the research and development system and on high tech and science-based innovations makes even less sense in the South" [8]. Appropriate and effective innovation policies for less developed economies require a broadening of the innovation policy framework to take into account the diverse ways by which the productive mobilisation and creative recombination of knowledge contribute to innovation.

Narrow high-tech focussed frames load the dice in favour of those particular advanced knowledge economies which are best placed to succeed in these particular industries, and restrict the range of policy options and strategies for coping in the knowledge economy. Within a broader framework, innovation in the knowledge economy can be about the creative mobilization and productive recombination of knowledge generally, in the whole economy, including the less glamorous low-tech, traditional industries which opens up for strategies which are better attuned to the needs and circumstances of economies where initial conditions are such that efforts to develop high-tech manufacturing will predictably be rewarded with meagre success. [9]

A broad approach also indicates a key role in innovation policies of less developed economies for efforts to identify, recognize and mobilize the unique innovative potential of local, community-based knowledge, including so-called 'traditional knowledge'. These and other specific forms of context-bound, experience-based knowledge may be marginalized, neglected and suppressed in R&D-biased conceptions about how knowledge sustains innovation, with highly problematic social implications as to who are qualified to participate in and contribute to innovation processes. They may be mobilized as resources which enhance the distributive end assimilative capacities of these economies and societies. But mobilisation should be different from the appropriation and use of traditional knowledge by modern scientific research, as seen in cases of alleged 'biopiracy'. In such cases neither the research nor its benefits are controlled by these communities themselves, the carriers of knowledge are dispossessed, rather than empowered. [10]

2.2.2 Diversity and divergence

Tensions and contradictions are built into narratives about the knowledge economy through the combination or amalgamation of ideas about the "knowledge economy" and about the "systemic" determinants of innovative performance, as embodied in particular in the concept of "systems of innovation". The wedding of knowledge economy and systems of innovation conceptions forms unstable conceptual amalgams. The shift from classical science, R&D and technology policy to modern, "systems"-based notions of innovation policy is based on the realization that the

[8] Lundvall, B A et al (2002) National systems of production, innovation and competence building, *Research Policy* 31, 226.

[9] Eduardo Viotti, National Learning Systems. A new approach on technological change in late industrializing economies and evidence from the cases of Brazil and South Korea, *Technological Forecasting and Social Change*, 69, (2002), 653 – 680.

[10] On how this as a key objective in STI policies of less developed countries , see e.g. Ariel Nhacolo;Khatia Munguambe & Pedro Aide: Community Involvement in Research Projects in Manhiça: the Case of a Malaria Intervention by CISM, http://www.resist-research.net/cms/site/docs/Ariel_Nhacole.pdf

persistent "paradoxes" of R&D and STI policy are in fact a symptom of overly narrow, implicit assumptions that underpin earlier conceptions of R&D policy. These are based on assumptions that investments in R&D will inevitably and quasi-automatically translate into actual innovations, productivity gain and growth. The concept of innovation policy grew out of the demise of the "linear models of innovation" that is seen to have sustained those assumptions. The scope of innovation policy must be extended far beyond R&D, in recognition that the effective commercial and social exploitation of the innovative potential of R&D and knowledge depends on the combination of complementary assets and competencies and on the configuration of a large number of factors, often with little or nothing to do with R&D as such, that influence innovative performance in complex ways. R&D is, hence, not a sufficient condition for innovation, and innovation policy must transcend R&D policy and address all these complementary assets, competencies and conditions. This requires a mix of policy measures and the synchronization of a range of a wide range of policies (education, industrial, social, ICT…) Moreover, highly effective forms of innovation may involve knowledge in essential ways, without being immediately based on results from R&D. In some economies, such forms of innovation may be far more common and economically more important than suggested by too R&D-focused and high-tech-biased conceptions of innovation.

The implication of "systemic" approaches to innovation policy is that innovative performance is contingent on the "systemic" interaction and complementarity of resources, assets and conditions, not on specific strengths or weaknesses considered in isolation. This dynamic at the "systemic" level is captured neither by single benchmarks, nor by their simple aggregation. While policy approaches predicated on benchmarks and best practice creates a dynamic of convergence pull on policy development and learning, systemic approaches also open up for the possible success of widely divergent configurations of policies, assets, resources and conditions. Emphasizing diversity and divergence may open up for policies predicated on specific systemic qualities and assets that are not easily identified in single and/or aggregated benchmarks, nor effectively addressed through trans-systemic transfer of best practices.

If the innovative capacity of innovation systems is defined in terms of capacity to mobilise and recombine knowledge (including traditional knowledge or context-specific competencies or assets) in a productive way, that capacity is not only or primarily determined by the productive capacity that is primarily measured by capacity and output of research, or R&D. Innovative capacity is as much a function of the capacity of innovation systems in terms of knowledge distribution and absorptive capacity of the key actors (deriving from the particular local context within which they are operating). R&D contributes to innovation not only as immediate source of innovations, but also by expanding and enhancing the capacity of people, firms and institutions to assimilate knowledge and put it to productive use. This is why it is important that knowledge production is strongly connected to the needs and capacities of local communities through more open innovation systems and knowledge exchange strategies linking researchers and end-users. The more proactive universities in developed economies in cash-strapped situations are already mobilizing themselves in their strategies plans to

develop knowledge exchanges strategies with local development agencies to meet local knowledge needs [11].

While this is an essential contribution by R&D to the innovative capacity and performance of any innovation system, it may be particularly important in the context of less developed economies, where innovation strategies may – according to conventional assumptions – to a larger extent build on imitation and adaptation rather than original inventions. However, phrasing the difference of innovation systems and strategies of developed and developing economies in these terms may, however, to overstate their differences. On the one hand, imitation, adaptation and incremental innovation may – in both developing and economies – be seen to involve innovation and novelty to a higher extent than the terms themselves suggest, while, on the other hand, imitative and adaptive forms of innovation remain, and will remain, a key and dominant feature of innovation also in developed economies.

2.3 Aligning and balancing economic and social policy objectives

From a vantage point where the issues of social distribution of the benefits of STI is a core concern, it is a noteworthy characteristic of prevalent policies predicated on conceptions of the knowledge economy and of innovation systems (as well as their amalgams) that purely economic policy objectives are usually strongly dominant. Productivity, competitiveness and aggregate economic growth form their core policy objectives, while the distributional aspects are marginal, often embedded in 'trickle-down" conceptions of distribution.

While policy approaches that focus on market driven innovation have in many economies resulted in policies which have been highly effective in terms of overall innovative performance and aggregate economic growth, they have also in some cases remained too blind or tolerant to social costs and effects which these frameworks are not designed to take into account. Evidence indicates that the verso of the bright picture provided by economic indicators of a long period of strong, sustained growth, is increasing inequality, decreasing job quality and increasing insecurity. While some have enjoyed large increases in wages, others have benefited less, and many have even suffered an absolute income decline. What has emerged is a "picture of simultaneous growth in wealth and poverty unprecedented in the twentieth century" (Paul Krugman). This has taken place during a period of growth, at least partly explained by many by the success of policies to harness the potential for productivity increase of advanced technologies, in particular ICT. Assumptions based on the "trickle down" model of economic growth, that everybody will eventually benefit from overall growth although not in equal measure, have proven inadequate.

The unequal sharing of the benefits of technology-driven growth has become particularly salient on the global level. The issue of less developed countries' access to essential and affordable medicines has come to epitomize that gap. The issue of drugs for neglected diseases has become a case of "fatal imbalance" ("Campaign for access to essential medicines") between needs and innovation tailored to market demand, and as

[11] http://forera.jrc.es/fta/documents/anchor/HigherEdAnchorPaper.pdf pg 6

such a strong symbol of structural imbalances and mismatches between social and economic objectives of contemporary STI policies.

Innovation has become increasingly market based. A shift has taken place in the relative roles of public and private R&D performers and funders. The proportion of total R&D performed by business has increased in most OECD economies, in some cases dramatically. Public STI policy is less framed in terms of initiative and of directing the R&D towards specific objectives, and more in terms of facilitation and support. "Increasingly, government must become a facilitator, enabling business and consumers to adapt to the demands and opportunities of the new economy" [12]. Innovation policy remains firm-centred, about responding to "the needs of innovation" as perceived by these firms.

The access to essential medicines issue may, thus, be the symbol of one type of "market failure" that has not been addressed in prevalent policies framed in terms of effective market-based STI policies, viz. gaps that have widened between social needs and market demand. A needs-driven STI agenda needs to be developed to balance and supplement the dominant model of market-driven innovation [13]. Needs-driven research policies may be essential for ensuring that substantial public investments in research and innovation are fully valorised by users, by redressing inadequate absorption and take-up of research results. They may ensure that research becomes tailored to the needs of end-users such as local communities and citizens, and not driven, as it now often is, driven by priorities of peer review and publication in international scientific journals. This is particularly the case in developing countries as scientists and researchers who return after studies in developed countries continue to work on research topics which are disconnected from their local context.

2.4 The power politics of STI for competitiveness

Thus, while it may appear from the overall trends as captured by general statistics, that it is obvious that "knowledge" in general, and science-and research-based knowledge in particular, is playing an increasingly central part in emergent "knowledge-based economy and society", it is far less obvious how − and what – policy implications may be inferred from and justified by this general evidence. In the short and longer term, any chosen line of action will benefit some actors and interests and harm others, depending on perceptions of available opportunities and viable options. It is, in particular, not evident how policy objectives to be achieved within zero-sum games of competition and competitiveness, can be generalized to apply to and benefit all. While immediate conflicts of interests may be dampened and alleviated, mechanisms which sustain reconciliatory solutions are not easily found. In their absence, the raw pursuit of competitiveness objectives within global contexts will easily be accompanied by increasing conflict.

One case where such open conflicts of interests have emerged is, for example, for the issue of protection of intellectual property rights (IPR; more in a later section). The linking of IPR issues to trade, as was done for the first time in the Uruguay process of

[12] OECD Policy Brief, Sept. 2000.
[13] Roger Cortbaoui: Science and Technology for and by the Developing World, http://www.resist-research.net/cms/site/docs/resistwrm_programme_rc.pdf

GATT, with TRIPS as the outcome, have made global IPR an issue in which tensions and conflict have become salient. That linkage as initiated by developed countries and the US in particular, has been seen as a move in the development of a global "level" playing field in IPR regulation, which is based on stronger protection and more extensive harmonisation of IPR regulations, and is seen by many to primarily sustain the interests of the most developed knowledge economies.

Another issue where the creation of "level" playing fields may cement the competitive advantage of the already strong players of the game is migration of high-skilled labour. As economic competitiveness is seen to depend increasingly on access to a high-skilled work force, becoming a net beneficiary of these migration processes has become a key issue for gaining and retaining competitive advantage in the knowledge economy. Regions and nations are now developing specific policies to attract foreign students and researchers. As only a few developed countries have been net beneficiaries of migration of high-skilled workers, these inequalities may easily be exacerbated by such active policies to attract highly skilled personnel from abroad, as countries and regions that are already in advanced positions may extend and capitalize on that competitive edge.

Another closely associated issue of increasing importance for developing as well as developed countries where competition may be positioned in direct opposition to development is foreign direct investment (FDI) as a main avenue for sharing the benefits of the knowledge economy. Each country may be under pressure to underbid each other in a game in which the fate of countries and regions in the knowledge economy depends on investment and (re)location decisions by a small number of MNCs which are becoming increasingly dominant in terms of share of private and total global R&D expenditure and innovation. [14] "Over the past eight years only 2% of global FDI has gone to Africa. And the financial losses because of changes in the terms of trade have been greater than all the aid and investment flows the continent has received." [15]

While neither IPR protection, migration nor FDI are as such problematic from a distributional point of view, policies within these contested policy areas need to be balanced and designed with more explicit consideration of how they may specifically benefit less advantaged economies, nations and social groups. For any of these specific policy issues, a broader agenda and alternative options are being sought and developed: In response to stronger and ever-increasing global harmonisation of IPR protection, an 'development agenda' for IPR is under development, emphasizing the need for flexible IPR policies according to the needs and circumstances of developing countries. In migration issues, opportunities are sought, not to stop migration, but make it benefit sending regions and countries [16]. Increasing awareness is emerging on the importance of terms for FDI which may facilitate spillover and create virtuous circles of wider growth and development.

[14] See *Monitoring Industrial Research: the 2005 EU Industrial R&D Investment Scoreboard*, EU/Research
[15] World Economic Forum
[16] Lucas Luchilo: Trends, policies and impacts of international mobility of the highly skilled on developing countries, http://www.resist-research.net/cms/site/docs/resistwrm_programme_rc.pdf

Hence, the framing of STI policies cannot be seen as simple translations into policy of insights and knowledge about the 'nature' of knowledge as economical entity, of 'new production of knowledge' or of 'systemic innovation'. These framing processes are core parts of the politics of the contemporary global knowledge economy, where interests often conflict and the role of power is pervasive. Thus, developing effective STI policies is not only about learning to play by the "new rules of the game", contesting and re-writing of those rules may be as integral and essential parts of that competitive game itself.

3 The Social Cohesion Policy Paradigm

We envisage, then, the development of STI policy frameworks which put distributional concerns and objectives at their core. These approaches certainly continue to strive to stimulate economic growth, but they also strive to distribute the benefits and costs of growth more evenly, creating win-win situations. Reducing inequalities and increasing social cohesion are thus among their core missions. After introducing some basic concepts, this section traces the social cohesion approach at national, European, and international levels.

3.1 Inequality and Re-distribution

Inequality is the unequal distribution of something people value: some people have more of that valued object, some people less. This seemingly simple concept has complex applications when we use it to understand social, political, and economic dynamics on a global basis. In his masterpiece on inequality, Amartya Sen [17](Sen 1992) notes that inequality is a multi-dimensional space, within which different political philosophies emphasize equality on different dimensions. Some observers value equality in rights, others in power, and still others in income or the provision of basic needs like food and shelter. Decreasing inequality in one dimension, Sen notes, almost always increases it in another.

With our colleagues we have described three kinds of inequalities associated with science and technology [18]. Structural inequalities, that is, the unequal distribution of capacities, are a starting condition for processes of distribution. Representational inequalities in politics as well as socio-economic and cultural activities contribute to inequalities in levels and forms of accountability – that is, to making visible whose interests are embodied in proposed actions. Structural and representational factors combine to produce inequalities in effects, that is, in the distribution of benefits and costs for various individuals and households. Together, they form a cycle of CARE (capacities, accountability, representation, and effects), a wheel that can spin for the better or the worse. Inequalities in capacity contribute to inequalities in representation, which in turn perpetuate inequalities in the distribution of benefits and costs. Conversely, greater equality in capacity across groups and communities can contribute to more accountability

[17] Sen, A. (1992). *Inequality Reexamined*. Cambridge, MA, Harvard University Press.

[18] Cozzens, S. E., R. Hagendijk, et al. (2007). A Framework for Analyzing Science, Technology and Inequalities: Preliminary Observations. *ResIST Working Papers*. Oxford, UK, James Martin Institute, Oxford University.

in decision processes that lead to real improvements in meeting basic needs for a broader range of communities.

Economists, who tend to focus primarily on inequalities in income, distinguish between vertical inequalities (among individuals) and horizontal ones (between groups, such as between women and men or between ethnic or religious groups). The unequal distributions of other valued items also fall along these two dimensions. So, for example, a disadvantaged ethnic group may be disadvantaged in political power as well as income, and women may bear more than their share of the costs of technologies, as in the asymmetry in birth control devices. Horizontal inequalities are important limiting factors in social cohesion and inclusion.

Reducing inequalities in various dimensions goes on under a variety of names. Reducing inequalities between countries in national wealth is one way of describing the challenge of economic development. Reducing inequalities between countries in the extent to which the basic needs of their populations are met is a way of describing part of the human development challenge. Reducing absolute poverty is a central part of that challenge, which also has health, education, and environmental components. But inequalities between countries can also be seen in terms of power. When less affluent countries demand and achieve power, they reduce this type of inequality.

In this paper, we assume that reducing inequalities is an important step towards achieving social cohesion and social inclusion, two concepts that are general policy goals in many (although not all) countries. This is a simplifying assumption, not intended to ignore the complexity of and considerable analytic and empirical research on these two concepts. Little of that work, however, has focused on the roles of science and technology in inclusion and cohesion processes. We recognize that the subjective sense of cohesion or inclusion rests on more than the facts of inequality in income or basic needs, but rather reflects connections between material inequalities, cultural identities and patterns, and levels of social mobility. In brief, we take reducing inequality to be a necessary but not sufficient condition for increasing social cohesion and moving towards an inclusive society.

Given the complexity of the concept, there is a very wide range of actions that could be taken in STI policy to reduce inequality. It is important, therefore, to distinguish several basic approaches [19] (Cozzens, Gatchair et al. 2006). When the policy aims to reduce poverty or address conditions associated with poverty, we will put it in the "pro-poor" category. When the policy is directed towards decreasing horizontal inequality, we will put it in the "fairness" category. When the policy works to decrease vertical inequality, we will put it in the "egalitarian" category. Each of the categories rests on a different rationale and calls for different kinds of actions. It is thus useful to have a vocabulary to refer to them separately, even though they are all re-distributive.

[19] Cozzens, S. E., S. Gatchair, et al. (2006). Distributional Assessment of Emerging Technologies: A framework for analysis. Globelics 2006, Kerala, India.

3.2 Re-distribution in National STI Policies

Any policy actor can adopt the social cohesion agenda, but national policy actors play particularly strong roles in this process. They articulate STI issues with larger national values and set the agenda for attention to social cohesion by sub-national policy actors. To move towards social cohesion, policy actors can choose among a wide range of instruments. We will group those instruments into four categories: human resource, innovation, research and regulatory policies. The categories are analytically distinct, although often intertwined in practice. In the sections that follow, we will explain each category, outline its current connections to re-distributional goals, and point to possibilities for its contribution to social cohesion, illustrating with examples drawn from the ResIST project.

3.2.1 Human resource policies

Human resource policies work to ensure adequate supply of trained personnel within a given country or region. Typical policies and programs in this area include

- Student support for tertiary education
- Fellowships for science and engineering degrees, either domestically or on international exchanges
- Programs to build institutional capacity for research at new institutions, so that they can provide a higher quality research training experience
- Recruitment programs to interest under-represented groups in science and engineering careers (addressing horizontal inequalities)
- Provision of vocational technical training, e.g., for technicians and skilled operators

We begin with this category for several reasons. First, the development of human capital is taken to be a key element in economic growth in the dominant contemporary growth theories [20] (Romer 1990). Thus even competitiveness approaches stress the importance of this set of policies. But in addition, human resource policies are the pathway to reducing structural inequalities, one of the key factors in change through the CARE cycle and a central task in building a socially cohesive society.

At the base of the effort is the formal education system of a country, from primary schools through advanced education, as in recent programs in Portugal and the UK.[21] Unfortunately, formal education often embodies a great deal of inequality of its own, so science education has an uneven base to build on. Thus although human resource policies are the home of "fairness" efforts in many places to open science and engineering careers

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[20] Romer, P. M. (1990). "Endogenous Technological-Change." *Journal of Political Economy* **98**(5): S71-S102.

[21] Information on Portugal in this section is based on the analysis of PT (2005), *Plano Tecnológico: Uma estratégia de crescimento com base no Conhecimento, Tecnologia e Inovação. Documento de apresentação*. Lisboa: Conselho Consultivo do Plano Tecnológico do XVII Governo Constitucional Português (http://www.planotecnologico.pt/Docs_PT_DS/OPlanoTecnologico.pdf). Information on the UK in this section is based on the analysis of HMT (2006), *Science & Innovation Investment Framework 2004-2014: Next Steps*. London: HM Treasury (http://www.hm-treasury.gov.uk/media/D2E/4B/bud06_science_332v1.pdf.

to under-represented groups, including women and disadvantaged ethnic groups, they are most likely to recruit elites within these groups. A social cohesion approach would go beyond the numbers in recruitment processes, to assure that various cultural styles and approaches to knowledge are respected. A society that is not open to this variety of styles among its science and engineers is also unlikely to respect these various forms in public discourse.

The social cohesion agenda would also see informal science education as more than just a tool for recruiting more young people into science and engineering careers. Informal science education takes places in museums, newspapers, television, and other venues outside the classroom. These often provide the opportunity to reach out horizontally. In Portugal, for example, the effort is explicitly inclusive, stressing access through an Information Society program. In Brazil, a Junior Minister for Science and Technology for Inclusion carries science to the countryside in travelling exhibits.[22] The best efforts in science communication of this sort have moved beyond the "deficit model," which assumes that participants need to know more, to modes of engagement that assume that participants bring different kinds of knowledge to issues, all of which contribute. For example, the UK science strategy treats the lay public at a par with sciences, and "public understanding" has given place to "public engagement" and "public confidence" as key terms. Spreading the capacity for many people in society to participate in decision making involving science and technology is a step towards reducing representational inequalities and increasing accountability.

Human resource policy also concerns itself with building institutional capacity in disadvantaged communities for both science education and research. So for example in the United States, institutional development programs have been directed to historically black colleges and universities, and similar steps are underway in South Africa. An example of such an effort in Mozambique is the Centro de Investigação em Saúde da Manhiça (CISM, the Manhiça Health Research Center), a regional health center which is training health care workers for the whole country, while increasing capacity by doing clinical trials as part of international research efforts.

Institution-building is also a key element in technology-based regional development, an effort that aims at reducing rural-urban and other sub-national structural inequalities. The UK science strategy, for example, points to reducing regional inequalities in capacity. And the Brazilian social inclusion effort extends to "local productive arrangements," "technological vocational centers," and "digital inclusion." Local development, however, is an area of potential tension between the social cohesion and competitiveness approaches. The competitiveness approach focuses on regional agglomeration and the clustering of related activities. National policies with this focus can thus reinforce center-periphery and urban-rural differences, in pursuit of national economic growth.

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[22] Information on Brazil in this section is based primarily on the analysis of MCT (2004), "*Plano estratégico do Ministério da Ciência e Tecnologia 2005-2007"*. Brasília: Ministério da Ciência e Tecnologia do Governo Federal Brasileiro (http://www.mct.gov.br), as well as the presentation from the Ministry for Science and Technology for Social Development and Inclusion at the ResIST World Regional Meeting in Rio, Ildeu de Castro, "S&T and social inclusion," http://www.resist-research.net/paperslibrary/rio.aspx, accessed April 25, 2007.

Similar tensions also appear between countries. They are perhaps most visible in the context of the international mobility of scientists and engineers. The competitiveness agenda sets up competition between countries for trained personnel. At the same time that Europe and the United States are struggling to try to overcome their internal inequalities and over the long run recruit women and members of ethnic minorities into such careers, they are adopting policies designed to attract scientists and engineers from other countries.[23] Yet in developing countries, these professionals are crucial for addressing both economic development and human development challenges like agricultural productivity and tropical disease. Policies on recruitment of immigrant talent can run directly counter to the same government's international development plans for capacity building.[24]

The social cohesion agenda would first and foremost create the conditions for effective domestic recruitment everywhere, and in addition find ways to support scientists and engineers in all the countries where they are needed. This spreading of capacity would ultimately produce more global economic growth than the current unequal distribution of talent, and thus provide the opportunity for plenty of prosperity for everyone.

3.2.2 Innovation policies

Innovation policies stimulate the introduction of new products and processes. They are usually aimed at the private sector, but in principle could be aimed at public sector or community innovation as well – both important possibilities in a socially cohesive society. Common forms of innovation policies and programs include:

- Programs that require university-industry interaction.
- Joint research programs aimed at moving particular technologies forward more quickly,
- Policies that encourage invention, such as patent systems themselves and the policies that allow universities to own patents on their publicly-funded research results.
- Research and development tax credits.
- Science parks and other incubator programs to provide business help and infrastructure for high-technology start-up firms.
- Extension services that provide technical help to small businesses.

Innovation policies focused on private firms get the lion's share of attention in the competitiveness approach. Cozzens discusses the various dynamics through which this standard view contributes to inequalities, through distribution of assets, employment, and

[23] Lucas Luchilo, "Trends, policies and impacts of international mobility of the highly skilled on developing countries," http://www.resist-research.net/cms/site/docs/resistwrm_programme_ll.pdf, accessed April 22, 2007

[24] For example, the UK's work in four development centers (see http://www.dfid.gov.uk/pubs/files/researchframework/research-framework-2005.pdf, accessed April 28, 2007), including attention to "how citizens can hold states accountable…"

the design and diffusion of products and services [25] (Cozzens 2007 (forthcoming)). The decision processes of standard innovation policy are less participatory than in the other STI policy areas, with industry tending to articulate its needs through government actors.

The social cohesion approach, however, calls attention to other actors in the innovation system, including worker-innovators with a direct view of the production process, and user-innovators, along with community-based innovations or innovation in the public sector. The current effort in Mozambique to develop malaria-treatment tea based on a local plant illustrates such an effort, since if successful the tea will require "no dependence on highly qualified expertise, no dependence on imported medicine, no dependence on pharmacies (Green Pharmacies), no intellectual property rights related restraints on use, improvement and research."[26] Thus the community gains much more than a solution to a problem – it also frees up resources to address to other challenges.

Competitiveness approaches focus innovation policies on generating exports and national wealth first and foremost and only secondarily on generating employment and sustainable livelihoods. The social cohesion agenda, however, puts jobs front and center, paying attention to the quality of jobs, who gets them, and where they are located – all key re-distributive variables. An example from South Africa illustrates how the use of local knowledge for innovation can create export-oriented industries in ways that build local communities. BP1, a compound extracted from a local plant, is being developed as a mosquito-repellent product collaboratively between local community healers and a large government laboratory. If the business is successful, it will generate local jobs in growing the plant and in producing the repellent candles.[27]

Innovation policy can also be specifically directed in pro-poor and other inclusive directions. Brazil's social inclusion effort, for example, includes work on "social technologies," "assistive technologies," and "popular cooperative incubators." The micro-finance movement includes support for grass-roots entrepreneurs who develop simple technologies that can be produced locally and solve local problems [28](Fisher 2006). Likewise, policies that affect diffusion of innovations can facilitate or prevent such inventive uses as small businesses started by "mobile phone ladies."

In the international arena, the tensions between competitiveness and social cohesion approaches again become clear. Intellectual property is a key form of capital in the knowledge economy, and national trade policies often focus on preserving and extending those rights. Those rights sometimes stand in the way, however, of distributing the benefits of innovation equitably, as in the case of access to essential medicines, discussed in Section 2. Some national development policies have supported the search for ways to both preserve the rights and distribute the benefits, as in the UK's support for

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[25] Cozzens, S. E. (2007 (forthcoming)). Innovation and Inequality. *The co-evolution of innovation policy. Innovation policy dynamics, systems, and governance.* R. Smits, S. Kuhlmann and P. Shapira. London, Edward Elgar.

[26] Adelaide Bela Agostinho, "Malaria and herbal therapies: where science and traditional knowledge meet," slide 10, http://www.resist-research.net/cms/site/docs/Adelaide_Agostinho.pdf, accessed April 22, 2007.

[27] Vinesh Maharaj, "Bioprospecting Research: a case study," http://www.resist-research.net/cms/site/docs/Vinesh_Maharaj.pdf, accessed April 22, 2007

[28] Fisher, M. (2006). "Income Is Development: KickStart's Pumps Help Kenyan Farmers Transition to a Cash Economy." *Innovations: Technology, Governance, Globalization* **1**(1): 9-30.

exception clauses under TRIPS and advance purchase commitments for essential medicines.[29]

3.2.3 Research policies

Research policies stimulate the production of new formal knowledge. Typical research policies and programs include

- Funding for university research, whether it comes through the university's base of public support, through research council grants programs (e.g., the research programs of the South African National Research Foundation), or through sectoral project funding (e.g., from the U.S. Department of Energy for research on renewable energy sources)
- Support and management of government laboratories, such as the Councils for Scientific and Industrial Research in India and Australia, or the Centre National de Recherche Scientifique (CNRS) in France.
- Strategic research programs, which provide funding for a specific theme, like the main priority programmes under the European Union's Sixth Framework Programme
- Industry funding for research at either universities or government laboratories, with research in this case distinguished from product development by having knowledge as its result, rather than a prototype or product.
- Regulation of human subjects and laboratory safety, as well as national security concerns.

While private industry likes to see government invest in research so that new knowledge becomes publicly available, public decision makers are the dominant force in research policy. This policy area is therefore permeable to the influence of civil society, and there is often considerable open negotiation over the research agenda. Particular groups care about whether their problems are being studied. For example, the Women's Health Initiative in the United States was brought into existence by a feminist political coalition [30]. In these cases, making the priority-setting processes more accountable through an expanded process of representation contributed to reducing both structural inequality (by putting in place programs to recruit these groups into science and engineering careers) and addressing major health problems for these groups on a targeted basis (reducing inequalities in effects).

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[29] See the *UK Science and Innovation Investment Framework 2004-2014 (*www.hm-treasury.gov.uk/media/95846/spend04_sciencedoc_1_090704.pdf, access April 28, 2007), which identified international development as one of five key policy priorities for UK government R&D. A Parliamentary Report in October 2004 on *The Use of Science in UK International Development Policy(*http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/133/133.pdf, accessed April 28, 2007) reinforced the momentum and was followed in 2005 by the *Report of the Commission for Africa,* a UK government initiative with strong African representation in its membership (http://www.commissionforafrica.org/english/report/thereport/english/11-03-05_cr_report.pdf, accessed April 28, 2007).

[30] Cozzens, S. E. (2004). Gender issues in U.S. science and technology policy: equality of what? *Gender and Excellence in the Making*. D. Al-Khudhairy, N. Dewandre and H. Wallace. Brussels, European Communities.

Indeed, public research, in either government laboratories or universities, has historically been seen as an instrument of re-distribution, whether brought about by bottom-up representational processes or top-down articulation of the public interest. Public research institutions can build the knowledge base over the long term in directions that serve public goals, like research on affordable housing. They can also provide technical consulting for community-based innovation processes, as the science shops do in the Netherlands. Universities are also the site for spreading capacity through the education process, and their connections to the broader community are crucial in keeping them culturally attuned to this task. International research efforts can contribute to poverty reduction, as is the goal with new programs in the UK [31] or research on vaccines for the diseases of poverty [32].

In short, a socially cohesive society needs strong public research institutions to support broad, societal innovation processes. A competitiveness agenda focused on directing public research exclusively towards commercial applications undermines this goal.

3.2.4 Regulatory policies

Regulatory policies, those that set ground rules for health and safety, are an area of overlap between science and technology policy and other arenas such as health, labour, and environmental policy. Regulatory processes are often quite S&T intensive, calling for high levels of expertise and often for dedicated bodies of research knowledge. Examples of such policies include

- Approval of new drugs and medical devices after checking for safety and efficacy
- Environmental pollution standards, geared to public health goals
- Safety standards in food products, automobiles, telecommunication devices, workplaces, etc.
- Regulation of public utilities, including setting rates to assure broad access to basic services

The key actors in these areas are regulatory agencies, civil society groups with a focus on the regulatory area, regulated industries, and relevant portions of the research community. Some of these policies are explicitly re-distributional, such as setting utility prices in ways that do not negatively affect low-income households, or that make sure that utilities like Internet connections extend to rural communities that are more expensive to serve. Some regulatory policies are in principle not re-distributional and are instead intended to protect all citizens equally; but unequal power, capacity, and participation can make the results unequal nonetheless. Formal knowledge tends to be given more weight than situated, local knowledge in such processes, but industry is much more likely to be able to mobilize experts with the appropriate credentials.

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[31] http://www.nerc.ac.uk/research/programmes/espa/events/ao1.asp, accessed April 28, 2007.

[32] Neyland, D., J. A. Nunes, et al. (2007). Articulating New Accountability Systems; Towards an Integrated Framework Interim report. *ResIST Working Papers*. Oxford, UK, James Martin Institute, Oxford University.

Regulatory policy is often the site of citizen action to create accountability, sometimes extending well beyond health and safety to economic justice. The environmental justice movement in Brazil, [33] for example, has addressed the social as well as environmental consequences of large-scale soy production, including the closing of thousands of small farms. They have criticized the shipment of toxic waste from the rich state of Sao Paulo to the poor state of Bahia, and tried to prevent Europe from sending its used tires to Brazil. As the last example illustrates, the issues can extend across national boundaries, and new forms of accountability are needed to address such international regulatory issues as e-waste (Neyland, Nunes et al. 2007).

3.3 Europe: the Lisbon agenda

3.3.1 STI policy predicated on the European 'social model'

The differences and tensions between the competitiveness and social cohesion models of STI policy, and the possibility of aligning and fusing them, lie at the core of the framing of the Lisbon agenda of the European Union. While economic objectives - competitiveness, productivity, growth – remain firmly the core objectives of European STI policy, the Lisbon agenda frames a broader, multidimensional agenda by incorporating social objectives – the quality of jobs, sustainability, quality of life, social cohesion – into the STI policy agenda on, apparently, equal footing with economic objectives. This agenda recognizes explicitly that economic and social objectives often conflict, and need to be balanced. It also envisages the possibility that these objectives may be reconciled and aligned to an extent which makes it possible to develop "win-win" or "mutually supportive" policies through which everybody wins and nobody loses. Thus, the "eco-modernist" or "sustainable development" model of win-win policy ("prevention pays") is extended to encompass policy objectives that fall under the "social cohesion" category:

> *"A high level of R&D spending and a good innovation performance contribute to more and better jobs. In addition research and innovation are needed to make the EU economy more sustainable, by finding win-win solutions for economic growth, social development and environmental protection"* [34].

This circumscribes the ambition of an STI policy predicated on the "European model" for sustainable, economic growth, framed in opposition to the "US model", where growth is accompanied by increasing socio-economic inequality. The Nordic "sub-model" of economic development is now accordingly held up as evidence of the viability of the European social model.[35] These countries exhibit strong performance on R&D, innovation and growth, while retaining their distinctive features as welfare societies, with a high premium on social equality and security. The concept of the "learning economy" provides one rationale for social equality as an asset for innovation in the knowledge

[33] Juliana Malerba, "Environmental Justice Network," http://www.resist-research.net/cms/site/docs/resistwrm_programme_jm.pdf, accessed April 22, 2007.

[34] European Commission (2005) More research and innovation – investing for Growth and Employment: A Common Approach (COM(2005) 488 final, p. 4.

[35] See http://www.euractiv.com/en/innovation/eu-nordic-beat-us-competitiveness-challenge/article-158217

economy, as one essential part of the "social capital" on which innovative, interactive learning depends.[36]

These are significant shifts in the way the STI policy agenda is being framed, guided by ambitions to develop a type of a less economy-dominated, more multi-objective STI policy framework. Within this framework, economic and social policy objectives, including equality and equity, should be seen as equally important and in need of being balanced, made compatible and – ideally - mutually supportive.

However, the difficulty of this task must be acknowledged. Different and often manifestly conflicting policy objectives do not converge simply because it is politically desirable and urgent that they do. The very idea of win-win-policy, and the assumption that science, technology and innovation are instrumental for developing innovative, win-win policy options, does not in itself go a long way in making such policies real. Such harmonistic policy talk may easily remain mere ideology or rhetoric, serving to deflect political conflict. Extensive policy innovation will be required, as will difficult political choices have to be made to change entrenched practices which are not compliant with 'win-win' criteria. And contrary to many statements that innovation policy predicated on the European model must be a type of multi-objective polices which balance, reconcile and integrate social, environmental and economic objectives, it also often transpires in EU policy statements that economic objectives prevail:

> *So the challenge for European innovation policy is: first, to develop increased awareness of the significance of innovation across all policy fields; and second to develop effective and efficient means of co-ordination through which we can ensure that conflicting policy aims are reconciled to the overall benefit of innovation and economic objectives* [37].

The concept of innovation and the conception of innovation policy may thus remain an instrument for achieving economic policy objectives, and thus hold back, rather than encompass and stimulate, the policy innovation required and called for by the terms of the Lisbon agenda and its call for a "balanced", "social model" of policy for innovation, development and growth.

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[36] The concept of mutually supportive, or "win-win" innovation policy has been elaborated by projects for the EU and OECD (Lengrand, L et al (2002) *Innovation Tomorrow: Innovation policy ad the regulatory framework: making innovation an integral part of the broader structural agenda*, Innovation papers no 28, DG Enterprise; OECD (2005) *Governance of innovations systems. Volume 1: Synthesis Report*, OECD: Paris). Here, it is introduced in terms of an emergent "3rd generation" innovation policy, which extends and re-articulates the idea that has been strongly emphasized in notions of "systems of innovation": that innovation policies must be *horizontal* in scope, cross-cutting traditional policy borders ands encompass all policies that impact on the conditions and performance of innovation. This idea is at the core of the Lisbon agenda, one implication of which is that "all policies at Member State and EU level should be tuned to support research and innovation, wherever possible" (EUC, 2005: 5). Putting "research and innovation at the heart of EU policies" (ibid) should, in terms of the notion of a 3rd generation horizontal innovation policy be interpreted to mean that while "1st and 2nd generation" policies for "innovation systems" were primarily focussing on the role of innovation policy for competitiveness and economic growth, 3rd generation innovation policy are essentially *multi-objective*.

[37] Innovation and Technology Transfer, EUC, Sept 2003: 6, see also,e.g., Building the Knowledge Society: Social and Human Capital Interactions, SEC(2003) 652

3.3.2 Tensions in Policies for the European Research Area

These tensions may be seen in policies for the European Research Area (ERA), in particular in policies for human resources. While the goal of the ERA is to make Europe more internationally competitive in research by reinforcing the highest standards, several re-distributive elements are included in the goals of the ERA. The ERA strongly emphasises 'excellence', but it stresses the need for its networking, and hence for the distribution of knowledge. It seeks to give more prominence to the place and role of women in research, as well as of young researchers. It also seeks greater European cohesion in research based on the best experiences of knowledge transfer at regional and local levels, and to bring together the scientific communities, companies, and researchers of Western and Eastern Europe. All these elements address horizontal inequalities within the European Union. Conspicuously missing in documents on the ERA is, however, any mention of reducing the horizontal inequalities of Europe's growing disadvantaged ethnic minorities.

From the start, structural inequalities create some of the challenges of reinforcing social cohesion through STI policies. The EU member states invest in research and development at very different rates, and while some established members are rapidly increasing their investments, some are experiencing declines. The top 15 research-intensive regions appear in five Northern European countries, and the EU's clustering policy is likely to reinforce the concentration of resources further. While a resulting concern on regional cohesion may be seen to be in tension with the primary competitiveness objectives, it is not necessarily so. The emphasis on 'excellence' in the ERA, while being a possible source of cumulative advantage, goes along with the emphasis on the creation of networks, through European collaborative projects. In this way, cooperation becomes an essential instrument *both* for improved competitiveness as well as for improved dissemination acrosse Europe, and therefore greater European cohesion.

While European research collaboration is often seen as the most clear positive impact of European RTD policy, a new step is taken with the establishment of the European Research Council, which clearly makes 'excellence' its priority, and where collaboration ceases to be the rule, expecting to establish a true 'free market' for science, supporting those proving to be the best. While this could be a source of tension regarding further concentration dynamics in Europe, it must be acknowledged that it works in parallel with other EU funding instruments. Regional policy, through the European Structural Funds, contributes directly to readdress these processes, and increasingly includes STI policy components, to advance their capability to absorb new knowledge and to actively contribute to the European knowledge economy, thus fully becoming part of the ERA.[38] But also at the level of the Framework Programmes, specific funding instruments contribute to different processes that attempt to go beyond the normal concentration of research resources. Examples of this are the Networks of Excellence, which have as its aims to strengthen the collaboration at the top, or the Regions of Knowledge initiative, which supports regional networking, or programs that target in particular the large population of SMEs, rather than the few large firms.

[38] Cf. European Commission, "The Regional Dimension of the European Research Area", Communication from the Commission, COM(2001)549 final, 2001.

Nevertheless, it is clear that the concentration of resources in turn has implications for where highly-educated scientists and engineers want to work. The distribution of R&D workers in the ERA is already heavily skewed; in 2003 54% of R&D personnel in the EU-25 were concentrated in Germany, France and the UK.[39] Mobility is central to the ERA strategy in two respects: first, increasing the *volume* of human capital through policies to retain researchers in and attract researchers into the ERA from other countries and, second, shaping the *distribution* of this human capital within the boundaries of the ERA. In many respects these two goals are linked, as the development of research concentration and the emergence of specific centres of excellence play a critical role in maintaining the attractiveness of Europe to those scientists already located within the ERA and acts as a magnet to those from outside. To support excellence, European researchers are expected to move to the places where excellence is strongest.

The expectation of mobility, however, can place the EU's ambitions for excellence in conflict with its re-distributional objectives. Disadvantaged regions that are trying to develop their S&T capacity will not be helped by having their best and brightest move to the European centers of excellence. Not only may this goal undermine the EU's cohesion policy, strongly supporting advanced training of young researchers in these regions, but it may also undermine efforts to bring women into science, as one of the reasons that women leave science is that they often do not want to be mobile, so meeting one goal may create challenges for the other.

The broader ERA perspective promotes market liberalization, unfettered individual competition and mobility as the vehicles for the achievement of these goals. The 'free market' is the means by which to recruit and retain the 'brightest and the best' and to 'match' skills and resources optimizing scientific potential. Individual decision-making and the 'matching process' associated with it is central to the European Commission's commitment to meritocratic recruitment, competition and excellence and mobility, an important ' instrument for the transfer of scientific knowledge.'

The fusion of economic and social goals reflected in recent ERA policy with social objectives essentially underpinning the competitive ethos is perhaps symptomatic of a new approach to the European Social Model. Rather than being presented as some kind of moral imperative with high social costs and potentially draining effects on competitiveness, equality objectives are now tied closely to the latter. The language and approach adopted in many of the ERA policy instruments and the Researchers' Charter and the Marie Curie Fellowship Scheme illustrate the 'dynamic tension' [40] that exists between the development of social rights and economic integration, as a consequence of 'an ever greater stress on the economic dimensions of social policy and in particular its links to the 'knowledge economy'.

The Lisbon objectives refer explicitly to the idea of 'sustainable economic growth'. What is unclear, however, is the unit of analysis. If one takes the whole of the ERA as the appropriate level of analysis then intra-EU mobility is effectively no different to internal mobility within an individual Member State. On the other hand, if the

[39] Gotzfried, A. (2005) 'Science, Technology and Innovation in Europe', Statistics in Focus, August 2005
[40] Catherine Barnard, Simon Deakin, Richard Hobbs, 'Capabilities and rights: An emerging agenda for social policy?', Industrial Relations Journal, 32 (5) pp 464-479

aggregate effect of individual career and migration decisions, fuelled by policy and resource allocation decisions within the ERA, leads to serious imbalances in flows and significant losses to less developed countries then one might question the compatibility of free market economics with sustainability at Member State level. The European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers [41] explicitly recognizes these inherent policy tensions both in terms of researchers coming into the ERA from third countries and imbalances within the ERA:

> *The development of a consistent career and mobility policy for researchers to and from the EU should be considered with regard to the situation in developing countries and regions within and outside Europe, so that building capacities within the EU does not occur at the expense of less developed countries or regions. (para 13)*

More recently, and following specific concerns around the impact of scientific mobility on capacity-building in developing countries (outside of the EU), the European Commission issued an 'EU Strategy for Action on the Crisis in Human Resources for Health in Developing Countries.' [42] In this context, the 'risks' of highly skilled migration are emphasized, as is the importance of being able to remain within 'one's own country':

> *'The long term manageability of international migration hinges on making the option to remain in one's own country a viable one for all people. Sustainable economic growth and equity and development strategies consistent with this aim are a necessary means to that end' (p5)*

European policy place a strong emphasis upon the identification and development of Centres of Excellence that lies at the heart of European R&D policy (mirroring that of most Member States) and to the role that mobility plays in 'matching' quality human resources with quality infrastructures. Mobility is the logical corollary of 'clustering' and the redistribution of human capital to support research infrastructures. This highly competitive form of capacity-building, which effectively augments existing resource-rich institutions and regions, does not sit well alongside a commitment to building new capacity and maintaining sustainable R&D in less research intensive regions. Although they are often not expressed as such, concerns around 'brain drain' within the ERA – and policy responses to it - need to be understood as facets of this wider debate, underlying tensions between equality and equity.

But while the concentration of resources, human resources and other, may possibly be the most visible tension regarding inequalities in the European Research Area strategy, the main objective surrounding the proposal for its establishment has been focused on the policy-making processes. The ERA is expected to contribute to a greater coordination between STI policies in Europe, overcoming the limitations derived from the loose existence of the (now 25) national policies plus the EU's. The objective of improved coordination, based on the Lisbon strategy's open method of coordination (OMC), also challenges the corresponding decision-making processes. If the simple existence, side-by-side, of national and European policies, with its distinct policy-making

[41] Commission of the European Communities 11.3.2005 C(2005) 576.
[42] Communication to the Council and the European Parliament 'EU Strategy for Action on the Crisis in Human Resources for Health in Developing Countries' (COM(2005) 642 final dated Brussels 12.12.2005)

processes, may lead to significant duplication of efforts and resulting inefficiencies at the European level, strong coordination can also reduce the participation processes in decision-making. This has been noted for example in the build-up to FP7, where an initial proposal to reduce the number of programme management committees in order to reduce administrative processes has been criticised precisely for reducing the participation of Member-States in the decision-making processes of the FP.

One of the strategies devised to improve coordination while reducing the concentration of decision-making has been the openness for 'variable geometry' processes of decision-making, by which some Member-States can decide for their own cooperative actions with support from the EC (following Article 169 of the Treaty). While this opportunity was established with FP6, only one initiative has been initiated, the Europe Developing Countries Clinical Trials Partnership (EDCTP). The alternative it represents, in a "joint effort to combat poverty-related diseases through more and better structured research and development that meets the needs of populations in need", is nevertheless suggestive with regards to the need of alternative policy-making processes (such as this) to go beyond the dominant policy paradigm.

The existing tension at the policy-making level on the focus on the knowledge-based policy, and on the global competitiveness of the European economy, and its ability to be truly open and inclusive is evident in a recent European Communication on innovation:

> *"The Commission is convinced that even more is needed - Europe has to become a truly knowledge-based and* innovation-friendly society *where innovation is not feared by the public but welcomed, is not hindered but encouraged, and where it is part of the core societal values and understood to work for the benefit of all its citizens. That is why the Spring European Council called on the European Commission to present "a* broad based innovation strategy for Europe *that translates investments in knowledge into products and services"."*[43] *(EC, 2006: emphasis in the original)*

Even if proposing a *broad based* innovation strategy, it nevertheless does leave little room to questioning the impacts of innovation and of the translation process between knowledge and resulting products and services.

To conclude, a fundamental and pervasive tension exists in the European Research Area strategy between the pursuit of different levels of equality, namely for the sustainable development within the European Union (sometimes referred to as 'balanced growth') and at different lower levels (Member States, regions, or even at the level of individual equity, regarding the individual human right not to be discriminated against on grounds of nationality).

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[43] European Commission, 2006: Putting knowledge into practice: A broad-based innovation strategy for the EU, COM(2006) 502 final; emphasis in the original

3.4 International institutions

We have so far in this half of the paper reviewed the potential for national and European STI policies to incorporate re-distributional goals and objectives internally. We cannot leave this policy survey, however, without addressing the practice and potential to address these goals on a global level. A wide range of institutions with stakes in science, technology, and inequalities are operating internationally. We begin this review with a discussion of the international reflection of the competitiveness agenda, in the form of the TRIPS agreement on intellectual property. We then move on to three sets of organizations that are working on the social cohesion agenda in various forms: official development assistance agencies of national governments; the international development banks; and international civil society.

The assumption that S&T would inevitably provide the means for developing countries to break out of the vicious cycle of debt and poverty highlights the fact that the challenge of S&T for development relates not only to limited resources but also to wrong approaches, projecting S&T as "instant cures for deep-rooted economic and social problems"[44]. A key concern remains the limited exploration of alternative, more knowledge-based and sustainable approaches working in synergy with local culture, values, socio-economic patterns and ways of life.

The international development effort as a whole is of course directed to reducing inequalities between countries, in both economic and human development terms. Given the focus of our project, we focus our attention here on the place of STI in the development efforts of these various actors. The development community is exerting great efforts to reduce poverty, empower women, and give communities a greater role in their own development. We again focus our attention in this discussion on how they use STI to support those efforts.

3.4.1 World Trade Organization

One of the key global institutions of the Knowledge Economy is the World Trade Organization, and in particular the agreement on minimal standards of intellectual property rights (IPR) reached under its auspices on Trade-Related Intellectual Property Rights (TRIPS). Developments within the IPR domain have generally gone in the direction of stronger protection of the rights of "owners" of knowledge, thus contributing to a general shift towards the commodification and stronger private appropriability of the benefits of knowledge. A fast change in IPR regimes has ensued, as changes in various domains have converged towards what James Boyle has called a "maximalist" rights regime [45]. These changes include the emergence of relaxed standards of patentability; extending the domain of patentable subject matter to include living entities, software programs, business methods and research tools; lengthening the protection period; and enforcing rights more strongly. Developments in the US have led the way forward.[46]

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[44] Bezanson, K. And Oldham, G., Rethinking science aid (www.SciDev.net, accessed April 28, 2007).

[45] Boyle, James (2004) A manifesto on WIPO and the future of intellectual property.

[46] Coriat, B & F Orsi (2002) Establishing a new intellectual property rights regime in the Uniteds States. Origins, content and problems, *Research Policy* 31 (2002) 1491-1507

While the maximalist trend in the IPR policy domain is still dominant, it has become increasingly contested in a number of policy arenas. The extension of patentable subject matter, e.g., human genes, is seen to obfuscate the essential distinction between discovery and invention, and encroaches on human dignity. There is increasing concern that the "enclosure of the knowledge commons" may erode the essential role of the public domain and hinder rather than stimulate innovation.[47]

The TRIPS agreement marks the end of a process initiated by the US by which issues of IPR protection has become part of trade agreements. [48] One consequence of the TRIPS agreement is that developing nations may be deprived of an essential policy instrument, i.e., the adaptation of IPR policy to their specific needs and circumstances, for entering the global knowledge economy. As acquiring technological capacity through copying, imitation and reverse engineering is an essential part of catching up strategies, TRIPS may place limitations, including higher licensing costs, on the use of that strategy. Thus, TRIPS may be seen to offer few advantages to developing countries in terms of IPR; it was a trade-off where overall loss in IPR would be traded in for gains in trade, in particular export of agricultural products. It was also seen as an advantage that negotiations over intellectual property would be moved from bilateral to multilateral trade negotiations. However, TRIPS has not led to the removal of IPR from bilateral and regional trade agreements. These bilateral agreements have been retained as a channel to enforce higher, "TRIPS Plus" standards of IPR protection, alongside and over those of the TRIPS itself.

As these developments may be seen to have benefited primarily the already advanced economies, they have been characterized as the emergence of protectionism for the advanced knowledge economy:

> *Old protectionism was about keeping your rivals out of domestic markets. New protectionism in the knowledge economy was about securing a monopoly privilege in an intangible asset and keep your rivals out of world markets* [49].

Key IPR issues in the Doha Round have pertained to the relationship between the Biodioversity Convention and TRIPS. This concerns issues of "biopiracy", by which the "piracy" and "theft" discourse that have been extensively used to drive the maximalist agenda have been turned around to apply to the IP right holders of developed countries. Issues concerning the compatibility between the TRIPS and the Biodiversity Convention, which regulates conditions of "access and benefit-sharing" between patent holders and providers, have been part of the Doha Round as a number of large, developing countries, including India, Brazil and China, have pushed for a change in TRIPS to make it mandatory to include disclosure of origin of genetic resources in patent application. The Biodiversity Convention states the principle of national sovereignty of genetic resources, and the rights of origin countries to a fair share of the benefits of inventions based on

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[47] Heller M & R. Eisenberg (1998) Can patent deter innovation? The anticommons in biomedical research, *Science*, Vol 280, 1 May 1998, 698-701

[48] Drahos, Peter with John Braithwaite (2002) *Information Feudalism. Who Owns the Knowledge Economy?* Earthscan: London.

[49] Drahos, ibid, p. 87.

biological resources. A closely related issue is work on the role of traditional knowledge in relation to IPR issues, which particularly affects indigenous communities.

It seems, however, that multilateral IPR issues are now shifting back from the WTO to the WIPO. Here, the WIPO 'patent agenda' is a basis for taking new steps towards the world-wide harmonisation of both substantive and procedural IPR regulation. This is, according to some, a process for developing harmonised TRIPS Plus standards, and even indicates the – still distant – possibility of the universal 'world patent'. At the same time, pressure has mounted for WIPO's adoption of an explicit "development agenda", by which the WIPO would, as a UN agency, become more committed to development goals. This agenda is sustained by the assumption that a "one size fits all" approach to global IPR protection, as may be seen to sustain the WIPO "patent agenda", is inappropriate from a development point of view:

> *"The role of intellectual property is and its impact on development must be carefully assessed on a case-by-case basis. IP protection is a policy instrument the operation of which may, in actual practice, produce benefits as well as costs, which may vary in accordance with a country's level of development. Action is therefore needed to ensure, in all countries, that the costs do not outweigh the benefits of IP protection".50*

3.4.2 National Development Agencies

In 1970, the international community has committed itself to spending .7% of GDP on development. [51] In 2006, only five governments reached that goal, but many put considerable effort into what is called "official development assistance" (ODA), which totalled nearly $104 billion. Countries vary in their approaches to ODA, reflecting national strengths and priorities. Likewise, the place of STI in those efforts varies greatly. Since ODA is always led by different agencies than those that lead in STI policy, national STI policies may or may not be coordinated strongly with international ones.

The UK illustrates the rising interest in using science and technology for development. As mentioned briefly earlier, a change in UK policy on S&T in development was signaled in 2002 by a speech in Johannesburg by the government's Chief Scientific Advisor, Sir David King, himself a South African by origin. Subsequently the *UK Science and Innovation Investment Framework 2004-2014*[52] identified international development as one of five key policy priorities for UK government R&D. A Parliamentary Report in October 2004 on *The Use of Science in UK International Development Policy*[53] reinforced the momentum and was followed in 2005 by the *Report of the Commission for Africa*[54], a UK government initiative with strong African representation in its membership. This argued for strategic and coherent approach to capacity development at regional level within Africa, was strongly

[50] Proposal by Argentina and Brazil for the establishment of a development aganeda for WIPO, WO/GA/31/11, 17. Aug. 2004,
[51] http://www.oecd.org/document/17/0,2340,en_2649_37413_38341265_1_1_1_37413,00.html, accessed May 9, 2007.
[52] http://www.hm-treasury.gov.uk/media/95846/spend04_sciencedoc_1_090704.pdf
[53] http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/133/133.pdf
[54] http://www.commissionforafrica.org/english/report/thereport/english/11-03-05_cr_report.pdf

supportive of both needs and research based-approaches for development, and set out specific targets for the 2005 Gleneagles G8 meeting, including support for attempts to use exception clauses under TRIPS, and advanced purchase commitments, to encourage the development of affordable drugs for the poor.

The Commission Report saw centres of scientific excellence, on the model of the Indian Institutes of Technology, as springboards for capacity development. These were seen as needing to be regional within Africa, being both physical centres and the focal points of multi-country networks, and to incorporate 'innovation hubs' under public-private partnerships. They would link to everyday life through engagement with local communities and with the global knowledge community through links with the government, the African diaspora and international partners.

The Department for International Development (DFID) developed this policy link further in its *Research Funding Framework for 2005-2007*[55], which included an emphasis on the importance of research on governance in relation to development, and continuing work in four development research centres: 'one on the state itself, one on how citizens can develop the ability to participate, one on how states respond to crises, and one on ethnicity, inequality and conflict. Important issues that require further work include how citizens can hold states accountable…'[56]

In UK development related research policy the idea of having poverty reduction as one target of research is becoming more mainstream. An example is a current call for research within a budget of £13m on 'sustainable management of ecosystems to maximise poverty alleviation in Amazonia/Andes, semi-arid Africa, India and the Hindu Kush and China' which involves collaboration between DFID and two research councils – ESRC (social science) and NERC (environment)[57].

As another example, Sweden concentrates some of its development efforts in the science and technology sector.[58] Its priority is the engineering and environmental sciences, and it is providing support in particular to engineering faculties. Sweden has scientific partners in Uganda, Kenya, Costa Rica, and Thailand. Norway, another large donor in terms of percent of GNI, has an Oil for Development program to share its expertise in this sector, plus cooperation in ICTs for development and genetic technology.[59]

The largest national donors are members of the OECD's Development Assistance Committee (DAC).60 DAC's agenda includes many of the concerns of the social cohesion agenda under its "poverty, equity and development" theme, including empowerment, participation and gender, as well as income distribution. However, there is no apparent intersection between these concerns and the activities under its "IT and entrepreneurship" theme, which focuses on the development of the IT sector and e-commerce.

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[55] http://www.dfid.gov.uk/pubs/files/researchframework/research-framework-2005.pdf
[56] http://www.dfid.gov.uk/pubs/files/researchframework/research-framework-2005.pdf
[57] http://www.nerc.ac.uk/research/programmes/espa/events/ao1.asp
[58] http://www.sida.se , accessed May 9, 2007.
[59] http://www.norad.no , accessed May 9, 2007.
[60] http://www.oecd.org/department/0,2688,en_2649_33721_1_1_1_1_1,00.html, accessed May 9, 2007.

3.4.3 The Development Banks

International agreements at the end of World War II established a set of financial institutions that now play important roles in development. The World Bank Group is the largest and gets the most attention, but regional development banks for Asia, Latin America, and Africa also play important and growing roles. Far from lending passively, the banks develop their own priorities, implement these through lending conditions, provide technical advice on implementation, and evaluate results to try to improve performance over the long run.

Among these sets of expectations, the Washington Consensus has significantly affected STI policy. The Consensus stresses export orientation in an open market economy as the path to economic growth and therefore places a premium on upgrading technology for international economic competitiveness. The competitiveness agenda thus tends to be privileged in the STI arena, a tendency that has spread to the Inter-American Devleopment Bank (IDB) in its new program of research on innovation systems in Latin America.[61]

S&T continues to occupy only a small part of the agenda of international institutions largely as a result of a legacy of past fragmented approaches, lack of strategic vision and limited investments. This is evident in the World Bank's lack of a consistent S&T capacity-building strategy except in the area of agricultural research and the fact that only one in 50 projects focused on improving S&T or had a significant S&T capacity-building component (Review [62] of World Bank Lending for Science and Technology (1980-2004)). However, more recently there is evidence of a growing, enhanced role for S&T, with growing investments in S&T as a development objective per se as commitments to scientific understanding are perceived as critical to sustainable development.

An emphasis on activities in the banks that are specifically designated as STI, however, neglects the significant investment that goes into technical assistance more broadly defined. The World Bank, for example, maintains sector-specific staff in such technology-intensive areas as energy, environment, and water supply and sanitation. These support staffs can be an important source of knowledge transfer in the context of Bank-funded programs.

3.4.4 The United Nations

The Banks are also committed to addressing poverty and basic human needs through the Millenium Development Goals. These goals were developed by the United Nations in order to focus the development community on a prioritized set of targets to be met through broadly based efforts by 2015.[63] The science and engineering research communities have identified many ways that they could contribute to achieving the targets,[64] and a UN task

[61] http://www.iadb.org/sds/ict/site_6964_e.htm, accessed May 9, 2007.
[62] http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079975330/Review_WB_lending_ST_80-04.pdf
[63] http://www.un.org/millenniumgoals/, access May 9, 2007.
[64] See for example, the list of potential contributions of nanotechnology provided in Singer, P. A., F. Salamanca-Buentello, et al. (2005). "Harnessing nanotechnology to improve global equity." Issues in Science and Technology **21**(4): 57-64.

force has specifically focused on how innovation can support the development process [65](Juma and Lee 2005).

The United Nations agencies have generally taken the human development rather than economic development angle in their activities, implementing the Universal Declaration of Human Rights and following Sen's approach to "development as freedom" [66] (Sen 1999). Because UN funding is modest, its activities tend to be facilitative rather than providing the major funding of the Banks. But as another source for gathering experience and linking it to scientific and technological knowledge, several UN agencies play critical roles, including the UN Environmental Program (UNEP), the Food and Agriculture Organization (FAO), and the World Health Organization (WHO). The UN Educational and Scientific Organization (UNESCO) collects statistics from developing countries on their science and technology activities. The UN's Human Development Report in 2001 was devoted to science and technology for development, outlining a set of tensions very much like the ones we have discussed in this paper.[67] The empowerment potential of ICTs has received frequent attention, including in the area of gender.[68]

3.4.5 Foundations and International NGOs

The organizations that comprise international civil society have a particularly important role to play in assuring that STI are used for social cohesion as well as competitiveness. From large to small, the civil society organizations tend to act as a counter-balance to the economic development institutions, focusing on equity issues (including for women and indigenous groups) and community empowerment, in areas of basic needs.

The largest players in this category are the major foundations. The Rockefeller Foundation, as one example, has played a strong role historically in development. Its particular accomplishment is the Green Revolution, which came out of agricultural research that Rockefeller supported in the 1950s and 1960s and transformed agricultural yields in Asia, helping to dramatically increase food security in that region. Rockefeller has continued to be a key player in the international coalitions supporting agricultural research, and has recently turned back to innovation as a theme in its programs with a program "designed to spur science and technology solutions to pressing development problems."[69]

Rockefellers' resources, however, have been surpassed by the Gates Foundation, which has taken tackling global health challenges as its central mission.[70] This focus leads it directly into science-intensive areas such as the development of vaccines, drugs, and diagnostic techniques to fight AIDS, tuberculosis, malaria, and other diseases of poverty. The Gates Foundation has adopted public-private partnerships as their method of

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[65] Juma, C. and Y.-C. Lee (2005). *Innovation: applying knowledge in development*. London, Earthscan.
[66] Sen, A. (1999). *Development as Freedom*. Oxford, UK, Oxford University Press.
[67] http://hdr.undp.org/reports/global/2001/en/, accessed May 9, 2007.
[68] http://gab.wigsat.org/partI.doc, accessed May 9, 2007.
[69] http://www.rockfound.org/about_us/press_releases/2006/121406rf_innocent_pr.pdf, accessed May 9, 2007.
[70] http://www.gatesfoundation.org/default.htm, accessed May 9, 2007.

operation, for example, partnering with drug firms in developing approaches to under-studied issues.

Accompanying the major foundations are an enormous number of issue-specific non-governmental organizations working in technology-intensive areas. The environmental justice movement, for example, brings together local groups from many countries to address environmental issues from local to global scale.[71] Water and sanitation issues are addressed by some specialized NGOs, like the International Water and Sanitation Centre[72] in the Netherlands and WaterAid [73] in London, as well as by specific projects under more general purpose NGOs like CARE and UNICEF. Local NGOs and community-based organizations also play roles, as for example, Planet Kerala[74] does in Kerala, India.

3.4.6 Working together

With so many organizations operating in the international development arena, lack of coordination is a constant threat. The EU-funded SCOPE study completed last year found that a key inhibition on the development of STI policies and programmes in developing countries is the influence of international donor organizations like World Bank.[75]

> *All of the countries depend on support from multiple donors, operating both bilaterally and multilaterally. National funding tends to be committed to salaries and basic institutional costs. Donors provide funding, some logistical inputs and some sponsorship of training. This gives them a strong influence over the content and direction of research. In the short run these inputs are beneficial, even essential, but there are concerns about long-run dependency and reactive rather than proactive policymaking. Further concerns raised are that funding of this kind prevents countries in the region from developing their own "joined-up" strategy for science, technology and innovation because each project is an opportunistic response to different donor strategies. Efforts are thus often fragmented and not sustained beyond the lifetime of projects. Benefits of international cooperation are insufficiently exploited on many levels, including lack of opportunity for policy learning, and lack of development of institutional and technical capacities [76].*

However, there are many examples of the various parts of the development community working together effectively in STI-intensive areas. One is the Mozambican clinic and health research center mentioned earlier. This was started in a partnership between Mozambique and Spain, and has been nurtured by funding from Gates-supported clinical trials, which are in turn partnerships with a European pharmaceutical firm.[77]

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[71] For an account of recent activities in Brazil, see Juliana Malerba, "Environmental Justice Network," http://www.resist-research.net/cms/site/docs/resistwrm_programme_jm.pdf, accessed April 22, 2007.
[72] http://www.irc.nl, accessed May 9, 2007.
[73] http://www.wateraid.org.uk/, accessed May 9, 2007.
[74] http://www.planetkerala.org/, accessed May 9, 2007.
[75] http://les.man.ac.uk/PREST/SCOPE/reports.htm, accessed May 9, 2007.
[76] Georghiou, L., M. Keenan, et al. (2006). Scenarios for future scientific and technological developments in developing countries. Brussels, European Commission.
[77] http://www.manhica.org/pages/ingles/ingles.htm#, accessed April 13, 2007

Another successful collaborative effort is the CGIAR, a consortium of over 60 donors who collectively support fifteen international research centres.[78] Growing out of the Green Revolution success, the centres in turn provide a critical link between international research frontiers and national agricultural research systems. They are aggressively pro-poor, and work closely with communities in developing their approaches, including the recent success of NERICA rice in Africa.[79]

4 In Conclusion: Adding Momentum to the Emergent Agenda

Our analysis indicate that a process of reassessment, extension and re-articulation of dominant STI policy frameworks is taking place which does, if hesitantly and ambiguously, seek to incorporate distributional concerns and objectives more integrally into STI policies. The criticism and reassessment of dominant narrow framings of the STI agenda as too myopically focused on economic objectives alone are becoming an integral part of that agenda itself. The full development of that framework and agenda depends, however, on sustained, long-term work to develop new performance criteria, new objectives and different accountabilities. Different types of correlations and causalities need to be identified and explored; and a different set of learning-enhancing experiences and "best practices" should be selected, on the basis of different objectives and performance criteria than those that have been predominant in previous, narrow STI policy frameworks.

Our initial assumption is that this can be done by addressing, explicating and strengthening of *interdependencies* between what we have (in section 3.1 above) called the *structural, representational, and distributional* aspects of science, technology and innovation systems. Different types of S&T policies can be utilized by bodies at various levels of the political system, from sub-national to multi-national to act on these forms of inequalities. The *structural* aspect concerns the organization and distribution of STI resources and capacities. The *representational* aspect refers to political power and voice, and therefore to the processes of accountability. The *distributional* aspect refers to who gets the benefits and who bears the costs of science and technology. Our rapid tour of the policy issues and dimensions where distributional issues may be of prime concern, indicate the many opportunities to work towards reducing inequalities through science and technology. Capacity-building efforts can be targeted to disadvantaged groups. Research and innovation can be aligned with the needs of poor communities. Participation by women, disadvantaged ethnic groups, and the poor can shape the research and innovation agendas and build capacity at the same time. By changing who is involved in research and what problems are addressed, both public and private sectors actions can have more positive distributional effects. In short, experience shows that a re-distributional STI policy is possible. Our further work is designed to illustrate ways that such a policy can be put into action.

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[78] For an account from one CGIAR center, see Roger Cortbaoui,, "Science and Technology for and by the Developing World," http://www.resist-research.net/cms/site/docs/resistwrm_programme_rc.pdf, April 22, 2007. For information on the CGIAR system, see http://www.cgiar.org/, accessed May 9, 2007.

[79] http://www.warda.org/NERICA%20flyer/technology.htm, accessed May 9, 2007.