Distributional Assessment of Emerging Technologies

WP4 Policy Paper

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Distributional Assessment of Emerging Technologies[1]

In WP4, ResIST undertook a cross-national, cross-technology study of the distributional effects of emerging technologies. Our central research question was how policy interventions affect distributional outcomes for the same technology under different national conditions. Our goal was to identify options for policymakers to spread the benefits of emerging technologies broadly.

Emerging technologies are a strategic research site for examining the interactions of inequalities between countries and inequalities within countries. We define emerging technologies as new and research-based, with potential broad impact. Why study emerging technologies in ResIST? First, precisely because they are new, emerging technologies are the site of change and growth in both global and local economies. The techno-economic networks that support them are still young and malleable, but are projected to be more significant as time goes on. They therefore represent a good place for public interventions towards equality. Second, because emerging technologies are research-based, they are more likely to be sold at high prices (as firms try to recoup research and development costs) and to demand high levels of skills in the production process. Both these characteristics give emerging technologies a higher potential than older technologies for increasing inequalities in access and employment.

Third, emerging technologies stand at the intersection of global and national distributive processes. The dominant pattern in emerging technologies has been that new technologies have been developed in North America, Europe, or North Asia (the "Triad" regions), then diffused to other parts of the world, either when a multi-national firm decides to place a production facility there or when the technology becomes available for purchase. The benefits and costs that people experience in creating, producing, and using countries as a result of this process vary greatly among countries and technologies, but a global pattern of inequality nonetheless emerges. When we consider only this pattern, technology-creating countries always appear to be starting the revolutions, and technology-using countries always appear to be trying to catch up.

To create a different pattern, however, many non-Triad countries invest in their local capabilities in emerging technologies, not only to provide better absorptive capacity for using the technologies to meet local needs, but also as the basis for using the emerging technology to create local business opportunities. Indeed, the Millennium Project task force on innovation (Juma and Lee 2005) recommended that every developing country invest in "platform technology" areas, such as biotechnology, ICTs, and nanotechnology. These investments might create a re-distributional pattern with significant implications for the relationships between technologies and inequalities.

Work Package Four studied five technologies that emerged in the past, in order to inform thinking about technologies that are emerging now or will do so in the future. This summary describes our approach and reports the main results and conclusions of the study. Each technology's history is different, making the findings complex. They illustrate both the best and the worst of distributional outcomes. They all show, however,

[1] The case studies in the Americas were funded as Project Resultar by the U.S. National Science Foundation under Grant SES 072-6919. All opinions, findings, conclusions and recommendations are those of the author and do not necessarily reflect the view of the sponsors

that public interventions do make a difference, from commercialization environments to competition policies. Options are available to public decision makers for spreading the opportunities and benefits of emerging technologies more broadly.

Methods

WP4 used case study methodology, which starts with a qualitative model of the phenomenon of interest and uses that model to try to understand the dynamics of each case. This method depends on replication logic rather than statistical generalization to a population. If the model predicts what happens in the cases, it is confirmed. If reality does not quite match the model, as happens quite often, then the analyst has a basis for modifying the model, which is then ready to be tested against another case.

The model WP4 was testing, although largely implicitly, was the classic model of technology diffusion. It posits that after a new science-based technology is developed in the research and development department of a firm, it is typically introduced in a sophisticated, high-priced version that is marketed to a limited number of high-end users. As the market expands, the price of production falls and the firms producing the technology market simpler versions in order to reach broader markets. Eventually, the price drops far enough that the product reaches a mass market.

We chose a diverse set of technologies to compare with this model as well as a diverse set of national contexts. This diversity gave the model a series of tough tests and created many opportunities to modify and improve it. The information and communication technologies (ICTs) we included are **mobile phones** and **open source software**. They represent both the proprietary and non-proprietary ends of the ownership spectrum. Mobile phones are widely hailed as a modern technology that has helped the poor a great deal, and open source is thought to create better, less expensive software options as well as new business opportunities. Among biotechnologies, we chose one health product, **recombinant insulin**, the first biotechnology health product to be approved and one with wide applicability. In agriculture, we chose both a sophisticated product, **genetically-modified maize**, which is produced through genetic engineering, and at the other extreme, **plant tissue culture**, an older and relatively simple technique that was nonetheless just reaching one of our chosen country contexts at the beginning of the study.

Table One: Case Study Countries

	Argentina	Canada	Costa Rica	United States	Germany	Malta	Mozam-bique
Population[2]	38.7m	32.3m	4.3m	296.5m	82.5m	404,000	19.8m
GNI/capita[3]	$4,470	$32,600	$4,590	$43,740	$34,580	$13,590	$310
Technological Achievement[4]	.381	.589	.358	.733	.583	na	.066

[2] World Bank, World Development Indicators, data for 2005
[3] Gross National Income per capita, World Bank, World Development Indicators, data for 2005
[4] United Nations, Human Development Report 2001.

We gathered data on these five technologies using a common data collection protocol in eight different national contexts, including four developed and four developing countries. The ResIST team studied their own countries in Europe and Africa (Germany, Malta, and Mozambique), and a companion grant from the U.S. National Science Foundation allowed the U.S. colleagues to study countries in the Americas: Argentina, Canada, Costa Rica, Jamaica, and the United States. The fact that these countries ranged widely in size, national wealth, and science and technology capability is a strong point under the case study approach, since the operation of the classic model were examined under a wide range of conditions.

The basic logic of the data gathering and analysis was that *technological projects* affect *inequalities* in *valued items* through pathways that are technology-specific, mediated by *national conditions,* and shaped by *public interventions*.[5] We looked for distributional consequences of the technologies in four valued items: business opportunities, employment, benefits, and costs. Not every technology was relevant in every country, but in the end we gathered data for 34 country-technology pairs. We then synthesized the results for each technology across the country examples and synthesized results for each country across the technologies covered there. We used the country synthesis as an opportunity to develop policy options that were tailored to each of the eight quite different country contexts.

Patterns across Technologies

One of the main lessons learned from the cases concerns diversity. On the one hand, the specific distributional consequences of the technologies are quite different and are clearly strongly influenced by all the factors we included in our analysis: how the technological project was shaped by its champions; national conditions, in particular skills and poverty; and public interventions. On the other hand, the public interventions in each technology were relatively standard. And the overall distributional patterns followed some general patterns that we were able to see much more clearly from the comparison than we could have from individual cases.

Technological Projects. Although we had a focus for each technology in the study, we still needed to search in each case for the technological project itself – something that some actor or set of actors (the "champion") was trying to make happen. Among our five targets, it is clear that the technique or capability is not the only influence shaping the project. Instead, the way the technique is packaged – with what services, priced, in what way, with what accessories – is of the essence. Mobile phones are a product-service combination, and in this case, it turned out that the pricing for the service itself was a crucial factor in extending the market: pre-paid plans are widely seen as the way low income consumers have been to afford cellular access. Open source software is the

[5] For a fuller description of the concepts, see Cozzens et al., "Emerging Technologies and Social Cohesion: Policy Options from a Comparative Study," available at http://prime_mexico2008.xoc.uam.mx/papers/Susan_Cozzens_Emerging_Technologies_a_social_Cohesion.pdf

technological project of an evangelical movement of programmers, along with some corporate giants who are interested in a way to compete with the proprietary software manufacturers. The business model is new: the product is free, but in its business forms, the service that adapts it and keeps it running are not. BT maize is one product designed to be used with another, a pesticide, and recombinant insulin is also marketed along with, although not designed for, a set of supplies for testing blood sugar and administering the drug itself.

But each technology is not completely malleable; each carries certain requirements of technical skills and infrastructural conditions that limit the creativity of technological champions. Micro propagation, for example, has to be done in a clean facility. This creates a floor on the level of investment that must be made for the technology to be available and thus limits the possibility for the industry to lower the cost of the product far enough for small farmers to afford it in some of the countries we studied.

Distributional consequences: business opportunities. The science base of the emerging technologies we have studied leads, in three out of five technologies, to a strong role for intellectual property in creating a business opportunity. In the mobile case, a welter of IP holdings tend to be cross-licensed within the industry and the advantage of being a country that is home to a technology creator is seen in the role the Blackberry patents are playing in Canada in keeping some manufacturing there. The original patent on recombinant insulin was licensed to firms that are still the main competitors in the field, and Monsanto protects its intellectual property in GM maize with an aggressive legal campaign. In all these cases, IP protection has the tendency of concentrating assets and business opportunities. In contrast, in two of the studies IP is either not important (tissue culture) or used to disperse the business opportunities (open source, which enforces open IP).

In these two cases, however, there were other barriers to entry for new businesses. In the open source example, an individual or company must have a high level of technical skills to get into the business. Skills are also quite important in plant tissue culture, plus the significant capital investment already mentioned for a clean facility. IP is therefore not the only aspect of emerging technologies that tends to concentrate business activity rather than spreading it. Likewise, the cases reveal a number of other strategies that large firms are using to hold onto monopoly rents that have their IP at the core, such as Monsanto's acquisition of local seed companies and related services.

The science base of the emerging technologies also implies that micro-enterprise is an unlikely beneficiary of the new development, and in three out of five stories, this hypothesis is confirmed. Bu software piracy is small business, and like open source undermines the concentrating effects of the proprietary software business. And in the mobile phone story, micro-enterprise is a prominent feature, from local businesses that sell minutes on cell phones to those who do not own them to the ubiquitous pre-paid card venders in Mozambique. Both these examples involve micro-enterprises based on re-selling small quantities of something that another company has manufactured.

Distributional consequences: employment. We were a bit surprised to find some manufacturing jobs associated with our five technologies located in the affluent countries in the study. These were high-skill jobs in the pharmaceutical industry, which are not numerous but pay quite well. At the other end of the spectrum are the sales jobs associated with emerging technologies that are shaped to reach a mass or even bottom of the pyramid market. Sometimes the new product does not produce new jobs, but is rather absorbed into an existing production process. New jobs in the new industries thus do not always displace older jobs, but may in fact retain them. The most obvious loss of jobs associated with the technological changes we studied were the losses in landline telephones. In the farm sector, although micro propagation as an expensive input tended to help small farms fold and larger farms grow, the larger farms were employing people in different kinds of jobs, so no clear downward trend in employment was visible. The employment issue associated with ownership was the unhappy circumstance that multi-national enterprises were able to move jobs into and also out of a national economy. This was obviously disruptive nationally and can contribute to unemployment and poverty. But from a global viewpoint, the practice probably has a dispersing rather than concentrating effect. And Malta has used attracting foreign direct investment as an employment-generating opportunity.

Distributional consequences: benefits and costs. All the technological projects we studied provided benefits, so the diffusion of the technology itself is one important indicator of the distribution of those benefits. As expected, price is an important determinant of diffusion or penetration rate, but we were interested to find that it was definitely not the only one. The most dramatic illustration of another factor determining patterns of use is in the open source example. By definition, the product itself is free; but this simply means that other factors shape the distributional patterns. For the business applications, large firms were more likely than small ones to use open source software, primarily because a firm needs in-house expertise to absorb and maintain the product when it does not come bundled with support from a proprietary software company. On the consumer side, open source software provides no benefit if you do not have a computer, so having enough money to acquire the computer itself becomes the limiting factor.

Likewise, the traditional diffusion model's prediction that products will initially be expensive but that prices will drop as a mass market emerges does not characterize all the cases. Tissue cultured banana plantings were free for a while in Jamaica, in a program subsidized by the European Union. When the subsidy stopped, large farmers were able to import material but the small farmers simply went back to using previous methods. The high capital and labor costs of micro propagation put a minimum price on the planting material that did not allow it to reach the market at the bottom of this agricultural pyramid.

The complementary assets of skill and infrastructure then serve as important secondary factors shaping distribution. Complementary assets can even turn benefits into risks and costs for emerging technologies. Our example is recombinant insulin. Doctors in Mozambique do not always prescribe insulin in medical situations where doctors in Europe or the U.S. would, because their patients are so poor that their lives cannot sustain the regimen of the treatment. Under the circumstances of these patients, insulin can actually be a life-threatening drug; the risks of taking it would be greater than the benefits.

Public interventions, a somewhat broader concept than pubic policies and programs but closely related, are key variables in our analysis. Public interventions affect emerging technologies in the contexts of both discovery and commercialization.

In terms of the context of discovery, our five technologies had diverse histories. The institutional environments that gave rise to the principles involved in the technologies included international public laboratories (plant tissue culture), publicly-funded university research (recombinant insulin, GM maize), and private laboratories (mobile phones and open source software). All were conceived in pursuit of some general public benefit. One could not predict which of the five would produce the broadest benefits by knowing where their underlying principles were discovered.

A sharp bifurcation begins to emerge, however, as the principles are turned into practices. At this stage, intellectual property rules, a traditional instrument of STI policy, make a significant difference, as we described earlier. In addition, five main categories of interventions that fall outside traditional STI policy appear in the cases: public procurement; public utility oversight; anti-trust actions; health and safety regulations; and environmental protection. The first three are mildly to strongly re-distributive, while the latter two affect access negatively because while reducing overall risk they also raise costs, often unevenly across producers. Let us say a few words about each.

Clearly, if an emerging technology represents an irreplaceable capacity to solve a basic problem, governments are likely to intervene to make sure that capability is available to everyone in some form. Among our cases, recombinant insulin exemplifies this phenomenon (with some exceptions, as noted below). Insurance schemes or health services provide access to basic medicines for most people in most places, and when they cannot afford to do so, NGO coalitions are likely to intervene to ameliorate the situation, as they did with AIDS medication. Interestingly, public provision also plays a role in tissue culture and micro propagation, where making quality planting material available to farmers is seen in some contexts as a public responsibility. Most consumer goods fall outside this "essential" category, so we would not expect governments to subsidize or purchase mobile phones for poor individuals; but interestingly, governments have started to acquire for their populations the new inexpensive laptop computers, some of which are equipped with open source software.

Public utilities are also closely regulated because of the perception that they provide basic services that should be accessible to all citizens. Public utility oversight therefore plays a re-distributive role in some countries in the mobile phone example. Telecommunications regulators are concerned with keeping services "affordable" and encouraging tariff structures that extend service broadly rather than concentrating it only among the affluent or in urban areas that are easier to serve. These principles are historically rooted in oversight of land line telephones. They are clearly de-concentrating or re-distributive.

Telecommunications regulators have sometimes allowed "natural monopolies" in land line service, but are more concerned with creating or maintaining competition in the mobile phone sector. The higher level of competition in the sector appears to contribute to the push to provide service in smaller increments to lower-income consumers. The characteristics of the technology also contribute: the ease of installing capacity and the negligible incremental costs of serving additional consumers within a geographic area.

Anti-trust regulation also plays a role in the distributive effects of open source software. Open source software breaks one source of monopoly created by proprietary software companies, namely, ownership of and secrecy around source code. Opening up source code creates small and medium-scale business opportunities for support firms and others that want to develop applications, and thus distributes business opportunity more broadly than the five software giants (four American and one German) would do on their own. At the same time, however, the requirement for a high level of complementary programming skills to be able to absorb and maintain open source software has led to the irony that large firms are more likely than small firms actually to use it – a negative distributional effect.

The other sets of public interventions that we have encountered in the cases are health, safety, and environmental regulations. Recombinant insulin needed to be approved by the U.S. FDA, then re-approved in other countries, in order to be available for use. GM maize likewise needed to be cleared for planting, under regulations that vary from full approval in the U.S. and Canada to limited approval in Europe to outright prohibition in Costa Rica and Mozambique. The environmental regulations in Europe are an interesting example of how these kinds of regulations raise costs and therefore have a concentrating rather than dispersing effect. Farmers in the Czech Republic, our example country for GM maize in Europe, only find GM maize useful if they are in an area that where their crops are susceptible to European Corn Borer. If they need to use the GM variety, they not only face the higher costs of the seed, but also the higher costs of meeting European regulations for planting, such as leaving open zones around their field to prevent cross-fertilization. Small farms on the edge financially are not as likely to be able to absorb these costs as larger operations. Similarly, the regulatory approval process raises production costs for drug manufacturers – costs that they pass on to consumers in the form of higher prices. Those prices in turn make it harder for poor people and poor countries to get access to the benefits of the drug.

Patterns Within and Across Countries

National conditions, one of the key variables in our analysis, played a different role than we pictured when we started the project. Distributional consequences for the individual technologies are not mediated by averages, like those given in the introduction for the case study countries, but rather by specific conditions for particular individuals, firms, or companies. For example, for a firm to be able to use open source software, it is not the average level of programming skills for the country that is important but rather the firm’s own in-house expertise. Likewise, while the low average income per capita in Mozambique indicates that it is a country where many, many people are very poor, individuals with good incomes in the capital city can afford to buy a mobile phone or drive to South Africa to buy insulin.

This finding points to the fact that pockets of concentrated expertise can make a difference in whether a technology’s benefits are accessible in a particular country. However, some of the national contexts in our study were better able than others o provide multiple opportunities for the absorption of new technologies into economy and society. The two major non-price constraints that we described above -- skill and infrastructure -- are not often constraints at all in the affluent countries in our study, Canada, Germany, Malta, and the U.S. In those countries, there the distributional issues have to do with spreading the business opportunities around geographically, creating equal opportunity for traditionally marginalized groups, and subsidizing access in some cases. Without special policy efforts to distribute the benefits broadly, emerging technologies are absorbed through the existing relations of power and production and tend to increase the wealth and influence of those already at the top in those contexts.

The picture is much different for the low and middle income countries in our study, Argentina, Costa Rica, Jamaica, and Mozambique. There emerging technologies comes appear most often in the hands of multi-national firms. (Plant tissue culture is an exception to which we will return in a moment.) The multinationals not only own the new technology, but can also buy up any local firms that might compete with them – as Eli Lilly Company bought out the Argentine interest in synthesized porcine insulin in the 1920s. Ownership gives control and is clearly accompanied by relations of unequal power.

Across the four low and middle income countries of the study, there is significant variation in the extent to which local businesses grow up around the technologies. Argentina supports a lot, and Costa Rica supports local as well as multinational banana farms through its research facility. Micro-businesses may thrive in the shadow of the large firms, like the street vendors who sell recharge cards for mobile phones on the street in Mozambique. But a number of businesses we would have expected did not appear in the data: no open source firms in Costa Rica, despite a significant software sector; no plant tissue culture business in Jamaica.

As noted earlier, no major shifts in employment were visible in any of our case studies. The shift that seemed most likely was the substitution of recombinant for porcine-based insulin that affected the production facility in Argentina; but local action prevented the plant from closing and a local market maintains it. The contrast with well-known cases like Korea and Thailand in which production of high-technology products has moved to developing countries is striking, and illustrates how limited those other experiences are, and how hard it is to generalize from them to other developing countries.

All the technologies we studied were widely accessible in Argentina, Costa Rica, and Jamaica, with some rather specific holes in coverage. The wide availability of recombinant insulin, for example, was largely as a result of health insurance and public health services, so where someone did not have access, it was because they were not covered – a situation that characterized a surprising 25% of Argentines and probably the full 40% of Jamaicans who work in the informal economy.

The situation was different in Mozambique. Since there are only 20,000 computers in this country of 20 million, not many would have been able to benefit from open source software. Mobile phones are heavily concentrated among male users in Maputo, according to a telephone survey done by our Mozambican team. And for the estimated 80,000 diabetics in the country, only enough insulin for perhaps 50-100 is imported. Doctors in Mozambique are reluctant to prescribe insulin to people in poor households who will not be able to maintain the necessary regimen. So ironically, while insulin is free through the public health service there, rich people are much more likely to benefit from that policy than poor ones. Likewise, ironically, pre-paid phone plans make mobiles accessible to poor consumers, but they pay more per minute used.

None of these limitations is inevitable, as the story of the tissue-cultured orange flesh sweet potato plantings in Mozambique illustrates. In that case, a government laboratory has been working with several NGOs to provide the higher quality plantings to small farmers, mostly women. They are successful in part because the technique is publicly available and free, as well as because of their community-based multi-pronged approach involving education and subsidies.

The Technological Transition

We are beginning to tie these various observations together with a new concept, a structural feature of the global economy that we will call the technological transition.[6] One set of diffusion and adoption dynamics is characteristic above the transition point and another set below. Predictable shifts in dynamics therefore occur for any given technology at the point of transition, an inflection point in the global income distribution, placed such that below the transition point will be a disproportionate number of women and members of disadvantaged religious and ethnic groups.

Above the transition point, champions can choose among luxury or mass markets for the products they create from the technological opportunity. Basic infrastructure can be taken for granted and champions must compete for the portion of a market created by the variety they offer. Technological choices involve relatively small costs in relation to income, and consumers have the resources and leisure to shop around.

Below the technological transition point, the product may be irrelevant (open source software for people without electricity let alone computers) or downright dangerous (insulin in an urban slum). If the product reaches poor consumers at all, it is likely to be either in second-hand form (like the hand-me-down mobile phones common in Maputo) or broken down into small lots that cost more per unit (again, the higher rates per minute for pre-paid versus contract mobile phone access illustrate). They thus pay a larger share of their income to have access to the benefit, and the whole issue of benefits becomes more acute because the opportunity costs are relatively higher. The important questions then do not have to do with access per se, but rather with whether access might actually be counter-productive.

Policy Options

Clearly, there is no one-size-fits-all set of recommendations that can be made based on our findings. Even among the developed and among the developing countries, national circumstances and political traditions differ and call for different approaches to spreading

[6] This is an analogy to a concept in public health of the epidemiological transition: that one set of diseases characterizes countries with incomes up to a certain level, after which certain infrastructural conditions have been met and a different set of diseases emerges against the background of generally good public health. The first set is the “diseases of poverty” and the second set “the diseases of affluence.”

the benefits of emerging technologies broadly. We can, however, make a few generalizations based on the findings of the study.

The analysis has assumed that opening up new business opportunities with new actors in new places is one way to reduce economic inequalities. Intellectual property protection is a key policy for shaping those opportunities for emerging technologies, both within countries and in global economic relationships. Our results suggest that a broader range of economic actors will be able to develop the technology if patent and copyright protection are limited to their original purpose, providing a temporary monopoly, rather than a strategic resource for large corporations to extend the monopoly. The more licensing is required for publicly-discovered techniques, and the more techniques that can be put in the public domain, the more organizations will develop them and the more uses will be invented. This diversity is the most powerful tool for spreading the benefits of emerging technologies broadly.

On employment, the results suggest national vigilance, but not panic. Based on our cases, the new technologies are most likely to shift jobs from one category to another, demanding somewhat higher skills, rather than to cause wholesale unemployment. These results provide a cautionary note to counter the claims in developed countries that new technologies will generate enormous numbers of new jobs.

The uneven distribution of the costs of new technologies certainly features in our results. The costs in these cases were primarily financial, not the health and safety risks that often feature in accounts of emerging technologies. Our results suggest that policymakers want to be vigilant about uneven distributions of costs, for example, the additional cost of regulation that some Czech corn farmers face if their ecological position makes GM maize their best technological option; or the higher unit costs paid by pre-paid mobile subscribers. Regulators have a responsibility to spread costs and prices fairly.

This brings us to the center of our analysis, the distribution of benefits of the emerging technologies. The cases suggest that this is not an issue for every new technology. High-end consumer goods, like fancy mobile phones and the newest generation insulin, are luxuries that do not warrant the attention of public policymakers. When emerging technologies produce major improvements, however, that can be provided at low cost to large numbers of people, it is important for public policy to seek to create the conditions to let that happen. Sometimes that may be public procurement, as in health service provision of recombinant insulin. But the issue may also loop back to the discussion of business opportunities. Government can use competition to bring down prices and extend markets. Keeping IP protection to a limited term also helps.

Public interventions on emerging technologies can usefully incorporate two concepts that have been used across the ResIST project. On the one hand, ET policies should try to reduce the *representational inequalities* that now characterize high-technology decision processes. Different groups within society experience the same new technology differently. To maximize benefits, a variety of groups should have a chance to shape technology itself and advise on the way it is incorporated into society.

On the other hand, *structural inequalities* underlie all of our cases – gaps in capabilities that affect the absorptive capacity of various countries, that is, their ability to use the technology effectively, broadly, and on their own terms. Our cases reflect structural inequalities not only the lack of relevant scientists and engineers, but also differences in basic education and living conditions. Interesting, by looking one technology at a time, we have shown that countries do have the option develop pockets of expertise to increase absorptive capacity in relation to a particular, important technology. The work our colleagues have done on alternative STI strategies[7] also suggests that reducing inequalities can start in the conception of technological projects themselves. Countries that find the technical characteristics and economic relationships of current technologies difficult or unworkable can apply their inventive capabilities to discovering versions that work in a broader range of circumstances, including theirs.

In summary, the study moves the discussion of emerging technologies well beyond anti-corporate blame, North-South recriminations, and simplistic calls for liberating technological movements. The real worlds of emerging technologies are diverse, but all carry within them the possibility of more equal outcomes for the world's households.

[7] Cozzens, Kallerud, and Santos Pereira, "Science, Technology, and Innovation Policy for Social Cohesion," in preparation.