Seminar on UNCTAD's Technology Innovation Report 2021
Susan Cozzens commentary, April 27, 2021

Thank you for the invitation to participate in this interesting seminar exploring the implications of the Technology Innovation Report 2021 (TIR). I am honored to have contributed to this report, which is very thoroughly researched, beautifully presented, and addresses an important dynamic in the world economy. One of my roles in the report was to go through dozens of national plans on AI/digital economy and biotechnology. I will be drawing on some of what I saw there in these comments.

I was recruited to contribute to the report because of the many case studies my colleagues and I have done to understand the connections between emerging technologies and global inequalities. We started by studying innovation in water and sanitation in developing countries and then undertook, with colleagues from Europe, Africa, and Latin America, a large cross-national, cross-technology comparative study of distributional consequences of emerging technologies. This was published in a volume called Innovation and Inequality: Emerging Technologies in an Unequal World (Edward Elgar, 2014). We then carried the lessons learned into analysis of equity and equality issues raised by nanotechnology, as part of the Center for Nanotechnology in Society at Arizona State. All this work was funded by the U.S. National Science Foundation; I am grateful for that support.

Across the various studies, some summary points were evident. **Emerging technologies as produced and shaped by the market alone do tend to increase inequalities. But those tendencies can be counteracted with conscious design of policies and enterprises.** The question I want to explore with you in these comments, then, are "Which policies? What should be taken account in the conscious design?" for emerging technologies to become inequality-reducing rather than inequality-enhancing.

Three approaches

My colleagues and I gradually grouped the policy tools for this task into three categories: pro-poor, egalitarian, and equalizing. Pro-poor approaches aim to make life better for people at the bottom of the income scale. Egalitarian ones aim to reduce inequalities on the horizontal dimension, across culturally defined groups such as gender and religion. Equalizing approaches aim to change the shape of the economy to reduce polarization.

The examples presented earlier in this seminar by the Institute for Transformative Technology (ITT) exemplify *pro-poor approaches* well. Indeed, the overall thrust of the TIR to orient innovation using the Sustainable Development Goals (SDGs) supports this direction, setting the expectation that the technological projects will Leave No One Behind. There was actually very little of this kind of work reflected in the national plans we reviewed; India's was the only one to pay significant attention to this potential. The TIR thus provides an important counterweight to the visions national governments have been developing for these frontier technologies.

The case studies in Innovation and Inequality focused on "technology champions," whose vision of what the technology would do also determined whose needs it would serve as it moved from invention into innovation and practice. National governments seeking to include pro-poor elements in their strategies for frontier technologies also need technological champions with pro-poor goals, as exemplified by the presentations in this seminar. Having found them, they need to create the incentives and conditions they need to succeed in their projects.

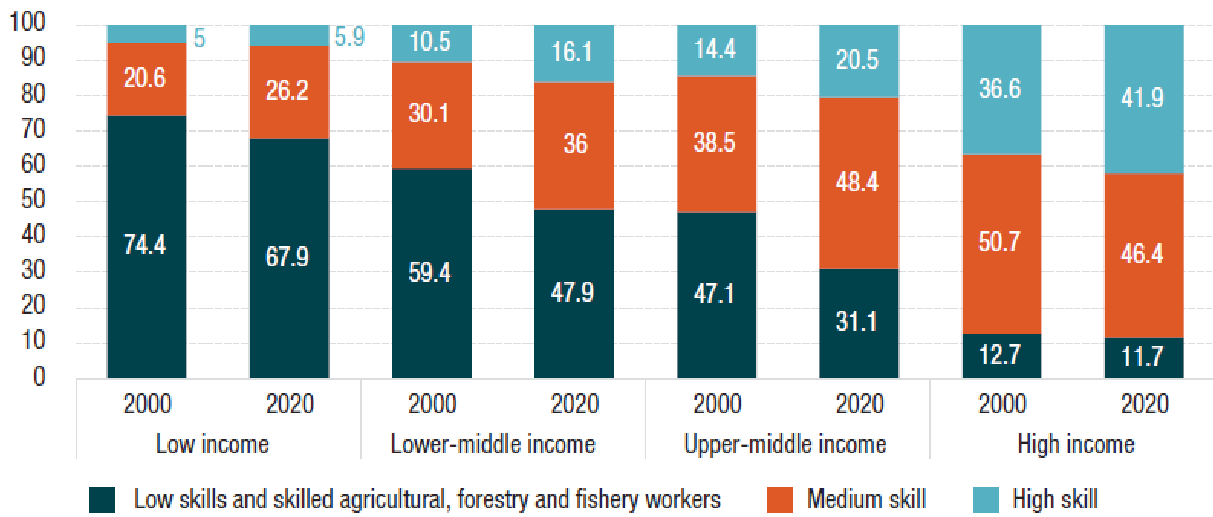
With regard to the *egalitarian approaches*, there is little mention either in the national plans or the TIR about reducing inequalities across racial or ethnic groups; the relevant groups vary greatly by country and region and would be hard to include in an overview of the kind the TIR provides. The national plans however, mention gender as a factor that should be taken into account in developing national frontier technology initiatives, as does the TIR, reflecting the UN's strong commitment to using a gender lens in viewing development. Most frequently mentioned are the importance of girls getting STEM education and women moving into STEM careers, along with the need to include women in technological design processes. For the context of the global South, however, the inclusion of women in project design is equally important and not nearly as often mentioned. Designing a community water project, for example, without co-design by the women who live there, is courting failure.

The national plans in general promise job creation, as do the ITT projects. These could be made more egalitarian by pointing to the importance of the new jobs being accessible to both women and men and to all cultural subgroups, as well as commitments to equal pay in those new positions.

The equalizing approaches change the shape of the economy in ways that reduce polarization. In the national plans, attention to regional disparities illustrate this approach. Many plans mention using the opportunity of the new technology to strengthen rural economies or revitalize regions that have lost older industries. There is another frequently mentioned goal that concerns me, however, from the viewpoint of its impacts on inequalities: the focus on high-skill jobs.

It is standard in the rhetoric of high-technology development to project creating high-skill, high-wage jobs. It sounds really wonderful, just what any economy needs. In the context of a discussion about inequality, however, that goal looks a bit different; and it is likely to have different impacts in different labor markets. To understand this, I refer you to Figure III-5 in the TIR. (Clovis showed this figure earlier in this seminar.)

Figure III 5
Employment by skill level
(Percentage of total civil employment)



If we add some high-skill jobs to the labor mix in the high-income countries in this figure, we are changing the mix only modestly. But if we add the same number of jobs in one of the low-income countries, we clearly increase polarization. The high-skill workers might even be paid at wage levels that compete with other parts of the world economy, perhaps well out of the local income range. And those jobs will be far out of the reach of the large number of low-skill workers in that economy.

For these reasons, I am a strong advocate of focusing innovation-related job creation in low and lower-middle income countries on middle-skill, middle-wage jobs – not to the neglect of some high-skill jobs but in addition. In the middle-skill range, there is the potential for larger numbers; the jobs are within training reach of many more people; and the incomes support goods and services often produced by the low-skill workers (through a process I call "trickle down from the middle"). These jobs fill in the middle of an income distribution and thus decrease polarization. National policymakers may therefore want to include a focus on linking innovation to middle-skill jobs as part of their designs for equalizing approaches to using frontier technologies. The supplier development programs that Al Watkins just described in this seminar might be an excellent place to try out such a strategy.

Lessons learned

With my last few minutes, I would like to share some of the lessons we learned in our cross-national comparisons about the conditions that affect how broadly the benefits of a new technology are spread. These points could be used in the design of initiatives that incorporate frontier technologies into either affluent or less affluent economies.

The first set of lessons concerns ownership. There is sometimes a feeling that technologies that have broad public benefit are most likely to be developed in the public sector. We did not find this to be the case. Mobile phones, the poster child high technology that has reached just about everyone, was developed entirely in the private sector, for example. Another kind of ownership, however, had a huge influence in our case studies, that is, who owned intellectual property. When key knowledge is turned into IP owned by one or a few companies, their visions for how it will be applied and used will prevail. When it is more open, however, there are more likely to be multiple visions and multiple uses. Our example was plant tissue culture, a technique that was born public without patent protection in the international agricultural research system. Because it was an open technique, it was used in many different kinds of enterprises, some public, some commercial, some non-profit, some cooperative. The entrepreneurial spirit, armed with an open technology, spread benefits to more people for more ends.

The second set of lessons that affect how broadly benefits are distributed concern the competitive environment. Anti-trust regulations can be very important, including opening competition beyond national champion firms. In the mobile phone case, this step was crucial. The new firms that entered the market had stronger incentives to expand their customer base, so they were the ones that picked up the technology (invented long earlier) that supported pre-paid plans. And it was pre-paid plans rather than monthly subscriptions that made mobile phones so widely affordable and generated the large number of small, often informal businesses that thrive in low-income communities with auxiliary services for mobiles.

A third set of lessons derives from a concept we introduced, the concept of distributional boundaries. Standard diffusion theory incorporates the assumption that new technologies are introduced at high prices and diffuse outwards as prices fall, until they reach the point at which prices cannot be lowered any further given the production costs. We did not find this to be the case; instead, the availability of other elements combined with price to mark a point at which diffusion got stuck: the distributional boundary. The fact that price is not the only determinant of diffusion is illustrated with open-source software, which is free. Yet large companies are more likely to use it than smaller ones, and large universities rather than small colleges. The reason is that an organization needs a high level of computing expertise in-house to modify and maintain open-source software; some organizations have it and others do not. Likewise for individual consumers, the free software does no good unless they own computers, which most people in the world do not. Dependable electricity would be helpful as well, to say the least. Another example from our cases is recombinant insulin, which is free through many national health plans but not prescribed by doctors for patients who do not have the home infrastructure to maintain the necessary regimen.

The distributional boundary, we assert, is set not only by price but also by skills and infrastructure. There is a relationship between this concept and the five A's of the TIR. An exciting potential of pro-poor projects like the ones ITT described earlier in the seminar is that they can move the distributional boundary outwards making the benefits of a technology available to a wider group by changing conditions of skill and infrastructure, in addition to lowering price through frugal redesign of the technology itself.

The case studies also pointed to an important aspect of expertise. Even though world-class experts may constitute an elite in many countries, just a few experts can make the difference in whether a whole country has knowledgeable access to a technology (its "absorptive capacity" in the term economists use). One nice illustration of this appears in the TIR: the local epidemiologist in Rwanda "using sophisticated mathematical algorithms … to minimize the cost and maximize the effectiveness of COVID-19 testing" (TIR p. 72).

Another policy that deserves attention in the design of initiatives is regulation. Health and safety regulations are essential, but their costs can accumulate unevenly. What are the costs to low-income countries, for example, of adopting regulations written in Europe or North America?

In brief, our case studies showed that many policies and programs are important, not just STI (science, technology, and innovation) policies, in shaping the distributional consequences of frontier technologies as they work their way into institutions, economies, and societies.

Conclusion

In summary, the TIR not only presents a solid analysis but also a number of promising pathways for setting the conditions for frontier technologies to address major inequalities. I look forward to seeing its impacts.