



Work Package 4

Distributional Assessment of Emerging Technologies

Introducing Work Package 4

The main task of Work Package 4 was to develop a framework for assessing whether new technologies are likely to increase or decrease inequalities. To accomplish this task, research teams from Germany, Malta, Mozambique, Norway and the United States carried out research on five technologies across eight countries with varying levels of development. In partnership with the project *Resultar*, funded by the U.S. National Science Foundation under Grant 0726919, we are working toward the production of an edited volume reporting on the research.

What is the problem?

Emerging technologies are new, science-based technologies that have a high potential to increase both economic growth and social inequality. Inequality becomes an issue because high research costs and skill requirements generates distributional consequences through high relative prices. For this reason, emerging technologies have a higher potential than older technologies for generating inequalities in access and employment. The benefits and costs of creating, producing, and using the new technology varies considerably across countries and people, a situation which is shaped by policy interventions.

The main objective of Work Package 4 was to model the distributional impact of new science-based technologies on business opportunities, employment, benefits, and costs. To accomplish this task, the research aimed to:

- Describe the dynamics that link emerging technologies to patterns of inequality;
- Identify the roles of public interventions in those dynamics; and
- Develop a framework that policy actors can use prospectively to analyze the distributional significance of a specific new technology in a particular national context.

Our central research question is how policy interventions affect distributional outcomes for the same technology under different national conditions.

Our study

This work package studied the distributional consequences of five technologies in eight countries. We looked at the distribution of business opportunities, employment, benefits, and costs. To capture the full impact of emerging technologies across different development levels, the project focused on technologies that emerged some time ago to be able to track actual effects rather than projecting them. The cases were information and telecommunications technologies and biotechnologies. Examples from the past were used to develop a framework for thinking about the future for new areas such as nanotechnology or synthetic biology. The five cases studied are: genetically modified (GM) maize, mobile phones, open source software, plant tissue culture, and recombinant insulin. They represent both proprietary and public ownership models, and range from simple to highly complex. The eight countries included are: Argentina, Canada, Costa Rica, Germany, Jamaica, Malta, Mozambique, and the United States. Half are high-income and half are low or middle-income countries.

Results and recommendations

Two factors were clearly significant in the distribution of business opportunities. One was intellectual property protection. In some of our cases, multinational corporations held tight control of intellectual property around a new technology, limiting the opportunity for other firms to enter the market. In GM maize, corporate control limited business opportunities even in related industries in countries far from headquarters. In recombinant insulin, the control is so tight that generic manufacturers had a hard time entering the market even after the original patents expired. In contrast, plant tissue culture, a public sphere technology, has created business opportunities in both developed and developing countries in our study.

A second constraint on business opportunity, however, is skill. If an environment does not have enough people at a high enough skill level to support or extend the technology, the ownership question is moot. Open source software illustrates this. Open source software is more likely to be used in large firms or universities

than small ones. The reason appears to be that in order to benefit from the open source code, the organization must have sufficient programming skill to be able to make adjustments to the software itself. For the same reason, open source software businesses appear to develop only in places where there is already a software industry; we did not find evidence of open source-based businesses in the developing countries in our study.

Direct employment effects of the emerging technologies in our study were small, except for the mobile telecommunications industry. In this industry, employment increased with the new form of service, and declined as landline subscriptions decreased. For the other technologies, high-technology manufacturing jobs tended to stay in affluent countries (e.g., in recombinant insulin), and there was a modest shift from lower-skilled, more dangerous jobs to somewhat higher-skilled, less dangerous ones. For example, GM maize allows for less pesticide use, a benefit to farm workers. By raising and stabilizing yields, the agricultural technologies we studied also stabilize incomes for family farms and their employees. Our study did not include any of the countries that experienced rapid growth in employment through electronics manufacturing – indicating that those experiences may be the exception rather than the rule.

Public policy had several effects on the distribution of benefits and costs from the five technologies. Environmental regulation in Europe raises production costs for farmers who grow GM maize to fend off European corn borers. Deregulation in the mobile phone industry increased competition and led to an expansion of pre-paid plans in several countries and hence a rapid proliferation of mobile telephones worldwide. Nevertheless the cost per call unit is higher in pre-paid plans, and the share of family income consumed is also disproportionate for low-income families and in less developed countries. Even the pre-paid plans, however, cannot reach the poorest consumers in areas where electricity is not dependable and the wireless equipment not installed. Thus we found that in Mozambique, mobile phone use is largely confined to the capital city, and men are much more likely to use them than women.

Recombinant insulin was made more available through public procurement by national health services in most countries in our study. But in the United States, the private insurance system creates significant gaps in coverage. And in Mozambique, doctors are hesitant to prescribe an insulin regimen for use in very poor households, as they have difficulties keeping up its complicated requirements. Public procurement also made tissue culture for banana plants available to poor farmers in Jamaica, but when the public subsidy disappeared, these farmers could not afford to import the material, as more affluent farmers could. These examples show that the distributional boundary for the technology is drawn partly by public action and partly by family conditions.

The study shows that national conditions matter a great deal in crafting policy options to spread the benefits of new technologies broadly. Furthermore, it suggests that:

- Intellectual property protection should be moderated so that it is not used to suppress business opportunities for local enterprises in developing countries or limit their access to essential goods.
- Creating pockets of highly-skilled workers is critical in giving developing countries local access to new technologies.
- Basic infrastructure and education are important investments in increasing the capacity of highly unequal countries to absorb and diffuse new technologies widely.

The project has produced a framework of questions to pursue about proposed technological projects, plus established patterns in expected answers, together constituting Distributional Technology Assessment (DTA).

Want to Know More?

Research carried out in the work package will be available on the ResIST website at:

<http://www.resist-research.net/paperslibrary/full-and-final-results.aspx>

A *background paper* by Susan E. Cozzens, Sonia Gatchair and Dhanaraj Thakur, 'Distributional Assessment of Emerging Technologies: A framework for analysis' is available on:

- <http://www.resist-research.net/paperslibrary/research-summaries.aspx>

Papers based on the project presented at professional meetings in 2008 include:

- http://prime_mexico2008.xoc.uam.mx/papers/Susan_Cozzens_Emerging_Technologies_a_social_Cohesion.pdf
- http://globelics_conference2008.xoc.uam.mx/papers/Dhanaraj_Thakur_The_Distributional.pdf
- http://globelics_conference2008.xoc.uam.mx/papers/Isabel_Bortagaray_Analyzing-the_interactions.pdf
- http://prime_mexico2008.xoc.uam.mx/papers/Dhanaraj_Thakur_Technology_Policy_and_Distributional.pdf