Distributive paths and channels of emerging technologies in developing countries: What can we learn from biotechnology and ICTs in Argentina and Costa Rica?[1]

Work in progress

Isabel Bortagaray
Associate Professor, University Research Council
University of the Republic-Uruguay
Research Associate, Technology Policy and Assessment Center
Georgia Institute of Technology
Isabelbortagaray@gatech.edu

Susan Cozzens
Associate Dean for Research, Ivan Allen College
Professor of Public Policy, School of Public Policy
Director, Technology Policy and Assessment Center
Georgia Institute of Technology
susan.cozzens@iac.gatech.edu

Paper presented to the 7th Globelics Conference
"Inclusive Growth, Innovation and Technological Change: Education, Social Capital and Sustainable Development"

Dakar, October 2009

Abstract

This paper analyzes the paths of emerging technologies in developing countries, particularly considering its distributive dimension along the chain of functions, from knowledge production, to the technology's production/provision, its incorporation into the productive system, and to its more generalized access and use. Two contrasting countries, Argentina and Costa Rica, set the context of study of these paths, the different conditions through which they make their way across sectors and actors, their functions and roles, and the type of distributive channels involved.

The analysis of the distributive patterns of emerging technologies must include at least two intertwined levels: at the level of knowledge production, diffusion and access, and the second related to technology's diffusion-commercialization, access and use. The twofold analysis involve a common emphasis on the identification and analysis of who

[1] This material is based upon work supported by the National Science Foundation under Grant No. 0726919. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

produces/gets what, how and when, and on the channels of distribution that contribute (or not) to the breadth and depth of the technology. More in particularly, it considers those policies, organizations and/or institutions that substantially influence/shape the way in which the technology penetrates society. In some cases these have to do with establishing channels for bridging knowledge production and use, while in others their contribution is towards the expansion of technological access and appropriation. It also looks at the different roles of policies along each phase of the technology.

This paper argues that at the level of knowledge production, public research organizations (national and/or international) are fundamental for catalyzing the expansion of the distributive path, in spite of differences and peculiarities of the technologies. Yet at the level of the distribution of the technology, this role is not always embraced by a specific actor or by policies, in which cases distributive paths are interrupted, and pockets of population remain outside from the technology's path.

It directly results from a large research project, RESULTAR[2], oriented to study the distributive consequences of emerging technologies in five countries of the Americas (Argentina, Canada, Costa Rica, Jamaica and United States), and concentrated on two sets of emerging technologies: biotechnologies (GM, tissue culture, and recombinant insulin) and ICTs (Open source software and Mobile Phones). Moreover, RESULTAR attempts to: "(1) describe the dynamics that link emerging technologies to patterns of inequality; (2) identify the roles of public interventions in those dynamics; and (3) develop a framework that policy actors can use prospectively to analyze the distributional valence of a specific new technology in a particular national context."[3].

This paper takes some distance from the focus on outcomes to concentrate on the paths of these technologies across the population, focusing on the mechanisms and channels through which they are accessed and utilized. In particular it draws on 40 in-depth interviews conducted to a wide range of actors, including researchers, policy-makers, technology users, NGOs, and productive actors related to the five technologies in the two countries[4].

---

[2] This paper has substantially benefited from insights and discussions at RESULTAR workshops (Malta, May 2008; Stellenbosch, November 2008 and Karlsruhe, February 2009).

[3] For more details see (Cozzens 2007)

[4] Interviews were conducted in November 2007 in Argentina, and in February 2008 in Costa Rica.

Setting the context

Among other characteristics, disparities and inequalities pulse the life of Latin America. Disparities in consumption is only one side of it, aggravated by enormous inequalities in the capabilities and freedom to choose what life to be lived (de Ferranti, Perry et al. 2003). The setting of this paper is defined by two Latin American countries, largely different but with a common Spanish colonial root. They serve as boundaries, delimiting the settings where to trace the paths and connections between science and technology, and outcomes. Argentina and Costa Rica conform a contrasting duo. Argentina is the second larger country in South America after Brazil, with near 40 million people. Richly endowed with natural resources and very fertile lands, Argentineans are often facing deep fluctuations between high growth and drastic economic crisis and political instability. An unfortunate illustration of these waves is the the 2001 crash of the *Plan de convertibilidad* (Convertibility Plan) that fixed the Argentinean Peso to the US Dollar: 1 peso – 1 dollar during the 1990s. After a profound socio-economic crisis, it followed the political conflict and the resignation of the President (Rock 2002), while banks were crowded with individuals attempting to cash their money as a result of the 'corralito' (little fence) implemented by the Economic Ministry to limit the volume of withdraws.

Turmoil impregnates the country's history since its independence in the 1820s. Crisis and recovery conform the limits of a pendulous movement by which the country passed from being one of the richest in the world at the beginnings in the early 20th century, to a serious impoverishment one century later. Between the end of the 18th century and the beginning of the 19th, it was the country with higher sustained growth rate over a period of time (Skidmore and Smith 2005). The question of why such a shift, points at the burden of rent-seeking governments and policy elites. Della Pollera and Taylor (2003) argue that the country "missed the opportunity to design the right institutions that would secure sustainable growth and insulate the society from the voracity of politicians and rent seekers" (p. 374) (della Paolera and Taylor 2003). This perverse orientation is aggravated by a 'short termism' by which the "present time is often purchased at the cost of the future's".

A current picture of the country shows high alphabetization (97.2%), high life expectancy (74.2), and a GDP per capita of US$ (PPP) 14,280; the nation is then placed among the group of high human development (#38), the first Latin American country in that group, seconded by Chile (UNDP 2007). That reality coexists with regional disparities along factors such as access to and quality of education and health, illustrations of the 'other Argentina'. Inequality levels are relatively high, with a Gini Index of 51.3 (year 2004) (note that the 2000 survey in US indicates an index of 40.8) (UNDP 2007).

Costa Rica in turn, a Central American country with 4.5 million people, is well known for the pervasiveness of its democratic value system along with a tradition towards peace and conflict resolution, in a context characterized by stability, both political and economically. Its pacifist trajectory led the ex-President Oscar Arias Sánchez to be awarded with the Peace Nobel Prize in 1987 for his efforts to get the region out of armed conflict. Costa Rica was the only country that did not suffer violent conflicts in the 1980s, and proof of its pacifist tradition is its abolition of the Army in 1949, under the Presidency of Figueres Ferrer.

A strong welfare state, combined with a tradition of a more equalitarian society make Costa Rica unique compared to its Central American neighbors. Traditionally Costa Ricans' have proudly seen their country as an agricultural, pacifist and equalitarian republic, oriented to democratic values and social justice (Molina Jiménez 2003).

Emerging and emerged technologies

'Emerging technologies' refer to technologies that are new, science-based, rapidly expanding, and with significant market potential (Cozzens, Gatchair et al. 2005). Mytelka (2004) defines 'new wave technologies' as*:* "…anchored in the sciences and their knowledge base has developed less as the result of incremental change along a single technological trajectory than through a combination of several distinct trajectories with different scientific roots. These diverse roots, however, increasingly share a common platform –at the nano level of photons and genes. As a result, the research laboratory has become central in the discovery and development of new products and processes based on these technologies" (Mytelka 2004) (pp.396-7).

The focus on 'emerging technologies' of this paper and of the larger Resultar project is because of several reasons. First, their novelty provide the opportunity to observe ongoing change in developed and developing countries, where the supporting techno-economic networks are still young and malleable, thus providing a place for public interventions towards equality. Second, their research-based character might make them costly and demand high-level skills, which turn them with higher potential for increasing inequalities in access and employment. Third, they are at the crossroads between national-international processes, both in terms of the technologies creation-diffusion patterns and regarding inequalities. They enable to trace this (dis)connections within the national borders but related to more global dynamics (Cozzens 2007). Yet the technologies analyzed here are not emerging *sensu stricto*, rather some time has passed since their emergence. It was necessary to have this lag for technologies to establish in the context of developing countries.

The analysis of emerging technologies must include two intertwined layers: that referring to the end-products or devices, and the one referring to the scientific and technological processes behind them.

Paths and distributive channels of emerged technologies

The next section briefly describes the technologies to then concentrate on the paths and circuits generated along each one of them.

Brief characterization of the technologies

1. Biotechnology: Tissue culture, GM Crops and Recombinant Insulin

Both Argentina and Costa Rica held a strong research tradition and capacities around life sciences, though biology sciences have been the core strength of the latter. The former has a strong and well known reputation in this area, with three Nobel prizes: in Physiology and Medicine (Bernardo Houssay, 1947), in Chemistry (Luis Leloir, 1950), and in Medicine and Pharmacology (César Milstein, 1984). R&D investment

however is low, reaching 0.4 % of GDP (2000-2005)[5] (UNDP 2007), a trend not exclusive to Argentina but to Latin America in general.

In Costa Rica biology has concentrated research and development efforts since the 19th century (Rocha 2000; Zeledón 2000). The country is one of the richest reservoirs of biodiversity in the world. Its biological diversity and the concern over the use of natural resources have been at the center of science-making in Costa Rica. This accumulation is evidenced through well-established achievements such as the production of anti-ophidian serum in the Clodomiro Picado Institute[6] (University of Costa Rica) that is exported to many countries, or the internationally known journal *Tropical Biology* (*Revista de Biologia Tropical*), which is indexed in the *Science Citation Index* (Bortagaray 2007).

Plant tissue culture

Plant tissue culture refers to the regeneration of a whole plant from a single cell grown in sterile and controlled conditions, which locus is a clean room in a laboratory. It is based on cells that could be obtained from different sources such as the leaf, root, anther, protoplast, meristem or could be grown in sterile culture medium within a test tube.

The history of this technique goes back to the end of the 19th century to the basis of cell theory developed by Schleiden (1838) and Sehwann (1839) who independently stated that cells have an autonomic capacity and a totipotent character. But it took 130 years to support the thesis of cell totipotency with experimental evidence (Gautheret 1983).

In vitro culture is a special type of vegetative propagation but with some advantages compared to conventional methods, including controlling for sterilized conditions, shorter time of propagation, exclusion of pathogens, and potential of longer conservation. In vitro culture has several potential applications, including: micropropagation of pathogen free plants, development of new genotypes, conservation of germplasm banks, and culture in bio-reactors to extract secondary metabolites for industrial and/or medical purposes (Capdevielle and Castillo, INIA).

GM Maize

GM crops refer to those which gene structure is scientifically altered and manipulated. Different processes are involved, from isolation to manipulation, transfer and reintroduction of DNA into cells or model organisms. rDNA technologies applications to plants did not happen until the early 1980s. One of the most extended uses on genetic engineering on plants has been for herbicide resistance (Sharp 1995).

Recombinant Insulin

Diabetes mellitus is a widespread disease affecting large number of people across the globe. One of the responses pushed forward by drug companies to control for the

[5] In both cases the data is for the most recent year available in that period (UNDP 2007).

[6] Clodomiro Picado was a Costa Rican scientist who in the beginnings of the 20th century begun a line of research on biological and medical sciences that today gives name to one of the most respected research institutes in the country and its production of horse-based anti-ophidian serum which today is exported to several countries in Latin America and Africa.

human body's impairment of insulin production is recombinant insulin, a biotechnology-based product. R- insulin is synthesized in bacterial or yeast cells which genetic material is modified to include the insulin's nucleotide sequence coding (Walsh 2005) (Gatchair, Bortagaray et al. 2009). The global supply of r-insulin is concentrated in three multinational pharmaceuticals: Lilly, Novo Nordisk, and Sanofi Aventis.

The type and doses of insulin depend on prescription, diagnosis and the physician's preferences. A good diagnosis, changes in life style and blood sugar tests to establish the necessary quantity of insulin are key preconditions, strongly dependent on health care access. For type I diabetics, access to insulin is a matter of life or death (Gatchair, Bortagaray et al. 2009).

2. Information and Communication Technologies

Open Source Software

Open source software constitutes an alternative model to the traditional proprietary software (PS). The actual products developed under this model crosscut the different broad types of software: operating systems, application tools, and application solutions (Mowery 1999). Differences between PS and OSS are many and along several dimensions. First, the development of OSS is not carried on by a defined individual/organization/company, but distributed among several individuals, and built over time, as the source code is open and users keep contributing to its development. Secondly, it constitutes an alternative business model compared to PS. While in the latter the benefits are mainly associated to the software's IPRs, through royalties or licenses, in the former the software can be distributed, and copied with no or few restrictions. Lower costs, efficiency and individual freedom are some of the reasons for its appeal (Thakur, Beckert et al. 2009b).

Mobile Telephones

Mobile phones are increasingly serving as platforms for the development of other sectors, while also enable access to other fundamental services such as health.

Paths of technological production, access and use

Tissue cultured banana in Costa Rica

Banana is the first item in the export of primary products in Costa Rica. Almost all exported banana originates in the laboratory as tissue cultured plants. Banana research and development, and the production of tissue cultured plants take place in the country, and is handled by local firms, though there are also imported plants from Israel.

Exporters of banana have a well-established system, including both R&D and production of tissue-cultured plants. R&D concentrates at CORBANA, the national corporation of Banana, a levy based organization. From each box of banana exported CORBANA gets USD 5 cents, and from this, USD 2 cents go into the R&D department. CORBANA's research agenda is decided based on farmers' needs and problems. The production of commercializable tissue culture plants of banana is supplied by few local laboratories, plus some that are imported from Israel, as mentioned above.

On the other hand, CATIE has banana as one of its research areas. CATIE, the Centre of training and research on Tropical Agriculture, is an international organization created in 1973, after IICA's initiative and supported by Costa Rica's government. It dedicates to the training and education of human resources[7] in agriculture-related areas. Biotechnology is one of its core strengths; particularly related to Musaceas, apart from cacao, coffee, etc..

Small farmers and tropical communities are at the core of its mission. It used to operate based on donations, but gradual budget constraints are pushing towards partnerships with large companies.

Non-exporter small banana farmers are not under the scope of CORBANA. That niche has been only covered by CATIE, which has been working with small farmers not only in Costa Rica but in the region. These small farmers plant banana as part of a broader mix. They tend to combine coffee, banana and plantain for instance. Banana plants provide a good shade for coffee. The area where CATIE is located used to be a banana growing area, later dismantled by the Panama malady. Few years ago banana was re-introduced as a result of a Ministry's of Agriculture program. For one year the initiative provided farmers with plants (conventional plants) and the technological package. It is easier to deal with a banana plantation than with plantain, which is more susceptible. CATIE involves small farmers in their training and experiences, providing them with tissue-cultured plants.

Tissue cultured potato in Argentina

In Argentina, almost all potato seeds are in vitro originated. They are grown in few regions, isolated and semi-desertic regions. Pathogen free plants combined with the substantial decrease in the timing of the process are key reasons to choose for in vitro plants. The industry of seed production is locally established, in part as a consequence of a government decision from 1993 of closing the import of potato seeds (tubers and mini-tubers) from other countries to promote a local industry.

There are two parallel markets with different rules. One is the potato grown for industrial processing, with pre-established contracts and clear prices. The other is the market of fresh potato, a centralized market with obscure rules and uncertain prices. As for growers, the typical farmer exploits 200 or 300 hectares, rents the land, and owns or rent the machinery. Potato farmers are 'gamblers', can get multimillionaire one year, and the next go into bankrupt.

Access to seeds is through the market. Varieties are developed locally, mainly by INTA. There are other potato growers in the north of the country, small farmers who are pointing at a gourmet niche, and recouping pre-colonial crops, such as quinoa, which was prohibited in colonial times and substituted by wheat.

[7] Since 1947 CATIE has graduated 1,700 students. For more details see http://www.catie.ac.cr/, February 2006.

Recombinant insulin

Argentina's core strengths on life sciences are shown in the case of insulin research and development. Argentina has a long history in the production of insulin, bovine insulin in particular, and started almost by chance when in 1923 at the Malbran laboratory a medical doctor, Dr.Sordelli, became the first scientist who was able to depurate bovine insulin, filter a certain amount of pathogens, established a production protocol and packed it, before Eli Lilly (Bisang, Cogliati et al. 1986). The process of filtering the pancreas, leaving aside all impurities was a critical bottleneck. Large quantities of bovine pancreas used to be literally thrown to the trash, as the meat industry, a major sector in the national economy, left several residuals, which were later turned into by-products, one of them being the production of biologically-based medicaments. Porcine insulin came later as a more suitable drug due to its larger similarity with human insulin. The problem is the cost. If bovine insulin costs 1, porcine insulin costs 3 and recombinant costs 10.

In 2004 a local company, Beta, decided to manufacture r-insulin, based on technology developed by CONICET (CONICET 2004). In 2007 the firm was sold to *Sanofi-Aventis*. In 2006 other local company, Denver Farma, announced the introduction in the market of the first r-insulin produced in Argentina ('Densulin'), based on a joint venture between the company and Diosynth, one that is part of the Dutch group Akso Nobel (Farma 2006). Other local biotechnology company with a scientific trajectory and recent promising achievements is BioSidus. Their approach is different: they are developing a pharmaceutical dairy, growing GM cows. It is a medium term project; in 2007 was born the first transgenic cow (*Patagonia*) for insulin production[8].

In Costa Rica insulin is imported by the CCSS, which provides health care to most of the population. In both countries, the public health care system operates for the working population. In Argentina, health care is publicly provided. Universal coverage to lower income individuals involves access to medical infrastructure, professionals, internment, prevention campaigns, vaccination plans, free provision of medicaments, etc., at three administrative levels: the national, provincial and municipal. But between these three there are some gaps, leaving some individuals without proper coverage. Individuals' access to health care varies depending on capacities and location within the labor market (Anlló and Cetrángolo 2008). The Ministry of Health is responsible for national health policies and programs, and for norms and actions that enable the coordination of the different subsectors (Tobar, Montiel et al. n/d)

In Costa Rica the CCSS was created in 1941 to handle workers' health care, on a solidarity basis: the worker, the employer and the State, each one pay part of it. One worker in the household is enough to have the whole family covered. Around 95% of the population is covered with health insurance, that is the economically active population.

[8] Their approach uses the mammal gland as a bio-reactor to get the insulin, which is going to be purified from the milk. The mammal gland contains the gene precursor of human insulin, and that molecule is produced with the other natural proteins of milk. The milk with this precursor of human insulin is just an intermediate phase in the production process. The next phase is to optimize the isolation and purification processes to get the milk-based human insulin, at an industrial scale. They are waiting for the expansion of the transgenic rodeo, and their maturity to get the milk, and thus begin the process of filtrating and purifying the insulin.

The system is benevolent, and grants health care to whoever requires it. First health care is provided and then it is assessed whether can pay for it or not, is legal resident or not.

An official list of medicaments is defined, and within that list no co-payment is required. Even some medicaments that are not included in the official list get paid by the CCSS. Insulin is fully provided, and the insulin included in the official lists are Nph and Ersalina (Gatchair, Bortagaray et al. 2009).

GM maize[9]

Argentina is the second largest grower of GM crops after United States (57.7 million hectares of GM crops) with 19.1 million hectares of soy, maize and cotton, which account for 19% of global biotech crop hectarage (James, 2007 #1348). Maize has had the highest improvement in performance in the last 30 years (Gear 2006).

Local R&D efforts on maize have been put in place in the country, mainly by universities and INTA, the national agricultural research organization. The country hosts a rich genetic variety, such that more than 40 local varieties have been identified (Eyherabide 2006). Along the history of maize improvement in Argentina, INTA has been a key player through its Maize improvement program (Bárcena 2004) implemented since 1962, strengthened by the establishment of a germplasm bank in 1969 (Eyherabide 2006). INTA's achievements have relied upon government support and close ties with CIMMYT[10] in Mexico and CIAT in Colombia.

Hybrid cultivars have been increasingly dominating the maize market, substituting open pollination varieties. Such was the massive adoption of hybrids in the 1970s that looking back it turns into one of the main milestones of maize production in Argentina (Gear 2006). This shift obeys to different reasons, an important one being productivity, yet it has been accompanied by strong industrial interests given that the hybrids themselves embody the key for intellectual property protection (Rossi 2007). Hybrid seeds carry along a built-in advantage in terms of property protection, as they have to be re-purchased every season, which is very attractive for seed companies. According to an interviewee this explains why most local seed companies' efforts have been in maize rather than in soy, as maize enables them to capture the rent.

Access to GM maize is through the market, mainly sold as part of a package that includes not only the seeds but the fertilizer and often financial credit, which turns the offer more attractive. Progressively the agricultural landscape entails more GM maize, which nowadays accounts for more than 70% of the total maize planted area. Farmers'

[9] The case of GM in Costa Rica is not included in the analysis because even if there have been on one side, strong research capabilities around GM maize, rice and banana, and on the other, large quantities of GM seeds being planted in the country only for propagation purposes, no GM crop has been grown for consumption or commercialization within the country. The propagation of seeds has led to the authorization of 663 GMOs events between 1991 and 2004 (Cabrera Midaglia 2004): 54.4% in soy and 41.3% in cotton (for more details see (Bortagaray 2007).

[10] Both centers are members of the CGIAR network, the International Maize and Wheat Improvement Center-CIMMYT and the International Center for Tropical Agriculture-CIAT.

main reasons for adopting GM maize have to do with cost reduction as well as the simplification of the task by forgetting the insecticides, reducing the fungi and mico-toxins, and its innocuousness over beneficial insects and vertebrates (Rossi 2007).

As for GM regulations, in Argentina they are distributed in two main bodies: the National Institute of Seeds (INASE), and the Secretary of Agriculture, Livestock, Fisheries and Food. The latter acts under the advice of the Advisory National Commission of Agro-Biotechnology (CONABIA) and the Office of Biotechnology. INASE is oriented to control the production and commercialization of seeds, including imports and exports. In practice the Institute's ability to control all the volume of planted seeds across the country is rather limited. But in the case of maize, the main protecting instrument is the hybrid nature of most planted maize. On the other hand CONABIA is an advisory body on technical and bio-safety requirements. It involves representatives from both, public and private organizations related to agro-biotechnology[11]. Its main role is to advise the Secretary of Agriculture on biotechnology related issues (GM being an important part of it), which ultimately holds the decision capacity. For instance between 1991 and 2005, 922 vegetal GMOs have been assessed for their liberation in the environment (CONABIA s/f).

Mobile phones

The case of mobile telephones results in a unique story among these technologies, not only due to the associated high rate of penetration, but to the speed of their diffusion and breadth across different social layers. Access to mobiles does not seem to be a problem. The rate of penetration of mobile phones is very high in Argentina and moderate in Costa Rica. Data from 2007 suggests more than 100 subscribers per 100 people in Argentina (40.4 million subscribers), while in Costa Rica the rate is 33.76 subscribers per 100 person (1.5 million) (ITU 2007).

Costa Rica has had a peculiar approach towards the provision of mobile services compared to Argentina, which more or less illustrates the general trend[12]. In Costa Rica, mobile phones have been managed monopolistically by a public agency, ICE, which accounts for the country's provision of electricity and telecommunications. Here, the pattern is to some extent inverse to Argentina's. Unlike in most other cases, in Costa Rica the handset is not subsidized, and getting the mobile line takes time after some bureaucratic procedures, but as a tradeoff phone call fees are very cheap compared to the region.

In Costa Rica where the rationale behind the supply of mobile phones is that of a public service, there are not large differences between or within groups, even after distinguishing by income level (Monge and Hewitt 2006). In Argentina, the types of use are largely dependent on socioeconomic level. There, more than 90% choose the prepaid alternative (CNC n/d), while in Costa Rica that is not a choice.

Mobile phone is the only case among the studied technologies in which local contribution to technological production/manufacturing is non-existing, both in

[11] For more information, please see http://www.sagpya.mecon.gov.ar/new/0-0/programas/biotecnologia/index_en.php

[12] For more details, see (Thakur, Beckert et al. 2009a)

Argentina and Costa Rica. Handsets are imported, as well as the infrastructure for ensuring connectivity. The content is standardized, and for the most part is imported and provided as another component of the handset.

Local inputs are the electro magnetic space, which is a key scarce public resource regulated and distributed by public agencies; the personnel working in the provision of infrastructure to terminals; engineering companies working in the planning and design of where to establish cells, terminals, etc.; and a customer service support related to each provider. In Argentina, there is an informal market around the unlocking of providers' codes so that customers can interchange devices and service providers. In Costa Rica the monopoly involves a large extent of the chain of services, though the building of infrastructure required might or might not be carried on by this same agency. For instance, in the case of the provision of 3G the plan was to contract the installment of the infrastructure out from a third party.

Another fundamental local component is the regulatory environment put in place to safeguard customers' access. Once again in the case of Costa Rica the very rationale of mobiles provision makes it unique. Access to mobile phones has been granted as a public service, and given the public monopoly, the same agency ICE provides the service, controls the phone lines and establishes the price of the public service. On the other hand, in Argentina the CNC controls the electro magnetic space, overviews the phone call and SMS rates that must be registered there by service providers and imposes the limits within which multinational companies play. In reality, scarce human and financial resources at the public regulatory entity prevent a symmetric game[13]. But the public regulatory body does aim at safeguarding a healthy competitive environment.

The prevalent concern refers to access and do not focus much on use. Some existing practices act against customers' freedom to choose, for instance:

- Calling party pays system
- Numerical in-mobility
- Local loop unbundling

In Argentina most regulatory instruments concentrate on the provision of the service. There is not a corresponding tool or agency dedicated to the user, and the quality and conditions of such use. The choice for pre-paid systems constitutes an adaptive response from lower-income individuals to grant and expand their use. For the most cases, these are mainly preferred by lower-income as a mechanism for controlling the budget, though it is also chosen by middle income parents for their teens, even when end rates are more costly. Another group paying higher costs are those who do not have a mobile and have to call one, as fixed line–mobiles rates are higher than inter-mobile phone calls. This does not apply to Costa Rica where ICE publicly provides mobile phone services, together with fixed-lines and electricity.

[13] Personal interview, CNC representative, November 2007, Buenos Aires.

Table 1. Brief characterization of players in Argentina and Costa Rica

	Main distribution channel	Local R&D	suppliers	Regulatory/ policy agency	object of regulation	Type of regulation	Marginalized/not visible costs	Corrective/re-distributive mechanisms, policies
Mobile Phones	Market		3 MNE	CNC	Fair market competition (sanction anti-trust behavior), control assignment and use of radio electric space, overviews mobile phones fees (registered not regulated)		Differential use (prepaid and postpaid), depending on income and age;	Universal service fund: from mobiles to fixed line phones (formally established but not yet utilized)
OSS	Civil society, users-producers network	Users' groups, Natl. and intl.firms	Local and intl.firms; users-producers	ONTI (just informal interlocutor)			The use of PS by public agencies indirectly forces citizens to do the same	
GM Maize	Market	Public org.-INTA, Public universities		CONABIA, Biotechnology Office, SENASA, Market direction, INASE	Environmental, human and animal impacts; market impacts; registration	Approval/not approval-additional requirements (biosafety, international markets)		

				(SAGPyA)				
Tissue cultured potatoes	Market	Public org.- INTA, Public universities		INASE				
R-insulin	Government	Public and private labs (natl. and intl.)	National and MNEs	ANMAT	security, quality and efficiency of medicaments, and establishments		Type II diabetics; complementary tests (i.e.,blood glucose)	Law passed in 1998: insulin provided by medical care system (type and doses depending upon prescription)
Costa Rica								
Mobile Phones	Government	Recent software developments related to content	ICE	ICE				
OSS	Civil society; Users-producers network	Users' groups, Natl. and intl. firms						
Tissue cultured bananas	Market + public academic orgs.	CORBANA, CATIE, Private labs.	National and MNE private labs, CATIE,	OFINASE				

			CORBANA					
R-insulin	Government		MNEs	CCSS				

Final remarks, learnt lessons and the (policy) road ahead

The paper argues that the consideration of emerging/emerged technologies in developing countries must involve not only the metric of access, but also one related to types and conditions of use. Furthermore, an analysis concerned with distribution and distributive outcomes must bring into light those that for different reasons do not access get into the technology's loop.

Regulatory and policy instances focus on the beginning of the 'pipeline'; that is the provision of the service or the product. In the case of mobiles in Argentina, the regulatory agency aims at ensuring a balanced competition and safeguards the existence of broad guidelines to prevent consumers' lock in companies' practices. The idea of a pipeline between technological supply and use seems to be underlining many of the existing institutional landscapes. The control is on technical requirements, but leaves out the concern on who gets what, how and when. What would happen if the pipeline would be extended up to the final user, considering the type and quality of use, and expanding it up to bring to light those who do not even access the emerging technology.

Another open question is that of the (a)symmetry between regulatory organizations and multinational companies. In the case of mobile phones and in the health and agro-biotechnology sectors in Argentina, the scarcity of available resources makes an exhaustive control of MNEs difficult, at the least. The asymmetry between MNEs and regulating agencies leaves a gap that ultimately affects users and consumers.

References

Anlló, G. and O. Cetrángolo (2008). Políticas Sociales en Argentina: Viejos problemas, nuevos desafíos [Social policies in Argentina: old problems, new challenges]. Crisis, recuperación y nuevos dilemas. La economía argentina 2002-2007. B. Kosacoff. Santiago de Chile, ECLAC.

Bisang, R., C. Cogliati, et al. (1986). "Insulina y Economía Política: El difícil arte de la política pública [Insulin and Political Economy: The difficult art of public policy]." Desarrollo Económico-Revista de Ciencias Sociales **26**(103): 369-388.

Bortagaray, I. (2007). The building of agro-biotechnological capabilities in small countries: The cases of Costa Rica, New Zealand and Uruguay. Public Policy. Atlanta, Georgia Institute of Technology.

Cabrera Midaglia, J. (2004). Informe sobre el Marco Regulatorio Nacional en Materia de Biotecnología y Bioseguridad [Report on the Regulatory Framework regarding Biotechnology and Biosecurity]. San José, UNEP-GEF.

CNC. (n/d). "Estadisticas e Indicadores del Mercosur - Diciembre de 2004." Retrieved February, 2008.

CONABIA. (s/f). "Bioseguridad agropecuaria: La experiencia de la CONABIA." Retrieved December, 2007, from http://www.sagpya.mecon.gov.ar/new/0-0/programas/conabia/bioseguridad_agropecuaria2.php.

CONICET. (2004). "Invertirán tres millones de dólares en insulina humana recombinante [Investment of 3 million dollars on recombinant human insulin]." Retrieved December, 2007.

Cozzens, S. (2007). Distributional Assessment of Emerging Technologies: Case Studies in the Americas. Research proposal, National Science Foundation.

Cozzens, S. E., S. Gatchair, et al. (2005). Emerging Technologies: Quantitative Identification and Measurement. A Report Prepared for The Korea Institute of Science and Technology Information. Atlanta, Technology Policy and Assessment Center.

de Ferranti, D., G. E. Perry, et al. (2003). Inequality in Latin America and the Caribbean: Breaking with History? World Bank Latin America and the Caribbean Studies. Washington, D.C.

della Paolera, G. and A. M. Taylor, Eds. (2003). A New Economic History of Argentina. Cambridge, Cambridge University Press.

Eyherabide, G. H. (2006). Mejoramiento genético de maíz y su trayectoria en la Argentina. Maíz y Nutrición: Informe sobre los usos y las propiedades nutricionales del maíz para la alimentación humana y animal. Buenos Aires, ILSI. **II**.

Farma, L. D. (2006). "Lanzan al mercado la primer insulina humana recombinante producida en Argentina." Retrieved November, 2008, from http://www.denverfarma.com.ar/noticias.asp?tipo=1&Id=14.

Gatchair, S., I. Bortagaray, et al. (2009). Cross-national Analyses of Distributional Consequences of Recombinant Insulin Technology. Atlanta, Technology Polciy and Assessment Center, Georgia Institute of Technology.

Gear, J. R. E. (2006). El cultivo del maíz en Argentina. Maíz y Nutrición: Informe sobre los usos y las propiedades nutricionales del maíz para la alimentación humana y animal. ILSI. Buenos Aires, ILSI. **II**.

ITU (2007). World Telecommunication/ICT Indicators Database. Geneva, International Telecommunications Union.

Molina Jiménez, I. (2003). Costarricense por dicha [Costa Rican by fortune]. San José, Universidad de Costa Rica.

Monge, R. and J. Hewitt (2006). Los Costarricenses en la Economía basada en el conocimiento [Costa Rican in the Knowledge-Based Economy]. San José, CAATEC.

Mowery, D. C. (1999). The Computer Software Industry. Sources of Industrial Leadership: Studies of Seven Industries. D. C. Mowery and R. R. Nelson. Cambridge, Cambridge University Press.

Rocha, O. J. (2000). La Biología: Una Vocación Centenaria [Biology: A hundred years old vocation]. Desarrollo Científico y Tecnológico en Costa Rica: Logros y Perspectivas [Scientific and Technological Development in Costa Rica: Achievements and Perspectives]. San José, Academia Nacional de Ciencias.

Rock, D. (2002). "Racking Argentina." New Left Review **17**.

Sharp, M. (1995). Applications of Biotechnology: An Overview. The Biotechnology Revolution? M. Fransman, G. Junne and A. Roobeek. Oxford, Blackwell.

Skidmore, T. E. and P. H. Smith (2005). Modern Latin America. New York, Oxford University Press.

Thakur, D., B. Beckert, et al. (2009a). The Distributional Consequences of Mobile Phones. Atlanta, Technology Policy and Assessment Center.

Thakur, D., B. Beckert, et al. (2009b). The distributional consequences of Free and Open Source Software: A cross–national comparison - Draft version. Atlanta, Technology Policy and Assessment Center.

Tobar, F., L. Montiel, et al. (n/d). La Red Pública de Atención Primaria de Salud en Argentina: Diagnóstico y Desafíos [The Public Network on Primary Health Care in Argentina: Diagnosis and Challenges]. Buenos Aires.

UNDP (2007). Human Development Report 2007/2008: Fighting climate change: Human solidarity in a divided world. New York, Palgrave Macmillian.

Walsh, G. (2005). "Therapeutic insulins and their large-scale manufacture." Appl Microbiol Biotechnol **67**(2): 151-9.

Zeledón, R. (2000). Marco Institucional en Costa Rica: Pasado, Presente y Futuro [Institutional Framework: Past, Present and Future]. Desarrollo Científico y Tecnológico en Costa Rica: Logros y Perspectivas [Scientific and Technological Development: Achievements and Perspectives]. San José, Academia Nacional de Ciencias. **III-Ciencias y Sociedad**.

List of acronyms

Country	Organization	
Argentina	ANMAT	National Administration of Pharmaceuticals, Food and Medical Technology (1992)
	CNC	National Commission of Communications
	CONABIA	National Advisory Commission on Agro-Biotechnology
	INASE	National Institute of Seeds
	INTA	National Institute of Agricultural Technology
	ONTI	National Office of ITs
	SAGPyA	Secretary of Agriculture, Livestock, Fisheries and Food
	SENASA	National Service of Agro-food Sanitary and Quality
Costa Rica	CATIE	Tropical Agronomic Center of Education and Research
	CCSS	Costa Rican Agency of Social Security
	CORBANA	National Banana Corporation
	ICE	Costa Rican Institute of Electricity
	OFINASE	National Office of Seeds