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Title

An agent based model of inclusive innovation

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State of the art: At present in different spheres, including business, management, development and innovation studies, how innovation can contribute to meeting the needs of the low-income sectors is being discussed. In the literature we can identify different approaches as to how to address this problem, among them are Bottom/Base of Pyramid (BOP), inclusive business, grassroots innovation, appropriate technology, below the radar innovation, pro-poor innovations and research and innovations oriented to social inclusion (IIIS).

Research gap: The different approaches do not analyze the role of the market or of regulation. The aim of this paper is develop an Agent Based Modeling (ABM) to understand the process that ranges from the identification of a social need to its solution, in order to identify the set of policy instruments in STI to convert a social need into an opportunity for the development of inclusive innovation.

Theoretical arguments: Income distribution in Latin America is one of the world's most inequitable. This persistent inequality causes broad sectors of the population to have to survive in contexts of permanent social exclusion. Following Sen (2000), social exclusion may be viewed as deprivation of capabilities to develop a full life and share the opportunities that others enjoy.

The debate is still open on the relationship between innovation and inequality. Cozzens (2006) points out that said innovation and inequality evolve together, that is, in certain circumstances innovation reinforces inequities and in others it reduces them. For their part, inequities stimulate innovations and in other cases they limit them.

Furthermore, Nelson (1959) and Arrow (1962) highlight the importance of State intervention to guarantee optimal investment levels in R+D from the social point of view. This paper maintains that the market alone does not direct production of knowledge or innovation towards solving social problems. There are market failures associated with the characteristics of generation of knowledge and its creative application for social purposes which determine sub-optimal levels of private investment. Therefore, if what is sought is to improve well-being by meeting the needs of the low-income population sectors, government participation is important to spark processes of inclusive innovations.

Method: Based on an approach of appreciative theory (Nelson y Winter, 1982), we made a qualitative analysis of seven cases that correspond to research projects financed within the framework of the Research and Innovation Program oriented to Social Inclusion (IIIS-UdelaR, Uruguay) (Table 1). Based on the stylized cases (Table 2) an ABM is built. The heterogeneous agents are: (i) the government; (ii) the university; (iii) firms, and (iv) the agents that makes up the demand of those goods and services. The Uruguayan case enables an analytic generalization of this process to be made.

Results: Based on results showed in Table 3-5 we can argue that greater complementarities between incentives offered by STI policy, greater is the amount of social needs that can be met and satisfied. When STI policy is widely committed to

putting knowledge and innovation for social inclusion, it is possible to create inclusive innovations. Our model provides clear patterns to sustain that success that STI has to contribute to social inclusion also depends on the coordination between STI policies and other public policies, such as social, industrial, government procurement, among others policies.

TABLE 1: The cases

Case Num	Name (problem/solution)	Year funding
1	Skin lesions/synthetic skin	2008
2	“Medicinal Plants" / production of phytotherapeutic	2008
3	B Streptococcus in pregnant / diagnostic kit (**)	2008
4	Cancer / diagnostic procedure and treatment (**)	2008
5	Refractory epilepsy / software epileptogenic focus detection for diagnosis and treatment	2008
6	Plombemia / nanotechnology-based technique for diagnosis (*)	2010
7	Toxocariasis / diagnostic tool and protocol	2010

Source: Own elaboration based on IIIS-CSIC-UdelaR

Notes: 1. (**) These projects have not achieved a scientific-technological solution to the problem; however, continue to develop research in order to find other solutions to the same problem. 2. (*) This project is not yet complete, the final report will be delivered in April 2013. The information given corresponds to the expected benefits of the research project.

TABLE 2: The cases: Agents and Functions

Case	Type of Agents	Agents	Functions required (activities)
1	Governmental	National Institute of Donation and Transplants	Carry out studies to distinguish the quality of segments of synthetic skin developed locally
		National Resource Fund	Provide financing for treatment
		National Burns Center	Provide comprehensive treatment
	End users	Target population	Greater prevalence in socially excluded population with highly precarious housing and heating systems
	Productive Sector	Firms	Transfer the solution found in the research sphere to the production phase to supply the domestic and external markets
	Generators of knowledge (UdelaR)	School of Chemistry	Develop low-cost, quality synthetic skin (prototype)
		School of Medicine	Carry out studies to distinguish the quality of segments of synthetic skin developed
2	Governmental	Ministry of Public Health	Incorporate medicinal plants into the regulations on phytotherapeutics and regulate their use in medical practice
		National Institute of Agricultural Research	Articulator for the transfer of knowledge to rural producers
		Departmental government	Articulator for the transfer of knowledge, production and training for local farmers
	End users	Target population	User population of medicinal plants, health professionals and small rural producers
	Productive Sector	Small rural producers	Cultivate verified medicinal plants
	Generators of knowledge (UdelaR)	School of Chemistry	Distinguish medicinal plants
		School of Medicine	Distinguish and analyze pharmacological impacts, clinical studies
		School of Engineering	Develop prototype of machinery for plant drying
		Paysandú University Center	Facilitate production and training of local producers: transfer knowledge to rural producers
5	Governmental	Does not pertain	Does not pertain
	Non-governmental	Hospital of Clinics (UdelaR)	Physicians express demand and establish the technological requirements
	End users	Target population	Patients with refractory epilepsy Treatment in these cases requires surgery
	Productive Sector	Does not pertain	Does not pertain
	Generators of knowledge (UdelaR)	School of Engineering	Develop the software adjusted to medical needs, provide technical advice and transfer the software to the medical team for use in diagnosis and treatment of patients
6	Governmental	Ministry of Public Health	Incorporate the procedure into medical practice
		Ministry of Public Health	Allow the testing of new reagents and procedures in their laboratories; supply the samples; and carry out the analyses in parallel for correct implementation and validation of the new techniques.
	Non-governmental	Civil Society organization: Workers' Center (PIT-CNT)	Carry out dissemination tasks regarding the benefits derived from research
	End users	Target population	Workers protected in Law No. 17.774.
	Productive Sector	Firms	Transfer the solution found in the research sphere to the production phase to supply the domestic

			and external markets
	Generators of knowledge (UdelaR)	School of Sciences	Develop the low-cost nanotechnology-based technique, of easy use that makes possible the analysis to detect cases of plombemia *in situ*.
7	Governmental	Ministry of Public Health	Introduce regulations for carrying out epidemiological study of toxocariasis Information generated: input for the development of sanitary measures, diagnosis and treatment of the disease
		Local Health Institutions	Carry out the epidemiological study in risk zones
		Local government	Facilitate carrying out the epidemiological study in risk zones
		National Administration of Public Education	Develop educational measures that contribute to prevention of the disease
	End users	Target population	Population living in urban and peri-urban settlements, lacking sanitation, with few and poor hygiene conditions and deficient drinking water supply
	Productive Sector	Firms	Does not pertain
	Generators of knowledge-UdelaR	School of Sciences	Develop tools and protocol for detection of the toxocariasis parasite

Source: Own elaboration based on IIIS-CSIC-UdelaR

Table 3: Simulation results without complementarity between instruments

3ª							**3B**					
PB=[0,0], CF=[0,330]	p=0	p=.25	p=.5	p=.75	p=1		PB=[0,330], CF=[0,0]	p=0	p=.25	p=.5	p=.75	p=1
Transitory	24	34	40	41	42		Transitory	32	45	54	55	56
Persistent	1579	1882	2178	2476	2773		Persistent	2668	3166	3673	4180	4684
Time to stabilise	56	54	56	57	56		Time to stabilise	75	76	71	75	75
PB=[0,0], CF=[0,660]	p=0	p=.25	p=.5	p=.75	p=1		PB=[0,660], CF=[0,0]	p=0	p=.25	p=.5	p=.75	p=1
Transitory	32	44	54	56	56		Transitory	40	55	67	69	70
Persistent	1852	2198	2548	2911	3252		Persistent	3260	3884	4482	5114	5725
Time to stabilise	54	52	54	55	54		Time to stabilise	72	74	73	75	72
PB=[0,0], CF=[0,1000]	p=0	p=.25	p=.5	p=.75	p=1		PB=[0,1000], CF=[0,0]	p=0	p=.25	p=.5	p=.75	p=1
Transitory	36	51	60	62	63		Transitory	48	69	80	83	84
Persistent	2011	2394	2770	3149	3531		Persistent	3553	4227	4914	5566	6238
Time to stabilise	54	54	54	53	54		Time to stabilise	73	72	75	72	73

Note: Productivity Bonuses (PB) and Competitive Funds (CF)

Table 4: Simulation results with different complementarity between instruments

PB=[0,500], CF=[0,500]	p=0	p=.25	p=.5	p=.75	p=1		PB=[0,500], CF=[376,875]	p=0	p=.25	p=.5	p=.75	p=1
Transitory	99	140	166	173	174		Transitory	55	80	94	97	98
Persistent	9455	11246	13020	14826	16602		Persistent	9433	11218	13009	14796	16564
Time to stabilise	189	191	193	191	189		Time to stabilise	170	175	174	162	170

PB=[0,500], CF=[126,625]	p=0	p=.25	p=.5	p=.75	p=1		PB=[0,500], CF=[501,1000]	p=0	p=.25	p=.5	p=.75	p=1
Transitory	87	126	146	153	153		Transitory	44	62	74	76	77
Persistent	9596	11418	13222	15035	16850		Persistent	3750	4456	5160	5876	6584
Time to stabilise	189	191	188	188	189		Time to stabilise	69	67	71	72	69
PB=[0,500], CF=[251,750]	p=0	p=.25	p=.5	p=.75	p=1							
Transitory	67	96	115	118	119							
Persistent	8926	10631	12311	13979	15673							
Time to stabilise	174	175	171	173	174							

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