The transaction costs in biotechnology

Estrada, Fernando and Diaz, Natalia

Universidad Externado de Colombia, Facultad de Finanzas, Gobierno y Relaciones Internacionales

December 2011

THE TRANSACTION COSTS IN BIOTECHNOLOGY

Fernando Estrada
Natalia Diaz

Universidad Externado de Colombia

Abstract

This paper aims to relate the principles of Ronald Coase Theorem with negative impacts of biotechnology, taking cases of specific research groups and medium-sized companies in biotechnology. We consider an application of economic theory on transaction costs (TEC) provides a good foundation for understanding the underlying problems of this sector, even more, when analyzing the political economy of biotechnology since the transaction costs can best viewed their limitations and the limited scope of government policy. In biotechnology it is possible to get a policy that combines both equity and efficiency, that is, a wider range of policy applications to improve the living standards of people in Colombia.

Keywords
Coase Theorem, Transaction costs, Biotechnology, Public Choice, Colombia.

JEL: B2, B21, B41, D03, D43, D82, N56, O13

THE TRANSACTION COSTS IN BIOTECHNOLOGY

Fernando Estrada
Natalia Díaz

1 - Overview and Hypothesis

1.1 Impact of Biotechnology

Biotechnology has made a profound impact on agriculture and food industry the world over the past 15 years (Phillips, 2002; Herdt, 2006:; Dahlandera and Gannb, 2010; biotecVisions 2011)[1]. Companies in developed and emerging countries have broadly adopted innovations in genetically modified (GM) with their relative advantages (Lusk, Jamal, Kurland, Rouco, Taulman, 2005, Qaim and Zilberman, 2003). What has led to efficiency gains ranging from higher yields, lower costs to control weeds and pests and diseases of depressed populations, the same way there have been significant environmental benefits (Pray, Paarlberg and Unnevehr, 2007). The evolution of the expectations and forecasts on crops with improved agronomic characteristics, and new ingredients in the food production potential of an extraordinary nature are, according to some researchers (Gaskell, 2006). Who observe these advantages, consider the fulfillment of the promises implicit in biotechnology requires overcoming barriers of restrictive regulations on genetically modified (Zilberman, 2006)[2]. However, there are problems that go beyond the legislative framework (McHugh, 2007). Mainly in countries with institutional imbalances, economic imbalances and limited investment in the development of scientific knowledge.

The concept of biotechnology as a key technology for emerging agricultural applications overflows obtained after multiple applications made basic

[1] The advent of biotechnology has presented major challenges for the food industry worldwide. However, while the scientific basis for food production are part of a revolution, it is unclear how to implement technologies for biotechnology advocates and much of agrifood policy makers around the world project a positive future technology overcomes the food shortages, improving the environment, eliminates disease and leads to healthy and prosperous societies. However, a reverse reaction expressed by consumers and environmental advocates have founded arguments for considering that biotechnology represents, in contrast, exacerbation of food insecurity, environmental threats and hazards to human security, ultimately, worsening global society. This thesis does not take a stand against these dilemmas, but rather we are interested in seeing how responsive government institutions and the implementation of biotechnology, in particular, if public policy in Colombia provide the conditions to adapt or innovate biotechnology so that it can improve the quality of life and welfare of a majority of its population.

[2] For an extensive argument on the subject of regulations, see: Ian M. Sheldon (2002), although the author responds to an excessive reliance on the rules of the World Trade Organization, which is observed in the policies of emerging technology, are relatively complex problems between collective action and institutions, as justifies the present investigation.

procedures for millennia by breeding and application of microorganisms in the food chain production[3]. The DNA rediscovery and new knowledge for handling, constitute a tipping point that opens many new opportunities for use and application of biological resources. From this perspective, the potential impact of biotechnology on society with new products and processes, and initiation of new technologies are an important source of added value to the innovation capacity of companies in different industrial sectors (Raney, 2006). Biotechnology and genetic processes have advanced a reality with new challenges (Colciencias, 2008). According to this understanding of the potential of these technologies to improve productivity and articulated in different lines of business, also support to biotechnology as a strategic sector of the economy in many countries as Colombia, in general, biotechnology is a special field public policy requirements imposed by an economic geography of international (Colciencias, 2008; McCann, 2011).

For countries like Colombia, the importance of developing the biotechnology sector within its borders, is also based on contemporary economic vision for the generation of competitive advantages as an engine of growth and development for the country. Biotechnology creates opportunities to promote the entry into new markets and create jobs in high level international qualification. Additional jump from one of peasant agricultural economy towards high value added sectors of biotechnological base is a challenge of considerable scope. What major changes can also predict the development of Colombian society in many areas[4].

On the other hand, are considerable opportunities provided by biotechnology to reduce problems related to hunger and malnutrition phenomena in many nations (Prakash, 2010)[5]. The techniques used could enhance global food production by more than 25% (Prakash, 2010.). An improvement in the capacity of the land to absorb minerals, have a greater level of productivity, allowing continuous planting, obtain resistant crops harsh weather, pests and diseases, foods with higher nutrient levels and counteract the deficiency of vitamin A , 'cause of blindness in these nations, and iron, which affects physical and mental delays and is causing major nutritional disorder worldwide killing half a million newborns per year (Lisinge, 2000, p.113) - are some of the direct benefits generated by this technology. The importance of such biotechnology applications is necessary not only for the current humanitarian crisis figures, but from the effects of climate change (Prakash, 2010)[6]. The conditions are still

[3] View and Santa Ana Andre Valle. Silvio (1995), "Public perception of biotechnology: problems in the Third World", Tibtech, Vol XIII. The thesis of the authors discovered that there are many prejudices in public policy related to a poor and widespread misinformation.

[4] Indeed, Colombia is considered one of the most attractive countries in the field of biotechnology applications from international markets in new technologies, see: (Myers, Sexton and Tomek, 2010).

[5] The conditions of the famine in Somalia is a sign that the economies of developed countries have not yet managed to create conditions to make way for public policies in the poorest countries. The case of Somalia is a typical case of imbalances in the global economy and severe disturbances of the local economy policies.

[6] The planet's climate change by the process gases caused by human activity, generate multi-million dollar losses to the agricultural sector. The increase in temperature and changing rainfall patterns will affect crops of rice, cotton, coffee, sugar, rice, cassava, corn and soybeans, among others. In general, several countries are expected to decrease areas suitable for agricultural crops. The set of alternatives to

critical gaps in policy load with global reach, as shown in the table below schematic:

MALNUTRICIÓN A NIVEL MUNDIAL
La malnutrición es un factor importante entre los que determinan, cada año, la muerte de aproximadamente 13 millones de niños menores de 5 años por enfermedades e infecciones evitables, como sarampión, diarrea, malaria, neumonía y combinaciones de las mismas.
Se estima que 800 millones de personas en el mundo sufren de subnutrición crónica y no pueden obtener alimentos suficientes para satisfacer siquiera las necesidades energéticas.
Aproximadamente 200 millones de niños menores de 5 años padecen síntomas de malnutrición aguda o crónica, cifra que aumenta en los períodos de escasez estacional de alimentos y en épocas de hambre y desórdenes sociales.
La situación es especialmente grave en África central, oriental y meridional, donde el 44 por ciento de la población total se encuentra subnutrida.
Los estudios indican la existencia de 526 millones de personas subnutridas en Asia. Sólo China alberga 164 millones de personas bajo estas condiciones.

* Information from FAO, 2006.

However, while global investment in agricultural research by the private sector continues to grow thanks to the growth of markets and the emergence of new technologies in developed countries (Alfranca and Huffman, 2001), the additional investment by the public sector and Governments in many poor countries has stagnated or declined (Byerlee and Echeverria, 2002). This research explores how the evolutionary dynamics between the public and private, with respect to the generation of new knowledge, adversely affects the diffusion of public policies on technological innovation, while offering advantages to the private sector on external support. Paradoxically, the best applications of those technologies that contribute to poverty reduction (Byerlee and Fischer, 2002). Comparing the recent historical evidence on private sector investment in agricultural biotechnology data, the findings indicate that a more open and international, with further expansion into agricultural research can be sensitive to addressing poverty (CGIAR, 2005a, 2005b; Dorward, Kydd, Morrison, Urey, 2004), only to the extent that the public sector leadership is reinforced by governments can change those conditions. The design of public policy-oriented research in biotechnology (Hall, 2005) should reassign the functions of private sector research (Kherallah and Kirsten, 2001). A public policy on biotechnology with an organizational system that is used in agriculture for the benefit of emerging countries, as in the case of Colombia[7].

address the problem posed by the movement of crops to new regions with better climatic conditions, generating millions in losses for the countries, or breeding to withstand climate change.

[7] This argument ignores the affirmative character who has had private initiative in biotechnology, but this makes collective coordination failures and public policy in countries with basic food needs. It is precisely such imbalances important premises of this research. Not many private investors willing to put their capital at the service of public causes. This phenomenon is not confined to emerging countries, but also the design of public policies in Europe and the United States, see: *Nature biotechnology*, "Firms seek new models to access public equity", volume 27 number 10 october 2009.

Concern about the concentration of power in the new bioeconomics[8], especially in the private sector in developed countries, from the use of patents, is valid justifications (Calestous.2002, Lesing, 2004). The trend towards the privatization of knowledge resulting from the research priorities determined by the financial return on investment, raises the possibility that the benefits of these favors only those with the necessary purchasing power (Leisinger, 2004. this sense, it poses important limitations to be imposed to the potential of biotechnology to improve farm productivity in developing countries and poor regions inhabited mostly by poor social class and low income. The problem is how to mitigate the effects poverty, hunger and malnutrition. In general the situation previously described, raises the urgent need to strengthen investment in research by the public sector, which for 2000 was only 20% of total investments at international similarly, the establishment of more partnerships between the public and private sectors. A public policy on biotechnology in Colombia should promote a correction to the income imbalance between private and public, as well as encourage people with children Social opportunities (Amartya Sen, 1997)[9].

On the other hand, the strategic importance of biotechnology has forced us to rethink mechanisms for their promotion in many developed nations and emerging countries in recent decades[10]. The complexity of biotechnology expertise derived from the multiplicity of agencies involved, and the resources required, further suggests the desirability of an environment that allows coordination to provide the necessary incentives to eliminate or reduce potential obstacles to development. In connection with this, the role played by governments is essential. In Colombia, many applications of scientific developments in biotechnology and the country's potential in this field, related to comparative advantages in terms of biodiversity, have prompted government agencies to make changes in order to coordinate the efforts made in isolation during the last decade in order to institutionalize their development.

1.3 Formulation of government

In this sense, in Colombia since the early nineties made the first steps to institutionalize the biotechnology program through the Department of Administrative Science, Technology and Innovation Colciencias. In 1991 under Agreement No. 1 of the National Council of Science and Technology, created

[8] The term does not define exactly a business school or mainstream markets in biotechnology, but includes a growing tendency to operate with capital in countries with important biodiversity reserves as Colombia.

[9] They are still outstanding contributions of Amartya Sen to reflect that originally raised an objection to the principles analytical expression of utilitarianism Pareto, as well as the criticism required by the first version of distributive justice of John Rawls.

[10] Again, André Sant'Ana and Silvio Street, "Public perception of biotechnology: problems in the Third World", Journal BTech, April 1995 (Vol. 13). The authors emphasized the mid 90's the strategic nature of biotechnology and the need to increase public awareness of it.

the National Biotechnology Program (GNP) as a component of the National Science and Technology, whose technical secretariat would be responsible for Colciencias, and whose creation was understood as a recognition of the strategic importance for the country (Castellanos, 2006.2). Later, in 1997, determine the lines of action and activities of GNP in 1998 would result in the formulation of the Strategic Plan 1999-2004 National Biotechnology Program, as a means of planning and prioritization of areas of research (p. 2.).

According to this line of action the Ministry of Foreign Trade, decided in 2000 to include biotechnology as one of the key areas in the National Exporter of New Technologies, the National Planning Department (DNP) defines biotechnology as an area In conducting an exercise on its focus, likewise, the group of Biogestión National University jointly with the Ministry of Commerce, Industry and Tourism Colciencias, made the proposal for an Industrial Policy in Biotechnology, The Institute Alexander von Humboldt published a key document in 2000 BioTrade in reference to the close relationship between international markets for biotechnology and bio-demand and considers this technology as a key factor to improve the benefits provided by natural resources has Colombia. Similarly, the national government through the Ministry of Agriculture said biotechnology as an instrument to support technological upgrading of agriculture to the North American Free Trade Agreement with the United States (Cano, 2003).

The relevance of public policy on biotechnology has also been highlighted in the documents Conpes 3527 of "National Policy on Competitiveness and Productivity", Conpes 3582 National Policy on Science, Technology and Innovation, Conpes 3080 of "National Policy on Science and Technology 2000 - 2002 ". And in the 2002-2006 National Development Plan "Towards a Communitarian State" refers to biotechnology as a "strategic area for development and competitiveness of the country" (Colciencias, 2008, p.31.)

In June 2011 under the government of President Juan Manuel Santos Conpes approving the 3697 Policy for Business Development in Biotechnology from the Sustainable Use of Biodiversity, to which public policy is formalized in biotechnology in Colombia. Among the policy objectives are: 1 - Create the economic, technical, institutional and legal resources for attracting public and private development companies and products based on the country's biodiversity; 2 - Improving the institutional capacity to commercial development of biotechnology, 3 - Develop a set of economic instruments to attract public investment in business development and biotechnology products, 4 - Adapt and revise the regulatory framework related to access to genetic resources, production and marketing of biotech medicines and herbal products, 5-Evaluate the creation of the national bioprospecting.

Finally, in the "Basis of National Development Plan: Towards Democratic Prosperity: Vision 2010 -2014," within the locomotives for growth and generating new agricultural products and innovation-based sectors recognize the importance of sustainable biodiversity and the development of biotechnology as key elements in improving growth and competitiveness (Conpes, 3697). Today, interest in developing the potential of biotechnology to produce knowledge Colombia is consistent with the tendency to regard science and technology as key issues that urgently need to be incorporated into the public agenda. Not in vain with the enactment in 2009 of the Law on Science and Technology, aims to identify strategic sectors for improving the competitiveness of the country from the comparative advantages, such as biotechnology[11].

Notwithstanding the foregoing, it is necessary to state that any development of the biotechnology sector requires additional factors to the creation of public documents. Need to build an adequate institutional framework and perform a successful intervention by the government "environment interaction between academia, the private and public, and eventually lead to what is the rationale for biotechnology: the generation of new biotechnology-based companies "(Colciencias, 2008). In turn, the latter two requirements need to be based on a correct diagnosis of the state of the art development of biotechnology in Colombia. That is:

> It requires knowledge of the potential, the progress and status of biotechnology in the country, to generate public policies that enable the development of this line of knowledge for the benefit of the Colombian business sector and citizens[12].

The public sector plays a key role during the development of science and technology. The cases of countries that have made significant progress in these fields corroborate this claim. Reason is that "biotechnology has become the workhorse of policy makers" (Pinilla, 2004, p.2). On the other complementary to the above has commented that:

> The implementation of biotechnology requires public policy decisions and investment. However, such decisions are as long as there is public will built from knowledge of what happens in different social fields in the scientific, economic and cultural. From this desire, and based on exercises of decision making are proposed and investment policy instruments (Pinilla, 2004, p.3).

---

[11] "Biotechnology: Colombia strategic sector for 2015," Colciencias, Ministry of Education, http://www.mineducacion.gov.co/cvn/1665/article-161751.html).
[12] Ibid

In turn, the strategic importance of biotechnology should be incorporated into the agenda of different public policies. One of the main reasons for this idea is supported by studies showing that:

> Developing countries increasingly dependent on knowledge and innovation capacity. (Perez) stated that biotechnology is a technological paradigm, and as such, affects the entire structure of production from the production of agricultural inputs and outputs, to the food industry, the mining and processing of minerals to human health and animal . If steel has been referred to as a key factor to achieve the industrial revolution, or the chip in the computer age, this new revolution is key genetic resources. Biotechnology has been used as one of their key arguments ability to meet the nutritional challenges of the third world (Pinilla, 2004.p.2).

Regarding public policy, they should aim at reducing obstacles facing the development of biotechnology in Colombia. Indeed, the biotechnology production occurs in an environment characterized by the existence of imperfect competition in the presence of monopolies as well as problems of coórdination, market risk, uncertainty, opportunism and inefficiencies arising from existing institutions, among others. Terms theoretical problems reminiscent of neoclassical thinking in relation to the characteristics of markets, and prove the existence of transaction costs.

1.4 Failure of government and market failures

The technological development in Colombia has two serious limitations. The first relates to the characteristics of the markets that have specific benefits for foreign-invested sector, namely companies with economies of scale projections and potential for exploitation of natural resources. The second is the shape government policy, with obvious mismatches also associated with an investment in key sectors such data were limited to the development of populations. In short, the policy has introduced technology-related governance failures and lack of resources imbalances, if you compare it with the initiatives that have accompanied the private sector[13].

[13] Concern about government failures and market failures does not correspond only to emerging countries, the presidential message of 2010 targeted at farmers' society in the United States, contains a vehement demand for collective action and public policy. View David Blandford, "Presidential Address: The Visible or Invisible Hand? The Balance Between Markets and Regulation in Agricultural Policy "(2010).

In these cases, government failures and market failures correspond to inefficiencies associated with the structure and design policies improved technology. Many biotechnology-based companies have operated on conditions beyond ex post policy decisions of government and governments in Colombia itself offered no technology-based policies with additional incentives for the private sector. One of the gaps in technology-based policy has been to consider biotechnology as a subsidiary of other sectors of the national production, which limits their relevance research leading to inefficient results. By failing to provide equilibrium conditions in the markets, the various governments away the possibility of opening benefits a key sector for growth and development. If public policy is limited in dictating restrictive rules, employers are losing incentives to help with investments in areas that benefit the population.

The biotechnology market in Colombia also presents information gaps. Policy documents containing obvious gaps on the conditions of the firms that invest in the sector. As data gaps are, individually, investors can not solve. In summary, these mismatches disorient both the government and the private sector. There is confusion about copyrights, patents and recognition of capital flowing into these markets. The consequences of this situation play an inefficient use of natural resources are there in much of the country's geography. Subsequently extended these considerations.

This research aims to link these negative impacts of technology policy improvisation, taking cases of specific research groups and medium-sized companies in biotechnology. We consider an application of economic theory on transaction costs (TEC) provides a good foundation for understanding the underlying problems of this sector, even more, when analyzing the political economy of biotechnology since the transaction costs can best viewed their limitations and the limited scope of government policy. In biotechnology it is possible to get a policy that combines both equity and efficiency, that is, a wider range of policy applications to improve the standard of living of the population in Colombia.

Bibliography

- Alfranca, O., Huffman, W.E., 2001, “Impact of institutions and public research on private agriculture research”. *Agricultural Economics* 25, 191–198.

- Argyres, N., and Silverman, B., *R&D, Organization Structure, and the Development of Corporate technological knowledge*, Strategie Management Journal Strat. Mgmt. 7., 25: 929-958 (2004) Published online in Wiley InterScience (www.interscience.wiley.com).

- Arrow, K. J., Cropper, M. L., Eads, G. C., Hahn, R. W., Lave, L. B., Noll, R. G., Portney, P. R., Russell, M., Schmalensee, R., Smith, V. K., and Stavins, R. N. (1996), 'Is There a Role for Benefit–Cost Analysis in Environmental, Health, and Safety Regulation?', *Science*, 272(5259), 221.

- *BiotecVisions* 2011, February A1–A8; 2011 John Wiley & Sons, Inc.

- Byerlee, D., Alex, G., Echeverría, R.G., 2002, "The evolution of public research systems in developing countries: facing new challenges". In: Byerlee, D., Echeverría, R.G. (Eds.),*Agricultural Research Policy in an Era of Privatization* (Chapter 1). CABI, Oxon, UK, pp. 19–34.

- Byerlee, D., Fischer, K., 2002, "Accessing modern science: policy and institutional options for agricultural biotechnology in developing countries". *World Development* 30 (6), 931–948.

- Calabresi, Guido (1968), 'Transaction Costs, Resource Allocation and Liability Rules: A Comment', *Journal of Law and Economics*, 67-73.

- Campbell, Alison F. 2005, "The evolving of the concept of value add in university commercialization", *Journal of Commercial Biotechnology*, 11, 4, pg. 337 – 345.

- Cano (2003), "*Los diez cimientos de las negociaciones internacionales de comercio en la agricultura*", Intervención del señor ministro de Agricultura y Desarrollo Rural en el foro de Portafolio "Oportunidades y amenazas del ALCA y el TLC" Bogotá, septiembre 04.

- Cantley, Mark, (2004), "How should public policy respond to the challenges of modern biotechnology?" *Current Opinion in Biotechnology*, 15:258–263.

- Coase, R. H. 1935. The problem of duopoly reconsidered, *Review of Economic Studies*, vol. 2, 137.

- Coase, R. H. 1937A. “The nature of the firm”, p. 33 in Williamson, O. E. and Winter, S. G. (eds) 1991, *The Nature of the Firm*, Oxford, Oxford University Press.

- Coase, R. H. 1937B. “Some notes on monopoly price”, *Review of Economic Studies,* vol. 5, 17.

- Coase, R. H. 1939. “Rowland Hill and the penny post”, *Economica*, vol. 6, 423

- Coase, R. H. 1945. “Price and output policy of state enterprise: a comment”, *Economic Journal*, vol. 55, 112

- Coase, R. H. 1946A. “BBC Enquiry?”, *The Spectator*, no. 176.

- Coase, R. H. 1946B, “The marginal cost controversy”, p. 75 in Coase, R. H. 1988, *The Firm, the Market and the Law*, Chicago, IL, University of Chicago Press.

- Coase, R. H. 1960, “The problem of social cost”, p. 95 in Coase, R. H. 1988, *The Firm, the Market and the Law*, Chicago, IL, University of Chicago Press.

- Coase (1994), *La empresa, el mercado y la ley, El problema del coste social,* Tha Nobel Foundation (1991), Alianza Editorial S.A., Madrid, (España).

- Colciencias (2008), *La Biotecnología, motor de desarrollo para la Colombia de 2015*, Grupo Biogestión de la Universidad Nacional de Colombia y CorpoGen, Bogotá, D.C., Colombia.

- Colciencias, (2008), “*La biotecnología: sector estratégico para la Colombia del 2015*”, División de Ciencia, Comunicación y Cultura, Ministerio de Educación Nacional, versión web, disponible en: http://www.mineducacion.gov.co/cvn/1665/article-161751.html, consultado el 28 de Febrero de 2011.

- Comunidad Andina (1996), *Decisión 391- Régimen Común sobre Acceso a los Recursos Genéticos*, versión web, disponible en: http://www.comunidadandina.org/normativa/dec/D391.htm, consultado el 20 de Diciembre de 2010.

- Cooter, Robert D. (1982), '*The Cost of Coase'*, *Journal of Legal Studies*, 1-33. Reprinted in Donahue, Charles Jr, Kauper, Thomas E. and Martin, Peter W. (eds) (1992), *Property: An Introduction to the Concept and the Institution*. Reprinted in Ackerman, Bruce, Ellickson, Robert and Rose, Carol (eds) (1995), *Foundations of Property Law*.

- Dahlandera, Linus y Gannb Davis, (2010): "How open is innovation?" *Research Policy* 39, 699–709.

- Dahlman, Carl J. 1979. "The Problem of Externality." *Journal of Law and Economics* 22, (October): 141–62.

- Dietz, F. J., and Vollebergh, H. R. J. 2002, "Explaining Instrument Choice in Environmental Policies", in J. C. M. Van de Bergh (ed.), *Handbook of Environmental and Resource Economics*, Cheltenham, Edward Elgar, 339–51.

- Dinero (2005), *El Tesoro inexplotado*, versión web, disponible en: http://www.dinero.com/edicion-impresa/negocios/articulo/el-tesoro-inexplotado/31360 consultado el 29 de Julio de 2011.

- El Tiempo (2011), "Santos dijo que su Gobierno le apostará a la ciencia y la tecnología", versión web, disponible en: http://www.eltiempo.com/colombia/cartagena/ARTICULO-WEB-NEW_NOTA_INTERIOR-9385004.html, consultado el 10 de Julio de 2011.

- FAO (2006), "El hambre y la malnutrición en el mundo", versión web, disponible en: http://www.feedingminds.org/info/background_es.htm, consultado el 17 de Junio de 2011.

- Foltz, Jeremy D., Kim Kwansoo and Brham, Bradford. 2003: "A dynamic analysis of university agricultural biotechnology patent production", Amer. J. Agr. Econ. 85(1): 187–197.

- Gaskell, G. et al. 2006. "Europeans and Biotechnology in 2005: Patterns and Trends".*Eurobarometer* 64.3, final report to the European Commission's Directorate-General for Research.

- CGIAR Science Council, 2005a, “CGIAR Research Priorities 2005–2015”. *ScienceCouncil Secretariat*, Rome.

- Dixit, Avinash K. 1996. *The Making of Economic Policy: A Transaction-Cost Politics Perspective*. Cambridge, MA: MIT Press.

- Dorward, A.R., Kydd, J.G., Morrison, J.A., Urey, I., 2004, “A policy agenda for pro-poor agricultural growth”. *World Development* 32 (1), 73–89.

- González, C., (2007), **“***Biotecnología: desde el punto de vista de los negocios*”, versión web, disponible en: http://www.unicauca.edu.co/biotecnologia/ediciones/vol5/4Vol5.pdf, consultado el 08 de Junio de 2011.
- Hayek, Friedrich A. 1976, *Law, Legislation and Liberty*, Vol. 111: The Mirage of Social Justice, London: Routledge & Kegan Paul.

- Hayek, Friedrich, A. 1988, *The Fatal Conceit: The Errors of Socialism* (The Colllected Works of Friedrich August Hayek, Volume I) Routledge y Chicago University Press.

- Hall, A., 2005, “Capacity development for agricultural biotechnology in developing countries: an innovation systems view of what it is and how to develop it”. *Journal of International Development* 17 (5), 611–630.

- Herdt, R. W. 2006, “Biotechnology in agriculture”. *Annual Review of Environment and Resources* 31: 265–295.

- Hoffman, Elizabeth and Spitzer, Matthew L. (1982), ‘*The Coase Theorem: Some Experimental Tests*’, *Journal of Law and Economics*.

- Joscow, Paul L, 1991, in Williamson, O. E. and Winter, S. G. (eds), *The Nature of the Firm. Origins, Evolution and Development*, Oxford, Oxford University Press

- Joskow, P. L. 2005, “Vertical integration”. In C. Menard and M. Shirley (eds), *Handbook of New Institutional Economics*. Berlin: Springer, 319–348.

- Kalmanovitz, Salomón. 2001, Las instituciones y el Desarrollo económico, Bogotá, Norma.

- Kherallah, M., Kirsten, J., 2001, "The New Institutional Economics: Applications for Agricultural Policy Research in Developing Countries" *Markets and Structural Studies Division Discussion Paper 41*.IFPRI, Washington, DC.

- Libecap, G. D. 2005, "State regulation of open-access, common-pool resources".

- Lusk, J. L., Jamal, M., Kurlander, L., Roucan, M. and Taulman, L. 2005, "A meta-analysis of genetically modified food valuation studies"; *Journal of Agricultural and Resource Economics* 30: 28–44.

- Ménard, C. and M. Shirley (eds), *Handbook of New Institutional Economics*. Berlin: Springer, 545–572.

- MacCann, Philip. 2011, "International business and economic geography: knowledge, time and transactions costs", *Journal of Economic Geography* 11, pp. 309–317.

- McEachern, (2000), W.A. Economics, 5th edition,Cincinnati: South-Western.

- McHughen, A. 2007, "Fatal flaws in agbiotech regulatory policies". *Nature Biotechnology*25: 725–727.

- Ministerio del Poder Popular de Ciencia, Tecnología e Industrias Intermedias, Gobierno Bolivariano de Venezuela, "Venezuela ha incrementado inversión en ciencia y tecnología", versión web, disponible en: http://www.mcti.gob.ve/Noticias/3064, consultado el 12 de Julio de 2011.

- Myers, Robert J, Sexton, Richard J., Tomex, William, "A century of research on agricultural markets": *Amer. J. Agr. Econ*. 92(2): 376–402.

- *Nature biotechnology*, 2009, "Firms seek new models to access public equity", volume 27 number 10 October.

- Phillips, Peter W, 2002, "Biotechnology in the global agri-food system" *Trends in Biotechnology* Vol.20 No.9.

- Pinilla (2004), "Herramientas para la competitividad a partir del uso de la biotecnología", Economía y desarrollo, volumen 3, Número 2, versión web, disponible en: http://www.fuac.edu.co/revista/II/II/seis.pdf, consultado el 15 de Junio de 2011.

- Polinsky, A. Mitchell (1974), 'Economic Analysis as a Potentially Defective Product: A Buyer's Guide to Posner's Economic Analysis of Law', *Harvard Law Review*, 1655-1681.

- Porter, Michael (1998). *Competitive Advantage: Creating and Sustaining Superior Performance*. The Free Press.

- Prakash, C.S., *"Benefits of Biotechnology for Developing Countries",* AgBioWorld, version web, disponible en: http://www.agbioworld.org/biotech-info/topics/dev-world/benefits.html, consultado el 23 de Octubre de 2010.

- Pray, C., Paarlberg, R. and Unnevehr, L. 2007 "Patterns of political response to biofortified varieties of crops produced with different breeding techniques and agronomic traits". *AgBioForum* 10: 135–143.

- Qaim, M. and Zilberman, D. 2003, "Yield effects of genetically modified crops in developing countries". *Science* 299: 900–902.

- Rawls, John, 1971, *Theory of the Justice*, Cambridge, Harvard, University Press (Traducción en español: ([1995] *Teoría de la Justicia*, México, Fondo de Cultura Económica).

- Regan, Donald H. (1972), 'The Problem of Social Cost Revisited', *Journal of Law and Economics*.

- Raney Terry, 2006, "Economic impact of transgenic crops in developing countries", *Current Opinion in Biotechnology*, 17:174–178.

- Reprinted in Medema, Steven G.(ed.) (1995), *The Legacy of Ronald Coase in Economic Analysis*, Aldershot, Edward ElgarPublishing.

- Robbins, Lionel C., *The Nature and Significance of Economic Science* (1932), La cita en español es de *Ensayo sobre la naturaleza y significación de la ciencia económica*, México, Fondo de Cultura Económica (1980), p. 104. Primera reimpresión de la segunda edición en español (1951).

- Salgado, C., Elvira, *Teoría de costos de transacción: Una breve reseña*, Cuad. Adm. Bogotá (Colombia), 16 (26) : 61- 78, julio-diciembre, 2003.

- Santa Ana André y Valle. Silvio, 1995, "Public perception of biotechnology: problems in the Third World", Biotopics, Vol. XIII.
- Sen Amartya, 1997, *Sobre la desigualdad económica*, Barcelona, Crítica. Pp. 146.

- Sheldon, Ian M. 2002. "Regulation of Biotechnology: will we ever "freely" trade GMO´s?" *European Review of Agricultures Economics*, Vol 29, (I), pp. 155 – 176.

- Schmalensee, Richard and Roberto D. Willing (eds), 1989, *Handbook of Industrial Organization*, 126.

- Tetlock, P. C. 2008, 'Has Economic Analysis Improved Regulatory Decisions?' *Journal of Economic Perspectives*, 22(1), 67–84.

- Torres, Ricardo (2002). *Bases para una política nacional de biotecnología*. Sexto Borrador.

- United Nations Conference on Trade and Development,United Nations New York and Geneva, 2002, "*Key Issues in Biotechnology*", version web, disponible en: http://www.unctad.org/en/docs/poitetebd10.en.pdf, consultado el 3 de Enero de 2010.

- Vesga, Rafael, *"Emprendimiento e Innovación en Colombia:¿qué nos está haciendo falta?",* Facultad de Administración Universidad de Los Andes, versión web, disponible en: http://cec.uniandes.edu.co/pdf/rav.pdf.

- Walker, B., Barrett, S., Polasky, S., Galaz, V., Folke, C., Engström, G., Ackerman, F., Arrow, K., Carpenter, S., Chopra, K., Daily, G., Ehrlich, P., Hughes, T., Kautsky, N., Levin, S., Mäler, K.-G., Shogren, J., Vincent, J., Xepapadeas, T., and de Zeeuw, A. 2009, "Looming Global-scale Failures and Missing Institutions", *Science*, 325, 1345–6.

- Weingast, B. R. 2005. “The performance and stability of federalism: an institutional perspective”. In C. Menard and M. Shirley (eds), *Handbook of New Institutional Economics*. 149–174.

- Wennekers, S. (2006) *Entrepreneurship at Country Level. Economic and Non economic Determinants*. Erasmus Research Institute of Management (ERIM).

- Williamson, O. E. 1991, “Comparative economic organization: the analysis of discrete structural alternatives”. *Administrative Science Quarterly* 36(2): 269–296.

- Williamson (1993), *Calculativeness, Trust, and Economic Organization*, University of California, Berkeley, Journal of Law and Economics, Vol. 36, No. 1, Part 2, John M. Olin Centennial Conference in Law and Economics at the University of Chicago, pp. 453-486.

- Williamson, O. E. and Winter, S. G. (eds) 1991, *The Nature of the Firm. Origins, Evolution and Development*, Oxford, Oxford University Press

- Winston, C. 2006, “Government Failure versus Market Failure”, Washington, DC. *AEI–Brookings Joint Center for Regulatory Studies*.

- World Economic Forum (2008) *Global Competitiveness Report 2007-2008.*World Economic Forum, Geneva.

- Zerbe, Richard O., Jr (1980), ‘The Problem of Social Cost in Retrospect’, *Research in Law and Economics*.

- Zilberman, D. 2006, “The economics of biotechnology regulation”. In Just, R. E., Alston, J. and Zilberman, D. (eds), *Regulating Agricultural Biotechnology: Economics and Policy*. New York: Springer Publishers, 243–261.