The ambivalent regulator: the construction of a regulatory style for genetically modified crops in Chile

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ABSTRACT

After decades of commercialization, genetically modified (GM) crops continue to generate controversy. Countries have developed different GM regulatory styles based on their risk frames, institutional arrangements, and participation modes. Our objective was to understand the development of Chile’s unique regulatory style. We reconstructed the use and regulatory evolution of the technology, identified key actors in the controversy, and compared Chile with other approaches. Chile’s style is ambivalent: restricting commercial use to seed-export but permissive in other domains. This approach reflects a market-caution framing of the issue focused on developing a promising agriculture sub-sector. Thus, Chile became a southern seed nursery for the GM industry. Opponents responded by framing their concerns around a basic demand for public information and transparency. Our case illustrates the challenges and relevance of discussing new technologies in emerging democracies. Access to information, early debates and greater transparency are key to evaluate new technologies in these contexts.

KEYWORDS

Transgenic crops; controversy; regulatory styles; GMOs; Chile

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RESUMO

Os cultivos transgênicos ou modificados geneticamente (GM) continuam gerando controversa mesmo estando no mercado há décadas. Em resposta, os países têm gerado diversas regulamentações baseadas nas suas molduras de risco, arranjos institucionais e modos de participação. No nosso objetivo é compreender o desenvolvimento do estilo regulatório no Chile, único no mundo. Reconstruímos o uso e a evolução dos atores chaves na controversa e comparamos o modelo chileno com outros no mundo. O estilo chileno é ambivalente: restringe o uso

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RESUMEN

Los cultivos transgénicos o genéticamente modificados (GM) siguen generando controversia a pesar de su comercialización por décadas. En respuesta, los países han generado diversos estilos regulatorios, basados en sus marcos de riesgos, arreglos institucionales y modos de participación. Nuestro objetivo era comprender el desarrollo del estilo regulatorio en Chile, único en el mundo. Reconstruimos el uso y evolución regulatoria de la tecnología, identificamos los actores clave en la controversia y comparamos el enfoque chileno con otros en el mundo. El estilo chileno es ambivalente: restringe el uso comercial a la exportación de semillas, pero es permisivo en otros ámbitos. Este enfoque refleja un enmarcamiento del problema de precaución ante el mercado, orientada principalmente al desarrollo de un sub-sector agrícola promisorio. De esta forma Chile se transformó en un semillero para la industria GM. Los oponentes a la tecnología enmarcaron sus preocupaciones en torno a una demanda básica por transparencia y acceso a información pública. El caso ilustra los desafíos y la relevancia de debatir sobre las nuevas tecnologías en países emergentes. Bajo estos contextos el acceso a información, discusiones tempranas y mayor transparencia son clave para evaluar las nuevas tecnologías.

1. Introduction

Almost 20 years after the introduction of the first genetically modified (GM) food into the market, the debate over genetically modified organisms (GMOs) remains contentious (Motta 2014; Hilbeck et al. 2015; Yamaguchi and Suda 2010; Levidow and Carr 2007; Bonneuil, Pierre-Benoit, and Marris 2008; Pechlaner 2012). Far from having reached a consensual stage, the discussion seems to be ever more polarized, intense and conflictive (Krimsky 2015; Bernauer et al. 2011; Hindmarsh and Parkinson 2013; Fischer et al. 2015; Rodriguez-Cerezo and Stein 2010; Borch and Rasmussen 2005; Freidberg and Horowitz 2004; Herrick 2005; Levidow and Carr 2007). As with other iconic technological innovations (Bauer 1995), there is no public or academic consensus about the risks and benefits involved in the use of GMOs (Motta 2014). Pro- and anti-GM arguments have multiplied, and are often framed as a mix of economic, agricultural, ethical, environmental, political, ecological, and cultural issues. Indeed, consumers, farmers, NGOs, national governments,
international regulatory bodies, scientists, retailers, and the biotech industry are some of the parties involved in the controversy – and each of them has assembled a complex web of positions, arguments, and facts.

We sought to understand the GM crop controversy in Chile, where agriculture plays a key role in the country’s export and domestic industry, and contrast our experience with that of other regions of the world. Chile’s approach appears quite distinct in the GM world: it restricts the technology’s use to the seed-export industry but appears to have a permissive approach in other domains such as events authorized, food imports, and labeling. The Chilean case, with its ambivalent regulatory framework and ensuing controversy, has been poorly studied by STS scholars. To our knowledge this is the first comprehensive account of the GM controversy in Chile. Furthermore, finding independent first hard empirical data about GM crops in Chile is often difficult. Our goal therefore was to raise awareness about the case, understand the development of Chile’s regulatory style and explain why, after several years, the controversy ensues.

2. Theoretical framework

In STS terms, sociotechnical controversies are an integral part of how science and technology is practiced and disseminated in the modern world. Controversies about science and technology bring to light friction between science, society, and democratic politics. They refer to situations of shared uncertainty when things and ideas that were once taken for granted become disputed and where actors agree on their disagreements (Venturini 2010). They highlight the challenges that the products of science both enact and pose for society as they move from the lab to the real world. The kinds of questions that they imply are multiple and complex: political, legal, economic, cultural, and scientific. In other words, sociotechnical controversies reflect upon the processes by which nations, communities, and people make sense of science and its products (Jasanoff 2005b).

Regulation is integral to the configuration of any technology. In its most general definition, regulation connotes a form of rule or directive made and maintained by an authority (Black 2002). In the case of biotechnology, regulation can be defined as the vehicle through which states provide assurance that the political, economic, and environmental risks of new technologies can be contained within manageable bounds (Jasanoff 1995). The scope, content, and contentiousness of biotech innovations vary significantly depending on their regulatory contexts. Regulation is therefore an interface between technoscientific inventions and society at large. As Jasanoff puts it, regulation “is a kind of social contract that specifies the terms under which state and society agree to accept the costs, risks and benefits of a given technological enterprise” (1995, 311).

To make sense of the technology, nations develop regulatory styles based on their particular framings of risk, institutional arrangements, and public participation modes (Jasanoff 2005a, 2005b; Aerni and Benauer 2005; Benauer and Meins 2003; Bernauer 2005; Hindmarsch and Du Plessis 2008; Howlett and Migone 2010). Assuming that regulatory schemes are embedded in larger political cultures, comparisons have usually relied on developed nations, particularly the cases of the US, and the European nations (Bernauer and Meins 2003; Lofstedt and Vogel 2001; Howlett and Migone 2010). Thus, for example, early comparisons contrasted the policy response of the US versus that of the European Community (EC). The US framed the risks of biotechnology as a stream of
products and the technology itself as familiar. In contrast, the EC framed GMOs as a process in some ways not yet well understood and which required “precaution” (Dunlop 2000; Jasanoff 2005b; Howlett and Migone 2010). While the US is a top world producer of GM crops, the EC restricts commercial cultivation and field trials. Despite these contrasts between two major markets, worldwide commercial cultivation continues to increase in acreage, with some developing nations among the top producers (James 2014).

Public responses to the technology – while varied – are embedded and consistent with their political culture (Jasanoff 2005a). In the US, for example, low public outrage in the context of centralized decision-making allowed for greater influence by the biotechnology industry. In the EU, higher public outrage coupled with multi-layer decision-making and low industry organization, generated greater influence by opposition groups (Bernauer and Meins 2003). Jasanoff’s groundbreaking comparison (2005a) highlighted how different actors within and across nations construct common narratives to make sense of the uncertainties associated with new technologies such as GMOs. More recent comparative studies suggest the level of public participation in policy-making can shape the specific promotional approaches taken by countries (Howlett and Migone 2010). Thus in the context of public-oriented participatory policy development, the public’s opinion may modify a nation’s otherwise promotional approach to biotechnology, such as in the case of New Zealand.

Motta’s (2014, 1370) review of social disputes over GM crops and foods notes that “one cannot start to understand it without considering, at first, the global and international character of the material and cultural support that has been promoting the technology in the last three decades.” However, she argues that while global forces are key to understanding the controversy, case studies of regimes for GM crops in different countries help us to understand the ways in which global processes shape and limit regulatory decisions at the local level. This is especially important if we wish to further understand the controversy over GM regulation in national contexts characterized by the lack of democracy. Regulatory styles are the result of different ways of articulating the relationship between the state, the market and citizens in democracies. But for many countries in the Global South, including Chile, biotechnological innovations such as GMOs develop in contexts where democracy is a recent achievement. In these cases, regulation is not only embedded in specific legal and administrative cultures, but also in processes of institution-building and democratic installment. Insofar as science “is called on to answer everything from what constitutes life to how to intervene in the world” (Barandiaran 2015, 254), science, politics, and the state intersect in several and crucial ways. To begin with, the form, extension, and strength of democracy play a crucial role in the regulation of technosciences (Ezrahi 1990). Science offers, in one stroke, both an opportunity to nurture evidence-based state interventions, and the justification of technocratic action in the name of universal rationality (Breslau 1992). Liberal democracies have found, not without conflicts, procedures to secure the utilization of science within the limits of politics. The proliferation of scientific panels and committees – or the advance of so-called regulatory science (Jasanoff 1998) – and the expansion of public participation in the governance of technosciences (Irwin 1995; Callon, Lascoumes, and Barthe 2009) are responses to the challenge of balancing scientific reason with (and within) political normativities.

The implementation of these procedures has been slow in Chile. A well-established technocratic culture, reinforced and expanded during Pinochet’s neoliberal restructuring, has prevented the development of formal platforms for the democratic interaction
between science and politics (Barandiaran 2016; Silva 2009). For example, Environmental Impact Assessments (EIA), a tool designed in the 1960s to balance the need of science-informed environmental policies with societal goals (Glasson, Therivel, and Chadwick 2005), was only implemented in the 1990s in Chile. Moreover, despite its formal functioning, EIAs are perceived as inefficient and biased by NGOs, citizen collectives, and even scientists themselves (Barandiaran 2015; Tironi and Barandiaran 2014).

The causes for the lack of credibility of EIAs have to be found in the permissive regulatory framework within which EIAs function and in the precarious conditions of Chilean science, but also in the overall perception of inequality (Tironi and Barandiaran 2014; Tecklin, Bauer, and Prieto 2011). While Chile is often presented as a country with strong institutions, low corruption, and stable politics (Stein et al. 2005), it is also one of the most unequal countries in the world (Lópex and Miller 2008). In this context, EIAs and other science-informed state interventions are perceived by social organizations as powerless against the lack of real institutional regulation of large corporations. The emergence in recent years of conflict around indigenous rights and the unregulated expansion of extractivist industries has reinforced Chile’s democratic deficit (Carruthers and Rodríguez 2009).

The case of EIAs and environmental politics and policy at large point at the challenges of implementing regulatory science in the context of developing countries. Biotech regulation, in other words, must deal with questions over social stability, human rights, political transparency, and scientific precariousness that are to some extent absent in the countries usually mobilized in cross-national comparative research.

We sought to understand the GM crop controversy in Chile, an emerging democracy where agriculture plays a key role in the country’s export and domestic industry, and contrasted our experience with that of other regions of the world. From an STS perspective, the Chilean controversy can shed light on the frictions between science, society, and democratic politics and especially on how global processes shape local regulatory decisions. Chile’s approach appears quite distinct in the GM world: it restricts the technology’s use to the seed-export industry but appears to have a permissive approach in other domains such as events authorized, food imports, and labeling. Our goal was to understand the development of Chile’s regulatory style and explain why, after several years, the controversy ensues. We reconstructed the technology’s use by analyzing primary data on GM crop production and its regulatory history, identifying key actors. Chile’s GM adoption experience and its peculiar regulatory style highlight the need to strengthen and broaden the accountability of technological applications worldwide. We believe this example also illustrates the need to better guide the discussion at early stages of development of new emerging agricultural technologies.

3. Materials and methods

3.1. Methodology for data acquisition

We used a qualitative case study approach to analyze the emerging GM controversy in Chile. Our main data sources were content analysis of public documents and hearings, along with government production data. We analyzed over 120 documents in the following categories: articles in the press, legal hearings, decisions and claims, academic reports, press releases and policy statements by the biotech and seed industry, government and NGOs, presentations by stakeholders at public events, and policy and regulatory
documents. We complemented this analysis with semi-structured interviews with 17 key informants during 2011–2012. These included small farmers (3), organic producer organizations (4), civil society organizations (3), government agencies (2), academic experts (3), beekeepers and honey exporters (2).

In accordance with the qualitative case approach (Stake 1998), our design was emergent but focused, i.e. initial questions and key actors were identified based on content analysis of public documents and participant observation. Initial interviews generated information about other key informants that were later interviewed. We used the interview data to triangulate categories and insights from our content analysis (Cea D’Ancona 2001). Using this data, we reconstructed the technology’s use and its regulatory evolution, identified key actors and their perspectives and compared the case with the US and European Union.

3.2. Interviews and document analysis

For the interviews, we initially identified key organizations participating in or that were party to the debate. These included farmers and producers, government officials, members of NGOs, and biotech industry representatives. After identifying these key entities, we interviewed their spokespersons or leaders. The interviews were conducted using semi-structured format, taped, and then transcribed. We analyzed interview and public document data using the software for qualitative analysis QRS International NVivo9. Briefly, an initial set of codes were created using the software reflecting themes that emerged from the data and/or were found in the literature as well as their relationships (Strauss and Corbin 2002). The initial set of codes were categorized using the themes from Bogdan and Biklen’s typology (1998): “setting-context,” “definition of the situation,” and “framings or perspectives held.” Sub-codes emerged and were classified in six categories: (1) general definitions about GM crops, (2) productive impacts, (3) environmental impacts, (4) public trust, (5) public participation, and (6) regulation. These were then used to further refine the analysis. On-going data analysis from documents, production data, and interviews was used to reformulate and further focus the research questions and the interview guide.

3.3. Mapping of the main actors in the debate

We categorized key actors in the public debate on GM crops in Chile into six main groups: (1) seed companies, (2) biotechnology firms, (3) environmental and other civil society organizations, (4) small and medium farmers, (5) organic producers and beekeepers, and (6) government and regulatory entities. These groups represent those actors who have intervened in the public debate in an organized manner and/or are directly affected by decisions related to GM crops. We identified five main framings of the problem used by key actors in the GM controversy in Chile: (1) market, (2) socioeconomic, (3) co-existence, (4) uncertainty and risk (closely associated with the status of the GM entity), and (5) transparency (information and participation). While not exhaustive, they represent the most salient cognitive and normative framings that shape the controversy and are used to maintain or unsettle the boundaries of Chile’s specific regulatory style. We mapped these key actors’ positions in relation to the first four frames (Figure 1) and located them in a continuum ranging from “opposition” to “support” for the technology, based on their use of the socioeconomic or market frames. We also aligned actors according to their use of the uncertainty/risk and co-
existence frames, in what we labeled as “radical” versus “moderate” positions. Briefly, GM opponents with a “radical” position frame GM crops as a highly uncertain, risky technology and consider co-existence as impossible. In addition, these actors view the struggle against GM crops as part of a broader critique against transnational corporations. GM opponents with a “moderate” position highlighted the risks of the technology for exports but accepted the possibility of co-existence. On the other hand, GM supporters with a radical position framed GM crops as a very safe technology and thus consider the co-existence approach as irrelevant and unnecessary. They also tend to view the technology in idealistic terms, for example, as an urgent solution to world hunger. GM supporters with a “moderate” position framed the risks of GM crops as manageable and co-existence as feasible. They framed the technology as one agricultural strategy for more efficient production.

3.4. Analysis of production and regulatory data

We analyzed production data – surface area, location, type of crop, and events authorized – for GM crops in Chile collected by the government agency in charge of authorizations for the years 1992–2010. We obtained this data via Chile’s Transparency Law enacted in 2009 which seeks to ensure access to public information; some but not all this raw data is now available on the government’s agricultural agency webpage (Servicio Agrícola y Ganadero SAG www.sag.cl). For surface area and type of crop, we included data up to the 2013–2014 productive season. Data for events authorized and location are only partially available for the 2013–2014 season. For our analysis of the number of events authorized, we considered new combinations of previously developed or authorized events in a single plant as a “new event.” We used this definition of new event for two reasons: (1) to reflect the diversity of stacked traits currently being developed and used in the industry and (2) because the effects on the plant of combining genetic modification events are more than the sum
of their parts. To our knowledge this will be the first time this data is analyzed and published. We have developed a searchable database on our website www.transgenicos.cl, which provides user-friendly public access to this data. We also reviewed government regulations and congress proceedings pertaining to GM food and crops, to establish the definitions, scope, and timeline of regulatory enactment.

4. Results

4.1. A historical perspective on GM crop adoption in Chile

According to our analysis of public regulatory data, the first adoption of GM technology for crop use in Chile dates back to 1992, with very small areas of production. Adoption grew slowly until 2000, when cultivation jumped from dozens to thousands of hectares with the onset of commercial GM seed production (primarily maize and soy). Since then, production has grown steadily, leveling off in the 20 to 30-thousand hectare range between 2007 and 2013 (Table 1). Levels dropped to below ten thousand in 2014, most likely in response to changes in the seed demand from the north. They have not recovered since, remaining in the ten thousand range in recent years according to government production statistics (for recent data see www.sag.cl/ambitos-de-accion/listas-y-estadisticas and www.transgenicos.cl). Commercial GM production in Chile has been restricted to the seed-export industry. Non-seed cultivation is permitted only for research purposes and limited to the sale of remnant seed for animal feed.

The main GM crops grown in Chile are maize, soy, and canola, where maize is clearly predominant (Table 1). The main traits present are herbicide tolerance and insect resistance. For maize, the most frequent modification is the stacked trait herbicide tolerance and insect resistance. Chile reproduces world commercial production patterns in three aspects: crops grown, main traits, and increased importance of stacked traits.

An in-depth look at production data, however, suggests a more nuanced local reality. First, Chile became a player in GM seed production early in the technology’s development and commercialization stages. Public records show that at least 6 different GM tomato lines – the first commercial GM crop – were authorized during the 90s (see supplement 1 for a complete list). Second, the number of events or specific genetic modifications authorized in Chile grew exponentially, becoming very heterogeneous by 2010 (Table 2) (http://www.transgenicos.cl). In the case of maize, for example, our analysis shows that more than 350 different events were authorized in the production year 2010. Public access to data on events authorized after 2010 is available for only 2% of the registrations. Considering this gap, we estimated that the number of events authorized in maize up to 2013 is in the range of the thousands. We also found that the variety of traits authorized extends well beyond the two main commercial traits of insect resistance and herbicide tolerance. We identified seed authorizations for second- and third-generation crops with modifications for industrial, processing, and pharmacological uses as well as nutritional quality in four crops (Table 3). According to the organization ISAAA, there are 140 commercial events authorized in maize worldwide. In both the US and EU, there are less than 50 commercial events authorized for either food, animal feed, or environment. Therefore, many of the events authorized in Chile are not commercial seed but rather part of the technology’s research and development pipeline.

Thus, Chile not only produces and exports commercial seed but also provides a location for field trials and non-commercial seed increase, fulfilling a role as a “world laboratory” for
## Table 1. Surface area of GM crops in hectare, per crop and production year.

| Crop            | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Canola or raps  | 139  | 746  | 628  | 445  | 1188 | 4012 | 1862 | 2648 | 4089 | 4369 | 2838 | 1568 |
| Maize           | 8436 | 7614 | 12118| 17982| 21831| 20977| 17389| 13614| 25192| 29555| 19534| 5878 |
| Soy             | 128  | 273  | 166  | 250  | 1398 | 5389 | 5474 | 3514 | 2239 | 1934 | 1543 | 1370 |
| Other crops a   | 4    | 51   | 18   | 163  | 47   | 4    | 44   | 22   | 2    | 1    | 1    | 1    |
| Total/year      | 8707 | 8684 | 12,929| 18,839| 24,464| 30,382| 24,769| 19,798| 31,522| 35,858| 23,916| 8817 |

*aOther crops include: rice, safflower, alfalfa, *Brassica juncea*, barley, eucalyptus, flax, pumpkin, sunflower, melon, potato, pine, sugar beet, tobacco, tomato, wheat and grapes.
the GM seed R&D pipeline. This role has contributed to the development of a thriving Chilean seed-export industry. Today it is the 7th world seed exporter, having previously occupied the 5th and 6th place (International Seed Federation 2017). In the case of maize, practically all the seed exported in 2013 was GM. Chile’s added value as a seed producer stems from its phytosanitary isolation and seasonal difference with the northern hemisphere where key markets are located. This seasonal difference or “counter-season” advantage allows companies to test products, carry out field trials or increase seed in the south during the northern hemisphere’s winter, cutting down product development time.

Despite Chile’s restriction on commercial production and its limited adoption scale, planting, testing, and commercialization of GM crops occurred early in the technology’s development trajectory. Today, it continues to play a key role in seed production for both R&D and commercial purposes.

### 4.2. Chile’s regulatory style is industry driven, fragmented, and with scant public participation

Regulatory action for GM crops in Chile began, albeit precariously, a year before their first market approval in the world. Chile’s first GM regulation was enacted in 1993 by the Ministry of Agriculture’s Animal and Livestock Service (SAG for its acronym in Spanish) and focused on the impact of these seeds on agriculture. This first norm limited seed reproduction for export purposes only and outlined a general frame for procedures. As the technology’s influence spread across the globe, regulators in Chile adapted the regulatory

**Table 2.** Number of events and traits types in GM crops in Chile in 2010.

| Crops             | One trait | Two traits       | Three traits | Total events |
|-------------------|-----------|------------------|--------------|--------------|
|                   | TH | RI | other | TH-RI | TH-X | RI-X | TH-RI-X |              |
| Canola or raps    | 19 | 0  | 12    | 0     | 4    | 0    | 0        | 35            |
| Maize             | 34 | 37 | 26    | 224   | 3    | 8    | 24       | 356           |
| Soy               | 38 | 3  | 5     | 0     | 4    | 0    | 0        | 50            |
| Other crops       | 4  | 3  | 6     | 0     | 0    | 0    | 0        | 13            |
| **Total**         | **95**| **43**| **49**| **224**| **11**| **8**| **24**| **454**|

Notes: HT: herbicide tolerance; IR: insect resistance; HT-IR: combination of herbicide tolerance and insect resistance; HT-X: combination of herbicide tolerance and another modification; IR-X: combination of insect resistance and another modification. Other modifications: yield increase, modification of fatty acid content, modification of oleic acid content, drought resistance, altered fertility, expression of alpha amylase, expression of pro insulin 2, expression of gamma linoleic acid. Other crops: zucchini, sugar beet, tomato y safflower

**Table 3.** Non-agronomic traits in GM crops in Chile.

| Crop       | Modification                      |
|------------|-----------------------------------|
| Maize      | Alpha amylase expression           |
| Soy        | Oil content                        |
| Soy        | Oleic acid content                 |
| Safflower  | Expression of proinsulin2          |
| Safflower  | Gamma linoleic acid content        |
| Rice       | Expression human albumin           |
| Canola     | Phytase production                 |
| Safflower  | Bovine enzyme production           |
| Rice       | Lactoferrin production             |
| Safflower  | Insulin production                 |
| Maize      | Monoclonal antibody production     |

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framework. For example, the first regulations defined the technology as a “phytosanitary risk” issue and only later, with the onset of commercial GM seed production, broadened the definition to include “potential benefits.” Regulators also modified the norm to include any locally produced GM seed and to allow some remnant seed to be sold locally for animal feed, effectively broadening the nature and commercial possibilities of the regulated entity. This is one example of the ways in which regulators changed norms and re-framed GM crops to accommodate the needs of the seed industry, shifting from an initial stance highlighting potential risks to one more focused on potential benefits. Thus, key norms and regulations in Chile both promoted and responded to the needs of a growing and expanding GM seed sector.

To fully understand why this framework became so controversial in Chile, it is useful to contrast the development of seed regulations with those for GM food that typically concern citizens and consumer groups. The first GM food norm was established in 2003, more than a decade after the first seed regulation. The norm, an amendment to the National Food Rule, delegated oversight of “biotechnological events” intended for human consumption to the food and drug safety agency. Under this mandate, the agency has reviewed petitions for GM food events and presumably submitted them for final approval at the Ministry level. However, after more than a decade a list of approved GM food events has yet to be published. There are no labeling requirements for GM foods or foods containing GM ingredients, either imported or produced locally. In practice, many processed foods containing GM ingredients are widely available in Chile. Presumably, once the Ministry publishes a “list of authorized events,” those not listed but present in food would be illegal. In some ways, the lack of regulatory action makes the regulated entity invisible for the time being. Once published the impact of the list, particularly for processors and importers, could be high. In Table 4, we lay out the principal norms that regulate GM food and crop technology in Chile today along with their enactment date.

Furthermore, no explicit framework coordinates the actions of these two key agencies involved in GM regulatory oversight. In practice, GM “foods” and “seeds” have been treated as two distinct and unrelated entities by regulators. Oversight for GM foods has lagged behind the reality of commercial GM products available in the country, while GM crop oversight has yielded a specific set of norms to address seed cultivation issues.

Table 4. Principal regulations and norms in GM food and crop oversight.

| Agency | Type of regulation | Year | Applies to |
|--------|--------------------|------|------------|
| Ministry of Agriculture’s Plant and Livestock Service (SAG) | Resolutions | 1993 | GM seed imports |
| | | 1997 | animal consumption of insect resistant maize |
| | | 1999 | biosecurity norms for some pharmacrops |
| | | 2001 | update of 1993 seed import norm |
| | | 2002 | time frames for import and liberation into the environment of GM seeds |
| | | 2005 | establishes technical committee for GMOs |
| | | 2010 | status of information included in petition |
| | | 2003 | oversight of GM food for human consumption |
| Ministry of Health’s Public Health Institute (ISP) | Modification of 1996 Food Safety Rule | 2007 | assessment of GM food events for human consumption |
| | Technical-administrative norm | 2007 | procedures for establishing Approved Events List |
| | Resolution | 2009 | Establishment of new expert panel |
At the same time, the country’s environmental authority has, for the most part, been absent from regulatory oversight of GMOs. Environmental impacts of these crops are considered only under the framework for phytosanitary control, under the purview of the agricultural agency. The Environmental Law enacted in 2009 includes the environmental release of GMOs under its purview. However, this newer mandate has not significantly changed the GM authorization process.

Our analysis of the seed authorization process indicates that highly technocratic decision-making restricts opportunities for public participation. The current GM seed regulation does not mandate any specific participation process, although it allows public comments on agency resolutions within a 15-day period. However, these resolutions are published in a national registry not easily accessible to the public. Thus, it is often hard – if not impossible - to obtain information on resolutions. In the practice, participation in decision-making is rare and any other forms of public consultation by the agency are discretionary. On the other hand, we observed that negotiated rulemaking and standard setting occur with stakeholders from the productive sector, particularly seed companies. The situation for GM food is not too different. Although the review process mandates public participation, in the practice it has been scant. Access to regulatory information is also difficult. For example, information on the status of petitions submitted or authorizations granted for food events is currently unavailable to the public.

4.3. Civil society responded to GM adoption with mistrust and a basic demand for information

Organized opposition to GM crops first emerged in Chile in the late 90s when dozens of civil society organizations formed the anti-GM network (“La Red por un Chile Libre de Transgénicos”). Opposition today has coalesced around the campaign “I don’t want transgenics” (“Yo no Quiero Transgénicos”), initiated in 2011 by a loose alliance of organizations, coalitions, “green” legislators, farmers, and individuals. The campaign has been effective in promoting discussions in a variety of social and mainstream media, revitalizing public debate amongst interested actors as well as maintaining an active website. The issue, until recently, had not attracted broader public or political interest.

Opponents to GM crops in Chile have focused primarily on transparency issues and used institutional means to advance their claims. The disclosure of GM field locations has been a dominant, shared issue in civil society’s framing of the problem. Their first organized action was to petition the agency (SAG) in 2000 for the exact location of GM fields. The agency’s negative response set off a legal fight over the status of this regulatory information that would last more than ten years. Initially, opposition groups were unsuccessful arguing for the public nature of the information in civil courts. However, with the advent of Chile’s Transparency Law in 2009, they contested and won their case against the agency before a special council, whose decision is legally binding (see supplement 2 for a detailed chronology of events).

Civil society’s framing of the problem as a “right-to-know” or “transparency” issue speaks to very basic issues of public participation and trust in regulatory institutions. The demand before the council also questioned a very basic aspect of public service: the agency’s balancing of public versus private interest. Throughout the decade-long dispute, the agency (re)interpreted its mandate to protect the confidentiality of regulatory information submitted by biotech seed companies. In response to the Transparency
Council’s final decision, the agency improved public access to information on its website. However, while it no longer considers field location as “confidential business information” it now restricts information on events authorized, if a seed company so desires; most opt to restrict. It is not surprising then that the agency was- and is- perceived as allowing private interests to trump public ones.

The dispute grew and attracted new actors – organic producers and beekeepers – when measures to prevent co-mingling and cross-pollination failed or were perceived as ineffective. In other words, productive actors took a more active stance when information access and participation became critical elements of regulation impacting their activities. To the extent that participation, trust and information access issues remain unresolved, the controversy has ensued.

The public debate in some ways has become polarized, masking the heterogeneity of positions held by the actors involved. We found that supporters frame GM crops primarily as an emerging and promising market opportunity and as a central solution to poverty, food scarcity, and economic development. Opposition actors frame GM crops as debilitating new market opportunities and creating rather than solving issues of world poverty and injustice. More “radical” actors on both sides of the debate frame the idea of co-existence in absolute terms, as either impossible or irrelevant often accompanied by framing risk issues as highly uncertain or very certain. This is often associated with a cognitive frame that defines GM technology as either something inherently novel or familiar. Moderate actors are more accepting of co-existence and the ability to manage risk. Our mapping (see Figure 1) suggests that (1) positions within each camp may be quite heterogeneous in terms of how actors use shared frames and (2) the two actors located at the extremes are precisely those more visible and active in the public arena.

In more recent years, the GM debate has grown and shifted to the property rights terrain. Here too opponents have taken advantage of institutional means to advance their demands, now more explicitly focused on the question of private versus public interests. An analysis of the property rights. An analysis of the GM property rights debate is beyond the scope of this paper (manuscript in preparation). However, it is worth noting that in its shift to the property rights arena the GM debate has become more political and has garnered a much broader range of interested parties. In other words, it is far from over.

4.4. Situating Chile within the global context: the ambivalent regulator

We compared Chile’s regulatory style to that of the US and EU based on key aspects laid out in Table 5 and selected from the literature (see Dunlop 2000; Jasanoﬀ 1995, 2005a, 2005b; Vogel 2004). The US and EU are useful models for comparison because they represent the first two approaches developed worldwide, which to some extent have served as template for other nations. Our comparison thus seeks to better understand the Chilean situation and as such is used as an analytical tool.

When compared with these two approaches, Chile’s regulatory style emerges as primarily ambivalent. It shares key aspects of the US familiarity principle policy: no new laws, a product-oriented approach, close adherence to the principle of substantial equivalence and a market regime. Yet it restricts the scale of the technology’s use by drawing a boundary between seed-export and all other commercial activity when it comes to deﬁning what is and is not permitted. The restriction on commercial production could be interpreted as a
nod to the precautionary principle, which forms the basis of the European stance towards GM crops. However, our data shows this is not the case, as within the boundaries of seed production Chile is rather permissive in terms of the diversity of commercial seed and field trials authorized. In other words, Chile’s framing of the technology’s risk is ambivalent: it both allows and restricts. This appears to be an effort to embed the system with export-market flexibility, in the context of a global regulatory scenario that is both fluid and changing. Chile’s stance thus seems to reflect a “wait and see” approach.

Chile’s regulatory style is the least participatory of the three, with scarce access points for public input. In this context, quasi-judicial and judicial reviews in arenas external to regulatory action have been the principal means to challenge regulatory framings of the problem. In some ways, this aligns more closely with the US style where reviews by courts play a key role in solving disputes and boundary setting (Jasanoff 2005b). Chile however belongs to the Continental Law tradition where law codes trump legal precedents. In this context, judges have limited authority and flexibility to interpret the law, which creates challenges to dealing with the complex issues posed by new technologies such as GM crops. In this scenario, opposition actors have been most successful in putting forward claims under the quasi-judicial review established by the recent transparency law. Their impact and influence has been limited and slow, focusing primarily on issues of transparency and public trust. This contrasts with both the US and EU, where opposition to GM crops raised a wider range of issues.

5. Discussion and conclusions

Under Chile’s existing regulatory scheme internal commercialization of crops or seeds is not permitted, but imports of GM food or ingredients for processing food are...
allowed and until recently essentially deregulated. Regulations allow commercialization of some seed of GM maize not exported. Imported animal feed is not segregated and hence may or may not be GM. There are no labeling requirements for GM products in general, either food, feed, or crops. Our analysis indicates that these norms and regulations were developed in a fragmented, reactive, and somewhat disconnected manner. Norms aimed at food consumption were developed much later than seed production ones, although GM foods have been on the market in Chile for some time. Production and market issues rather than consumer ones have prevailed in the process.

Chile is distinct in separating seeds from commercial crops and in bifurcating these from foods. In Latin America, for example, Chile alone has authorized GM seeds without authorizing GM crops (see IICA 2008 for a partial comparison of regulatory frameworks). In Chile regulation appears to be a response to (1) global GM market forces and regulatory developments, (2) the actions and needs of Chile’s business community and to a much lesser degree (3) civil society’s interests. The tenuous roles played by both the food and environmental agencies suggest that environmental issues or consumer attitudes were secondary to the development of a regulatory framework. The production of GM seeds for global export coupled with strict local regulations banning those same products, and the lack of environmental and consumer protection, may be instances of weak, disjointed policies. Thus, one of the challenges for emergent democracies like Chile is that overly technocratic and immature institutions manifest as weak implementations of regulatory policies.

We propose that Chile’s ambivalent regulatory style developed to manage export market uncertainty while promoting a promising agricultural product. The response is thus based on a governmental perspective regarding Chile’s role within the global economy and specifically within the agri-food production chain. Its regulatory style is based on what we call a market-caution framing of the issue by key actors involved in shaping policy rather than one associated to any specific view of environmental or human health risks. Chile’s ambivalent style appears to be an attempt by the authorities and key actors to embed the regulatory system with export-market flexibility. Chile’s slow implementation of effective mechanisms for democratic interactions between science and politics may have prevented alternative framings of the issue within the policy-setting arena. In this sense, global market forces may well be the determining factor in establishing regulatory styles for emerging, globally linked democracies like Chile.

To achieve this “market-caution” approach, the authorities in consultation with the seed industry actors, established a regulatory boundary that allowed different economic sectors to co-exist somewhat harmoniously initially. However, as the GM seed industry grew so did the challenges to the co-existence approach. One example is the episode of Chilean honey containing traces of GM-DNA exported to the EU in 2011. The unexpected detection of GM-DNA created an undue burden for producers because their honey could no longer be sold in the intended EU market. The shipments were returned to Chile and had to be placed in less demanding markets at an economic loss for both producers and exporters (DV’s personal communication with beekeepers and honey exporters). In this sense, the episode was a forewarning of future issues and problems, particularly in regards to questions of social justice and who wins and loses under the current co-existence approach.
Furthermore, authorities and regulators enacted a boundary between civil society’s claims and regulatory science. This boundary was sustained by defining GM seed production as an economic activity that could be effectively managed and contained by an expert-driven regulatory process. Opposition groups attempted to break this boundary, by appealing not to issues of risk but to a basic “right-to-know” argument. The relatively small scale of GM crop production in the early years contributed to containing their claims and any associated controversy. However, with the rise in challenges to the co-existence approach a broader range of actors brought opposition claims to the forefront. New government policies promoting transparency in the public sector enabled civil society actors to push the limits of those boundaries, at least in regards to information access. In this sense, our case illustrates that in emerging democracies policies aimed at strengthening and promoting transparency may provide critical opportunities for the engagement of civil society with sociotechnical issues.

Chile’s ambivalent regulatory style for GM crops restricts the production scale but is very permissive with regards to the heterogeneity of GM crops authorized and released into the environment. Thus, in addition to its role as a commercial seed exporter and nursery, we propose that Chile also functions as a world laboratory for authorized testing at different stages of the technology’s development. Some STS scholars use the concept of real-world experiments to describe how modern research experiments often extend beyond the laboratory, incorporating both social and natural factors (Krohn and Weyer 1994; Gross and Hoffmann-Riem 2005). Gross and Hoffmann-Riem (2005), in particular, argue that in these contexts the boundaries between knowledge production and technological applications in society at large become blurred and that “scientist’s participation occurs within a complex network of actors whose activities cannot be controlled with traditional scientific methods” (2). In this context, society is the laboratory and thus bears the main burden of any associated risks. In other words, the public becomes part of the experiment. We further this analysis by proposing that this “world laboratory” results from forces operating at the global and local scale, in often unpredictable ways. In a country like Chile with an open-market, export-based economy decisions about what agri-technology is and isn’t allowed greatly shape how economic sub-sectors operate, develop, and emerge. Furthermore, Chile’s reputation as a country with excellent expertise, that is politically stable and has clear but not excessive regulations, make it an attractive place for GM crop testing. Indeed, assuming a role as a “world laboratory” might be perceived as positive or necessary in a globalized world. However, an overly technocratic culture with strong neoliberal policies that does not easily accommodate dissenting perspectives risks ignoring broader considerations associated with a “world laboratory.” This raises important issues regarding effective mechanisms for sociotechnical accountability in emerging but globally linked democracies.

One, often overlooked, issue is that real-world experiments travel across political, regulatory, and cultural borders at increasingly fast rates. If public involvement is paramount to constructing them as learning processes, as some scholars suggest (Gross and Hoffmann-Riem 2005), then the process requires the involvement of multiple publics and contexts. Such is the case of GM seed (re)production in Chile: while not a strategic player in its initial development, Chile was and is linked to global GM development networks in subtle and surprising ways. It fulfills an important role as a southern and hence counter-season nursery for the GM seed industry. This has implications for the development of
new emerging technologies especially when they have explicit and strong commercial goals. How can countries at the periphery participate in global debates on these technologies? What mechanisms can promote meaningful public participation at the local level in these globalized contexts?

As some scholars suggest, public participation in policy-making can shape the specific promotional approaches taken by countries (Howlett and Migone 2010). Yet, how does the lack of participation shape regulatory policy development and implementation in emerging democracies? Chile’s case highlights the ways in which lack of transparency and overly technocratic processes hinder a nation’s ability to deal with the complexity and often context-specific issues posed by new technologies. It is noteworthy that some issues have not become dominant framings of what is at stake regarding GMOs in Chile. For example, GM opposition groups in Chile have not, for the most part, contested regulatory decisions on potentially controversial applications, such as pharmacrops or field trials of new yet unregulated events. Nor have they contested the procedures for assessing, communicating and managing risk. For the most part, they have been less vocal on many risk issues specific to the Chilean context. This is surprising given the heterogeneity of crops grown for seed in Chile. For example, they have not posed questions about the potential economic impact of low-level presence of events unauthorized in export markets, an emerging issue given the constant rise in number of events in the context of uneven authorization processes worldwide (Rodriguez-Cerezo and Stein 2010). It is possible that some of these regulatory challenges are discussed in arenas accessed by a limited number of productive sector actors. If so, Chile’s technocratic culture, by limiting public participation and information access, hinders the positive impact that public debate can have on regulatory learning.

Mechanisms for public participation in regulatory decisions and access to information are very poor in Chile. In this context, civil society’s response to the “GM issue” focused on basic questions of democracy: access to information, public participation, and technological accountability. Opposition groups (re)framed the problem early on as one of “transparency and public information,” seeking external mechanisms to contest agency decisions. The leading agency’s response to these concerns has followed the prevailing market perspective of government policy. Not surprisingly it is perceived as protecting business interests over citizen concerns. In this context, civil society organizations have continued to frame their opposition around a basic demand for transparency, raising the issue of public trust. The lack or poor quality of public information available about production in Chile has clearly shaped the public debate, and prevented key questions from arising in the public arena (for example, environmental and health risks associated with cultivation of pharmacrop). Like the EIA procedures studied by Barandiaran (2015) the Chilean GM crop regulatory framework lacks public credibility. On the one hand, the lack of information contradicts even the technocratic promise of science to nurture “evidence-based” policy decisions and may question basic societal assumptions about the common good. On the other hand, its ambivalent nature and overly narrow “market-caution” approach hinder the development of more robust, context-specific regulatory science as well as mechanisms to integrate a broader range of concerns in decision-making. In addition, the adversarial nature of the dispute has reinforced a culture of secrecy and exaggerated claims on all sides, further eroding public trust in regulatory institutions.
Our study contributes to a better understanding of the challenges that emerging democracies face in making socially robust decisions regarding new technologies. Emerging democracies may present weak or disjointed implementations of regulatory policies. They may also be slow in developing participatory approaches to the regulation of new technologies. In this context, alternative mechanisms for democratic interaction between science and democracy – such as transparency laws – may be more effective at shaping policy and public debate. In Chile’s case, opponents used the recent Transparency Law to broaden and open up the debate. Although, this situation may result from the peculiar Chilean technocratic culture that limits crucial public debate, it provides important lessons for adoption of new technologies worldwide. Furthermore, poor or lack of locally relevant information regarding GM crops shapes the public debate and may hinder regulatory learning required for more socially robust decisions. Chile’s existing regulatory style raises the issue of the need to both strengthen and broaden the accountability of technological applications.

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