

The limits of regulatory convergence: globalization and GMO politics in the south

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Abstract Is globalization promoting regulatory convergence in agricultural biotechnology policies in the South? This article examines the nature and limits of regulatory convergence in the field of agri-biotechnology and investigates the effects that international forces have on biotechnology and biosafety policies in developing countries. Based on detailed case studies of Mexico, China and South Africa this article shows that these three leading biotechnology countries in the South are exposed to powerful international influences but are responding to the regulatory challenges of genetically modified organisms (GMO) adoption in distinctive ways. The existing regulatory polarization between US and EU biotechnology approaches has not forced a convergence around either of these two international models. GMO policies in the South do not simply follow the binary logic of the US–EU regulatory conflict. Instead, they integrate elements from both regulatory approaches and are steering a course that suggests substantial regulatory diversity in the South. The globalization of biotechnology thus goes hand in hand with regulatory diversity in the developing world. Furthermore, regulatory polarization between the EU and US has helped to open up political space in key developing countries.

Keywords Globalization · Regulatory convergence · Agricultural biotechnology · Biosafety · Developing countries

Abbreviations

ACB	African Center for Biosafety (South Africa)
CIBIOGEM	Comisión Intersecretarial de Bioseguridad y Organismos Genéticamente Modificados—Inter-Sectoral Commission on Biosafety and Genetically Modified Organisms, Mexico
CPB	Cartagena Protocol on Biosafety

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DTI	Department of Trade and Industry (South Africa)
EU	European Union
GATT	General Agreement on Tariffs and Trade
GM	Genetically modified
GMO	Genetically modified organism
NAFTA	North American Free Trade Agreement
MOA	Ministry of Agriculture (China)
MOST	Ministry of Science of Technology (China)
OECD	Organization for Economic Cooperation and Development
SEPA	State Environmental Protection Agency (China)
SPS	WTO Agreement on Applications of Sanitary and Phytosanitary Measures
US	United States
WTO	World Trade Organization

1 Introduction

One of the central questions in the globalization debate is the extent to which globalization fuels cultural, political and/or economic homogeneity. One facet of this debate relates to regulatory convergence—the trend towards a growing similarity in national-level regulatory institutions, processes and outcomes. Over the last half-century, the twin processes of economic globalization and international institution-building have produced an unprecedented level of convergence around the world. Both public and private actors have set about integrating national markets by establishing common international standards and removing national barriers to the free movement of goods and services. Trade liberalization through the General Agreement on Tariffs and Trade (GATT), and since 1995 under the umbrella of the World Trade Organization (WTO), has been a key driving force behind this trend.

In this context, pressures for regulatory convergence in the realm of trade in genetically modified organisms (GMOs) have also arisen. In this policy domain, however, it is now widely acknowledged that, instead of convergence, two competing regulatory approaches dominate the global landscape: the more permissive approach of the United States (US), which assumes, unless proven otherwise through ‘sound scientific’ risk assessments, that products of genetic engineering pose no novel threat to environmental or human health; and the more restrictive approach of the European Union (EU), which justifies precautionary restrictions on GMO use and trade, even if scientific knowledge about risks is uncertain.

A burgeoning literature now exists on the causes and consequences of this transatlantic divergence in GMO regulatory approaches, in particular for US–EU relations. Less attention has been paid to how this “regulatory polarization” between the US and EU impacts upon developing countries. It is this latter question that interests us here. Of those who have analyzed GMO policymaking in the South, some tend to assume that developing countries will have to follow either the US or EU model in their domestic policy choices or, at the very least, that transatlantic regulatory polarization limits developing country policy options (see Sect. 2). Such accounts tend to privilege international influences in explaining domestic policy choices.

In contrast, this article argues that the debate on regulatory convergence versus polarization has been cast in terms that are too narrow. Through a comparative analysis of key

developing countries, we show that greater regulatory diversity exists in the developing world than the binary logic of polarization around EU versus US approaches implies. Although developing countries are faced with powerful external constraints and incentives, in the case of GMO policies we find that competing trade imperatives interact with domestic politics and priorities, with multiple nodes of power and actor coalitions negotiating policy directions that combine elements of both US and EU regulatory approaches within a given country. An intriguing implication of our analysis is that the ongoing transatlantic conflict creates room for manoeuvre that key developing countries can exploit in order to chart their own course in this socially and politically contested area of risk regulation.

The analysis proceeds in four steps. Section 2 reviews existing research on the relationship between globalization and regulatory convergence, with particular emphasis on the case of agricultural biotechnology. Section 3 discusses the international context for GMO policymaking in the South, including the transatlantic biotechnology conflict and global trade and biosafety regimes. Section 4 presents our empirical analysis of biosafety policy in selected developing countries. We conclude by stating our findings about globalization and policy convergence (or lack thereof) in the South.

2 Globalization: promoting regulatory convergence?

Much of the recent globalization debate has focused on the question of whether global economic integration is making national policies more similar across the world. Scholars have examined domestic responses to globalization and trends towards convergence in macroeconomic and sectoral policies (Keohane and Milner 1996), regulatory policies (Vogel and Kagan 2002) and broader development of political–economic institutions in capitalist systems (Hall and Soskice 2001). Most empirical studies have been conducted on convergence effects in the industrialized world, particularly in a European or transatlantic setting (for an overview, see Heichel et al. 2005).

It is important to clarify at the outset, how we use the concept of ‘convergence’, as it has provoked some discussion and even confusion among researchers (Knill 2005). Since the early 1980s, convergence has been seen as “the tendency of societies to grow more alike, to develop similarities in structures, processes and performances” (Kerr 1983, p. 3; see also Drezner 2001, p. 53). We focus here on ‘regulatory convergence’, i.e. the growing similarity of institutional frameworks, policy approaches and outcomes in the field of regulatory politics. All three elements are relevant, for we seek to capture the evolution of legal institutions as well as changes in policy content and outcomes. In other words, regulatory convergence can occur at any or all of these levels, with ‘convergence’ itself understood as a process rather than an outcome (on the latter, see Bennett 1991, p. 219).

The early globalization literature narrowly focused on whether convergence was happening or not. More recently, scholars have examined in great detail the mechanisms through which globalization impacts upon domestic politics. Among the most widely cited drivers of convergence are (i) political harmonization, i.e. deliberately negotiated agreements to adjust national policies (Simmons 2001; Singer 2004); (ii) regulatory competition and upward or downward adjustment of national policies as a consequence of global competitive pressures (Rodrik 1997; Vogel 1995); and (iii) policy diffusion and learning, in which political actors voluntarily adjust policies based on innovative policy models (Busch and Jörgens 2005; Levi-Faur 2005).

Our analysis builds on, but also departs from, this established research focus. Not only do we consider if convergence is happening and why (or why not), but our study also shifts the focus away from industrialized countries to developing countries, which only comparatively few studies have focused on to date (see the overview of empirical studies in Heichel et al. 2005). We also depart from the usual binary framing of the debate, which tends to view convergence as an either/or question, and ask how international and domestic factors work together, overlap or compete with each other in shaping domestic policy responses to globalization.

The literature on convergence in the GMO policy domain has followed a similar trajectory. Early analyses suggested that globalization of agricultural biotechnology (and development of global regulatory regimes) might fuel convergence, with the debate centering on whether such convergence would be towards higher or lower standards. Some scholars originally hypothesized that a nascent ‘trading up’ effect between the EU and the US was at work, which would lead to greater convergence between the two main contenders in international norm-creation on GMO trade, in the direction of the EU’s more stringent approach (Prakash and Kollman 2003; Young 2003). Others pointed to corporate interest in convergence between global regulatory approaches and the global pressures on states to create “common means by which to identify and manage risks associated with GM products” (Newell 2003, p. 63).

But this expectation has now given way to a more widespread recognition that such trading up is not proceeding far and fast enough, and that convergence in this policy domain is unlikely. In fact, two regulatory approaches now dominate in an international context: the restrictive precautionary EU approach versus the permissive “sound science” based US approach (Falkner 2007; Murphy and Levidow 2006), giving rise to regulatory “polarization” in this area of policymaking (Bernauer 2003; Drezner 2007).

Much recent research has focused on the causes and consequences for transatlantic relations of such polarization. Less attention has been paid to the question of how this global rift is impacting on countries of the South. Where analysts have considered biotechnology policy choices in the developing world, many have tended to privilege international factors in explaining domestic policy choices, suggesting that the transatlantic conflict not only shapes but also limits Southern policy options. Drezner (2005, p. 856) suggests, for example, that “divergent preferences among large states... lead these actors to attract as many allies as possible. In a bipolar distribution of power, the result is a bifurcation of policies, but strong policy convergence at two different nodes”. Bernauer (2003, p. 117) points to the negative implications for the South of transatlantic regulatory polarization, suggesting that it may be responsible for reducing returns on investment in agro-biotechnology, and deterring public and NGO support for biotechnology (see also Paarlberg 2001).

We provide a deeper empirical basis for examining these claims in the literature, viz. that EU–US regulatory polarization is driving, and ultimately restricting, developing country policy choices. A dichotomous view of Southern biosafety approaches does not, we argue, do justice to the growing complexity of policy choices observable in key developing countries and to the continuing diversity of GMO policies in the South.

Our arguments fit into a broader trend in the globalization literature that provides an alternative interpretation of how globalization affects domestic politics. In this view, globalization can co-exist with, or even enhance, regulatory diversity. As some sceptics noted early in the debate, globalization is not a straightforward story of global homogenization (Appadurai 1996; Rosenau 1995), nor is convergence always desirable (Sykes 1999). Global economic integration has not eliminated diversity in national policies

(Wade 1996; Hirst and Thompson 1996;), with convergence occurring only under restrictive conditions (Hay 2000; Hall and Soskice 2001). In particular, the mediating force of domestic institutions and domestic politics may facilitate a persisting diversity in national responses to globalization (Weiss 1999; Biermann 2002).

Similar perspectives are also identifiable within writings on GMO politics. In a relatively early and prescient analysis of GM policy choices in the South, Millstone and Zwanenberg (2003, p. 655) suggest, that “the tendency towards convergence is severely attenuated”, as long as certain conditions are met, such as compliance with (broadly defined) procedural requirements contained in biosafety-related treaties. They also suggest that persisting scientific conflicts with regard to GMO safety provide leeway to countries, including in the South, to pursue divergent choices (see also Gupta 2004). Others who have emphasized divergent rather than convergent responses in the South have attributed this diversity primarily to trade imperatives (Clapp 2006), rather than to scientific conflicts, international treaty obligations or domestic politics more generally.

In sum, scholarly research on globalization and its domestic impact has shifted from an initial focus on whether convergence is occurring to a closer examination of “the ways in which, paradoxically, globalization produces diversity as well as promoting lines of convergence” (Hopkins 2002, p. 18). A fruitful way to engage with this question is in issue- and policy-specific contexts (Heichel et al. 2005). Our analysis is in line with such an approach. We focus on international–domestic linkages and the influence of domestic politics in modulating external pressures towards regulatory convergence or polarization in GMO policy choices in the South.

3 The global context: EU–US conflicts and regulatory regimes

In first laying out the external context for GMO policymaking in the South, we discuss further the divergent US and EU regulatory approaches to GMOs. We then review the obligations that global trade and biosafety regimes place on countries, and assess their affinity (or lack thereof) with the divergent EU or US approaches.

3.1 The transatlantic GMO conflict

The first regulatory frameworks for dealing with the environmental and health risks of GMOs stem from the 1970s (for an overview, see Wright 1994). The US as a frontrunner has long emphasized scientific and industry self-regulation in biotechnology, and has been largely promotional in its regulatory approach. The 1986 ‘Coordinated Framework for the Regulation of Biotechnology’, which established key regulatory principles and divided authority between different agencies, sets out rules for a product-based approach to risk regulation. Following the principle of ‘substantial equivalence’, according to which genetically modified plant varieties do not pose fundamentally different risks vis-à-vis conventionally bred varieties, US authorities have allowed a large number of GM crops to be tested, planted and introduced to the market. US regulations apply a narrow definition of GMO risk, focusing on scientifically proven harm to humans and the environment (Bernauer 2003; Sheingate 2006).

Well into the late 1980s, most European countries adopted a similarly ‘light-touch’ approach to regulation. Following the strengthening of the EU’s environmental competencies and rising concerns over biotechnological safety in a number of member states, the EU sought to harmonize the uneven regulatory field in Europe and adopted a more

precautionary approach in dealing with GMO risks. In 1990, the EU established a European-wide system of biosafety regulation (Directives 90/219/EC and 90/220/EC) that institutionalized a process-based approach with comprehensive coverage of all GMO developments. In sharp contrast to the more limited US approach, the EU-based risk assessment and management on the precautionary principle, which legitimizes regulatory intervention to avert potentially serious or irreversible harm under conditions of scientific uncertainty. The 1990 directives were later revised and strengthened to include GMO traceability and labelling requirements (Pollack and Shaffer 2005; Levidow 2007).

These two models of GMO regulation—one product-based and emphasising ‘sound science’-based risk assessment, the other process-based and covering a wider set of risks under the precautionary principle—have undergone some modifications since the 1990s but remain more or less intact. As a consequence, the two most powerful players in international biotechnology are now promoting two rival regulatory standards. International GMO politics is characterized, as Drezner puts it, by “a single global cleavage” (2007, p. 169).

Both the US and the EU have sought to export their regulatory models to the international level, as well as to other countries (Bernauer and Aerni 2007). The two most important international regimes, where the transatlantic conflict has played out are the World Trade Organization and its Agreement on the Application of Sanitary and Phytosanitary Measures (SPS), and the Cartagena Protocol on Biosafety under the Convention on Biological Diversity. Potential conflicts between these regimes, and their affinity with US or EU regulatory approaches, are considered in the next section.

3.2 Global GMO governance regimes: WTO versus the Cartagena Protocol

The WTO’s SPS Agreement seeks to prevent national sanitary (human and animal health) and phytosanitary (plant health) measures from becoming non-tariff barriers to trade. It does so by calling for adoption of international standards in the areas of human, animal and plant health and safety, where these exist. In the absence of international standards, or if countries want to adopt higher standards, the SPS Agreement mandates that these be based upon scientific risk assessment, with only limited (time bound) allowance for trade-restrictive precautionary measures. Furthermore, to be compatible with the WTO, labelling, traceability, segregation and other GMO policy choices should flow from such a science-based decision-making process. This ‘sound science’ based approach is, in its broad contours, largely compatible with the US regulatory approach to GMOs.

The global rule-making effort with the potential to weaken the WTO’s push for trade promotion is the Cartagena Protocol on Biosafety, negotiated under the Convention on Biological Diversity and in force since 2003. It explicitly seeks to enhance importing country choice with regard to traded GMOs. Developing countries pushed for the Protocol, with strong support from the EU in the final stages of its negotiation (Bail et al. 2002).

The Cartagena Protocol requires the ‘advance informed agreement’ (AIA) of an importing country prior to trade in certain GMOs. In operationalizing AIA, it mandates, as does the WTO-SPS Agreement, that importer decisions about GMO trade be based upon a scientific risk assessment (Cartagena Protocol, Article 15). However, it permits precautionary restrictions on trade in the face of scientific uncertainty. Unlike the WTO-SPS Agreement, the Cartagena Protocol does not require a time frame within which precautionary restrictions must be reviewed, thus allowing more flexibility in restricting GMO trade (Gupta 2008a; Millstone and Van Zwanenberg 2003). The Cartagena Protocol on

Biosafety is thus more closely aligned with the EU's regulatory approach to GMOs, and has not been ratified by key GMO exporting countries, including the US.

Not surprisingly, the Protocol's relationship to the global trade regime remains contested and has become the focus of much scholarly attention (e.g. Young et al. 2008). The goal here is not to analyze regime conflicts in an international context, but rather to turn the lens of inquiry to look at their impact and relevance *from a domestic policy perspective in the South*. Below, we undertake detailed analysis of GMO regulation in three key countries of the South, and examine the international and domestic influences shaping the directions of national GMO policy.

4 Regulatory convergence in the South? Examining the evidence

Although their accuracy is hard to ascertain, recent figures suggest that use of genetic engineering in agriculture is rapidly expanding, particularly in key globally traded commodity crops, such as maize, soybean, canola and cotton. Both developed and developing countries are growing GM crops, with the US, Argentina, Brazil, Canada, India and China accounting for 118.3 million ha or 95% of the total worldwide GM crop area (James 2008). An estimated 300 million tonnes of grains, oilseeds, pulses and other crops are traded each year globally and the ongoing liberalization of agricultural markets is likely to increase agricultural trade in the future. This global commodity trade, now containing a sizeable quantity of GM varieties, is thus of particular commercial significance to both exporting and importing countries. The influence of this on domestic policy choices is likely to be greatest for countries that participate in this global commodity trade, either as exporters or importers of one or more crops subject to genetic modification.

In our empirical work, we focus on Mexico, South Africa and China.¹ We select these countries because, first, they are at the forefront of domestic biotechnology research and development. Thus, agricultural biotechnology is a key economic, environmental, political and social issue in these countries, necessitating the development of domestic regulatory policies. All three countries also participate in the GMO trade as importers of GM crops (with varying trade relationships with the US and the EU), requiring them to mediate competing global influences, including transatlantic regulatory polarization, in determining domestic policy directions.

In analysing the directions that GMO policy is taking in these countries, we first discuss the general context for biotechnology use and development in each. We then analyze GMO policy directions, highlighting both permissive and restrictive elements. We ground our analysis in qualitative methods of social science, including fieldwork in the countries and detailed semi-structured interviews with policy-makers representing diverse state interests (including agriculture, health, environment, economy, science and technology policy, foreign affairs and trade), as well as stakeholder representatives including scientists, civil society groups and the private sector.²

¹ Although Mexico is a member of the OECD, in areas of relevance to agricultural biotechnology it exhibits key characteristics of a developing country: a relatively large proportion of the population is engaged in agriculture, particularly subsistence farming; and the country is a centre of origin and diversity of key crops subject to genetic engineering, such as maize.

² Interviews with regulators and stakeholders were conducted in China in August 2004, in Mexico in June 2004 and in South Africa in May 2005. In order to respect interviewees' requests for anonymity, only their institutional affiliation is revealed here.

4.1 GMO policies: the context

4.1.1 *Support for biotechnology in the context of trade liberalization*

Each of the three countries has embraced biotechnology at the highest levels, as part of an overall thrust towards technology promotion, trade liberalization and a desire for greater integration into world markets.

Mexico, for example, is heavily integrated into regional and global markets, including agricultural markets. Until the 1970s, Mexico prioritized self-sufficiency in the production of basic food grains. Following the 1982 debt crisis, the country embraced trade liberalization and privatization and scaled back long-established programs of price supports and direct subsidies to small-scale agriculture. Mexico acceded to the GATT in 1986, became part of the North American Free Trade Agreement (NAFTA) in 1992, and the Organization for Economic Cooperation and Development (OECD) in 1994. It was also the first country in Latin America to sign a free trade agreement with the EU—its second most important trading partner after the US. Biotechnology policy in Mexico is inextricably tied into this move towards trade liberalization and global integration. Mexican participation in NAFTA, in particular, has been influential in shaping domestic policy choices, particularly given that GM maize imports from the US have soared in recent years as a result (Fitting 2006).

Since the 1970s, China has moved from near total economic isolation to growing integration into the world economy. Entry into the WTO in 2001 further accelerated liberalization of agricultural trade that had been under way in the 1990s. Biotechnology has been an integral element of China's agricultural strategy since the mid-1980s. In an effort to boost agricultural productivity and scientific capacity, the Chinese state has expended the largest public spending program on biotechnology in the developing world and is now in a leading position in advanced biotechnology research outside the industrialized world (Lakhan 2006). Public funding for biotechnology research has steadily risen with every new five-year plan, and biotechnology experts predict another dramatic rise to as much as \$1.4 billion for the next five-year plan (Hepeng 2008).

Technology promotion and market competitiveness are also key considerations in determining biotechnology policy directions in South Africa. Encouragement of biotechnology dates back to 1978, when a South African Committee for Genetic Experimentation was constituted to encourage research in molecular biology and biotechnology (Sasson 2000). In the 1980s, with support from the government, new biotechnology research centres were established. Beginning in the 1990s, South Africa became one of the first countries to undertake field trials and environmental releases of GM crops. Government support of modern biotechnology is evident from a 2001 National Biotechnology Strategy, which outlines a vision for biotechnology's role in ensuring South Africa's technological leadership in the 21st century (NBS 2001).

4.1.2 *GM crops: domestic imperatives and trade relationships*

All three countries can be considered as early adopters and developers of GM crops in the South, with China the most advanced in its biotechnology capacity. Mexico, for example, has permitted field-testing of GM crops since 1988, when the first government approval was issued to Monsanto for Bt cotton. Since then, a range of GM crops, produced primarily by the private sector, have been approved for field-testing. While the private sector focuses on corn, canola, cotton and soybean, GM crop development is also underway in the public

sector (Herrera-Estrella 1999; see also Massieu et al. 2000). According to one set of estimates, Mexico now ranks 13th amongst countries worldwide growing GM crops, with 0.1 million ha devoted mainly to commercially grown GM cotton and soybean (James 2008).

China was the first country worldwide to grow a GM crop in commercial quantities, a virus-resistant tobacco plant (Paarlberg 2001, p. 128). Since the mid-1990s, over a dozen GM crops have been approved for large-scale field trials, of which three (cotton, tomato and petunia) passed safety tests for commercial planting as early as 1997 (Huang and Wang 2003). Of the GM crops approved for introduction to the market, only GM cotton has since been grown on a large scale by an estimated 7.1 million farmers. In total, an estimated 3.8 million ha of GM crops were grown in 2007, making it the sixth biggest GM crop grower worldwide (James 2008).

In South Africa, as in Mexico, development and commercialization of transgenics remains largely the domain of the private sector. Crops approved for commercialization since 1997 include insect-resistant and herbicide-tolerant varieties of maize, cotton, and soybean, with many of these developed by Monsanto (Morris et al. 2005). South Africa is also the first country to commercialize GM white maize, a staple food crop of its population. While the public sector is involved with GM research (focusing on crops, such as potato, sugar cane, maize and strawberries), most products have yet to be commercialized. A growing number of GM crop varieties have received general release approval and/or commodity clearance, i.e. approval to be imported for use as food or feed (Morris et al. 2005). By latest estimates, South Africa is now the eighth largest GM crop grower in the world, with 1.8 million ha planted mainly to GM maize, soybean and cotton. (James 2008).

All three countries participate in the GMO trade as importers. For Mexico, the US is the most important trading partner. Imports of GM maize from the US (for the animal feed and food processing industry) continue to fuel controversy and conflict in Mexico, given that maize is at the centre of the national diet and is of enormous cultural, political and social significance.

The opening of China's farm markets has led to a sharp rise in agricultural imports, especially in GM soybeans (mainly from the US) for domestic food processing and animal feed. It has also, however, increased exports (to the EU, Japan) in areas, where China maintains a leading position, such as rice. The gradual enmeshment of China's agricultural system with world markets has led to a complex web of dependencies that have mixed effects on domestic biotechnology commercialization.

For South Africa, the US and Argentina are key trading partners for crops subject to genetic engineering, such as maize and soybean. Although Europe is South Africa's most important agricultural trading partner, this is not yet the case for crops subject to genetic modification. Of the GM crops approved for general release in South Africa that may enter international trade, currently only cotton is exported to Europe (Wolson 2006). Importantly, however, trade considerations vis-à-vis other African countries opposed to GM crops are also increasingly important in determining directions of South African GM policy.

As can be seen from the above, international trade links are likely to shape policy choices in the developing world. In our three cases, agricultural trade liberalization has if anything heightened sensitivity to trade policy imperatives in recent years. Notwithstanding this, as Gourevitch reminds us, the international system "has many dimensions, with multiple, often conflicting incentives, confusing signals, complex information" (2002, p. 310). We also need to take into account other external factors, such as development of

international environmental norms through the global biosafety treaty, and uptake of these in a domestic context. All such international factors find resonance in domestic politics through the mobilization of domestic interests both within and outside the core state.

4.1.3 Ratification of the Cartagena Protocol: domestic imperatives

All three countries, while promoting use of biotechnology in agriculture at the highest levels, have also participated in negotiations of the Cartagena Protocol on Biosafety and have ratified it, owing largely to domestic imperatives.

Mexico, for example, ratified the agreement in 2003, although its NAFTA partners, the US and Canada, were vocal opponents of the Protocol during its negotiation and neither has since ratified it. One reason for Mexico to ratify was to give domestic policy-makers the option to withstand NAFTA and global trade imperatives through reference to their global biosafety rights and obligations, should it become necessary to do so. By many accounts, ratification was also stimulated by the success of Ministry of Environment officials in persuading Mexican legislators of its importance during parliamentary debates on ratification (interviews with Ministry of Environment officials).

China maintained a low profile during Cartagena Protocol negotiations, where it participated as a member of the developing country negotiating bloc (designated the Like-Minded Group of countries). Although China appeared to be more conciliatory towards GMO exporter concerns than other developing countries (Lijie 2002), in the end, it supported the final compromise in the biosafety talks and, after some protracted domestic debates, ratified the treaty in June 2005. The decision to accede reflected the growing strength of domestic elite support for a strengthened biosafety agenda, but also China's broader desire to achieve full integration into international society (Falkner 2006).

South Africa also participated in the Cartagena Protocol negotiations as part of the Like-Minded Group, although tensions surfaced between South Africa and other developing countries during early stages of the negotiations. Observers explain South African ratification of the Protocol as politically unavoidable, given the country's emphasis on multilateralism since the early 1990s and its desire to show solidarity with other African countries. The timing of ratification is also significant because it happened just before the World Summit on Sustainable Development in August 2002. With South Africa playing host to the key sustainability event of the decade, Protocol ratification was an important signal of its support for multilateral environmental processes (interview with a civil society representative).

As seen above, all three countries are leaders in biotechnology research and development in the South. All are participants in the GMO trade with varying ties to the US and the EU as key trading partners. Moreover, all have ratified the Cartagena Protocol on Biosafety and are subject to its obligations. What mix of permissive and restrictive policy choices does this result in? We analyze next how external factors are transmitted into domestic politics by tracing the evolution of GMO policy in China, Mexico and South Africa.

4.2 GMO policy directions: restrictive and permissive elements

4.2.1 Regulatory frameworks, institutions and actors

All three countries examined here were among the first to develop domestic biosafety regulations, given their trajectory of GMO research and development dating back to the late 1980s. In Mexico, the first law governing GM crops was a set of standards (the

Mexican Official Standard NOM-056-FITO-1995, or NOM-056 for short) developed under the jurisdiction of the Ministry of Agriculture and in force since 1995 (Chauvet and Galvez 2005). The NOM-056 established procedures for field-testing of GM crops but did not address large-scale planting and commercialization. Partly as a result of this, and partly because of domestic ratification of the Cartagena Protocol, a comprehensive Biosafety Law was developed, which replaced NOM-056 in 2005. Regulations to implement this Law have only recently been published in early 2008, paving the way for legally developing, testing and planting GM crops (Cevallos 2008).

Controversies around GM crops in the late 1990s and Mexico's participation in the international biosafety negotiations left a clear mark on the institutional set-up of the regulatory system. While the Ministry of Agriculture was the key locus for regulatory oversight of GM crops in Mexico throughout the 1990s, other government departments became more involved from 1998 onwards. The Ministry of Environment, in particular, has gained more influence in domestic biosafety debates, not least because it is the lead agency for Cartagena Protocol implementation. Under the 2005 Biosafety Law, it has also been given a stronger voice in approving GM crops for deliberate release. With the earlier NOM-056, the Ministry of Environment had merely an advisory role, with the final decision resting with the Ministry of Agriculture.

To counter intra-governmental fragmentation and coordinate biotechnology policy more effectively, Mexico also established an inter-agency commission, the Inter-Sectoral Commission on Biosafety and Genetically Modified Organisms (CIBIOGEM), in 1999. CIBIOGEM has since been criticized by critics for failing to outline a vision for appropriate use of biotechnology in Mexican agriculture (interview with Ministry of Economy official), suggesting continuing difficulties in reconciling competing priorities within the regulatory system.

In the case of China, the early development and commercialization of biotechnology proceeded without proper regulatory oversight into the early 1990s. In 1993, the Ministry of Science of Technology (MOST), then the lead agency in the field of biotechnology, established the Safety Administration Regulation on Genetic Engineering, a set of general safety rules drafted largely by scientists for scientists. In 1996, the Ministry of Agriculture (MOA) followed this up with Implementation Guidelines and became the lead agency in the regulatory process. The MOA guidelines were informed by a desire to promote biotechnology and concentrated on scientifically demonstrated risks (Paarlberg 2001, p. 129)—a position that tended to downgrade the importance of long-term and uncertain threats from GMOs to human health and environment. Given its close links with the agricultural and biotechnology sectors, MOA is widely seen to favour the commercialization of GM crops, preferably those developed by domestic biotech firms (interviews with representatives of biotechnology industry and Chinese Academy of Sciences).

The State Environmental Protection Agency (SEPA), which was promoted to ministerial level in 2008 and renamed Ministry of Environmental Protection, was, however, the lead agency for Cartagena Protocol negotiations. This permitted greater weight to be given to environmental concerns in developing China's position, and SEPA was able to move out of its relative marginalization in domestic biotechnology regulation. With the adoption of a new national seed law in 2000, the final managerial authority over all new GM crop varieties passed to the State Council, a central decision-making body at cabinet-level.

The State Council's new Regulation on Safety Administration of Agricultural GMOs of 2001 was followed in 2002 by three implementing regulations issued by MOA, covering the areas of biosafety evaluation, import safety administration and GM food labelling. These new acts provided a more comprehensive system of risk management, for the first

time regulating imported GMOs and providing consumers with some degree of choice over GM food content. Efforts have since been made to create a comprehensive biosafety law in China, which would replace the existing system of regulations, but these have so far failed to come to fruition (interview with SEPA official).

The regulatory process in South Africa, as with Mexico, also dates back to the late 1980s. Initially, research and field-testing of transgenics was regulated under the 1983 Agricultural Pests Act (Sasson 2000). The first general release of transgenics in South Africa in 1997 coincided with adoption of a separate biosafety law. As in the case of Mexico, this law was advocated by biotechnologists who felt the need for a legal regime to lay down acceptable practice in this area (Morris et al. 2005; interview with a public sector biotechnologist).

The Genetically Modified Organisms Act (henceforth GMO Act) was passed in 1997 and implemented in 1999 (GMO Act 1997). It is administered by the Ministry of Agriculture but decisions on GM crop applications are taken by consensus by an Executive Committee, consisting of representatives from the Ministries of agriculture, health, environment, science and technology and trade. This ensures that all represented government departments can, in theory, veto specific applications. The capacity to raise concerns in the Executive Committee tends, however, to vary significantly between government departments (interview with a representative of civil society).

As in the other countries, biosafety rules continue to evolve in South Africa, with amendments to the 1997 GMO Act approved by Parliament in 2006, following a long and contentious domestic debate (e.g. Mayet 2004). The amended GMO Act has been criticized by civil society groups for its weak liability clauses, lack of mandatory labelling requirements, and unclear guidance with regard to when a risk assessment, environmental impact assessment or socioeconomic impact assessment is necessary (e.g. Biowatch 2006).

This brief overview shows that putting into place a domestic GMO regulatory system remains as an ongoing process in all three countries. Different laws and regulations have come into existence but domestic struggles over their implementation and legal revision continue unabated. Neither do these laws and regulations express a clear political commitment to either the US or EU regulatory approach. As will be discussed next, both restrictive and permissive elements of GMO policy can be identified in all three countries' evolving regulatory systems.

4.2.2 Regulatory directions: restrictive elements of GMO policy

Notwithstanding the overall supportive environment for GMO use in each of these countries, restrictive elements are discernible in each. The restrictive elements of Mexican biosafety policy are largely related to intense controversies over GM maize (e.g. ETC Group 2002). One prominent example of a restrictive policy is a 1998 moratorium on release of GM maize into the environment. Even though the moratorium was lifted for experimental trials in mid-2004, no planting of maize has been legally authorized in Mexico since then, not least because regulations to implement the 2005 Biosafety Law, which now governs experimental testing of maize, remain to be developed. This puts Mexico at odds with the situation north of its border, in the US and Canada, where GM maize has been rapidly commercialized.

The GM maize controversy received extensive global attention in 2001 following an article in *Nature* magazine suggesting that transgene ingressions into indigenous maize varieties had occurred in Mexico's Chiapas region (Quist and Chapela 2001). The source was believed to be GM maize imports from the US, intended for the food, feed or

processing sector. This resulted in another restriction in Mexican biosafety policy: an amendment to the Mexican Penal Code in 2002 making it a criminal offence to store unapproved GM crops or release them into the environment. This move galvanized some of the country's leading biotechnologists into action, making them active proponents of a comprehensive biosafety law to replace existing policies, including the moratorium. In their view, such a law was essential in order to provide a legal basis for GM research (interview with public sector biotechnologist).

The Mexican Academy of Science was the main architect of the resulting 2005 Biosafety Law (interview with representatives of Mexican Academy of Science and civil society). Although the biosafety law has been criticized for promoting biotechnology rather than operationalizing a precautionary approach to GM crop use, it does call for a special regimen for GM maize, to prevent release into areas of the country that are centres of origin. This requires demarcation of GM maize-free zones, and regulations to implement this are being developed only now (Cevallos 2008). This has meant that the de facto moratorium on planting of GM maize, has, in effect, remained in place for over a decade. Questions remain, however, over its effectiveness, given that imports of GM maize for food, feed or processing continue unabated from the US, with few monitoring or oversight mechanisms in place (interview with civil society representative).

China too imposed a temporary de facto moratorium on new GMO releases in 1999. The timing of this move—shortly after introduction of an informal EU moratorium on GMO authorizations in October 1998 and shortly before adoption of the Cartagena Protocol in January 2000—is significant. It signalled the growing impact that global GMO debates were having on regulatory developments in China—despite the government's hitherto unambiguous support for the development of GM crops. The moratorium was also a sign that Chinese authorities implicitly acknowledged shortcomings in the regulatory framework and moved to create new domestic regulations.

A key factor why the moratorium has largely remained in place is the threat of exclusion from important export markets. In 2000, EU authorities detected GM content in Chinese shipments of soy sauce to Europe, leading to a temporary ban on such imports. Although soybean production was officially GM-free, China's imports of GM soybeans from the US and domestically developed GM soybean varieties in field tests were suspected of having contaminated soybean production. More recently, unauthorized GM rice varieties were detected in shipments to the EU, leading to a European Commission emergency decision in February 2008 requiring GMO-free certification for rice or rice products from China (Mahr 2008). Such import restrictions in key export markets are widely cited to have contributed to the continuing moratorium on authorizations of important crop staples such as soybean, wheat and rice (interviews with representatives of SEPA and Chinese Academy of Sciences), giving rise to an informal 'baptist-and-bootlegger' coalition between agricultural exporters and biosafety supporters in SEPA and civil society groups.

In South Africa, a very active local NGO community is constantly striving to slow GM crop approvals, via filing detailed objections to the ever-increasing body of GM crop applications.³ Although largely unable to stem the tide of approvals, particularly in the early years of GM development, such NGO activity has had some notable successes. One success was to foil an attempt by Monsanto in 2004 to get approval to import GM wheat into the country, before it had received regulatory approval in the US. The company withdrew its application following objections lodged by the African Center for Biosafety (ACB 2004). Environmental organizations, in particular Biowatch, have also consistently

³ See, e.g. the detailed objections by the African Center for Biosafety at www.biosafetyafrica.net.

demanded access to information with regard to GM crop approvals from the government, with highly publicized and long-drawn out court cases (Biowatch 2008; see also Gupta 2008b).

In recent years, a trend towards a slowing of GM crop approvals is discernible in South Africa (Wolson 2007). One clearly restrictive move came in late 2005, when the Executive Committee responsible for evaluating and approving GM crops decided not to consider any further applications for GMO commodity imports, pending the outcome of a study by the Department of Trade and Industry (DTI) about the impacts of such imports on South African trade and agriculture. By some accounts, the concerns motivating this step include potential adverse impacts of cheap GM imports on domestic maize and other commodity producers. Trade unions, powerful domestic players in South African politics, are concerned about the price effects on local commodities of cheap GM imports in the long term (Wolson 2007, p. 189). Another concern is the impact on non-GM exports to countries in the region, given that segregation between GM and non-GM varieties of key export crops cannot be assured. Although the DTI study was to be concluded in 2006–2007, official results of the study do not appear to be available. Meanwhile, the moratorium on approvals for commodity imports is still largely in place (Mayet 2006.).

The perception of a more restrictive trend in policy is reinforced by a number of high profile rejections of GM crop applications. These include an application to fieldtest a bio-fortified variety of sorghum, produced by a consortium of public and private sector actors and funded by the Bill and Melinda Gates Foundation (Wolson 2007); and another to import the ‘first biofuel GM’, a GM maize variety produced by Syngenta for more efficient production of biofuels. The official reasons cited for these rejections included a mix of economic, trade and food safety concerns. Whether this cautious trend continues is likely to depend as much on regional and national imperatives and domestic alliances, as on global developments.

As is evident from all three cases, a combination of concerns relating to biosafety, domestic price stabilization, export markets and overall economic impacts of GM crops have given rise to actor coalitions that have sought to slow down the commercialization of GM crops. Environmental campaigners and various state officials have been strengthened by the creation of an international biosafety regime, and where the introduction of GM crops posed a threat to agricultural exports or domestic producers, they were able to bolster their efforts to enforce stricter biosafety oversight with economic arguments, often against a broadly promotional stance by key state institutions.

4.2.3 Regulatory directions: permissive elements of GMO policy

At the same time, each of the three countries has also adopted a more permissive approach in certain areas. In Mexico, this relates, first, to GM cotton and its commercialization. In this case, gaps in the regulatory framework were creatively interpreted to portray large areas—exceeding 10,000 ha—as experimental fields still requiring biosafety measures. This permitted the large-scale planting of Bt cotton, the first GM crop grown in commercial quantities in Mexico. Because cotton does not end up in the food chain for humans, it has so far escaped closer scrutiny by those concerned about food safety.

Permissive elements of Mexican policy are, however, also evident for maize, fuelling much greater controversy. The most prominent of these is the ‘trilateral arrangement’ that Mexico has signed with its NAFTA partners, the US and Canada, in order to fulfil its obligations under the Cartagena Protocol. The arrangement is intended to implement the Protocol’s requirement that bulk commodity shipments (in this case, those coming from the

US into Mexico) state that they “may contain” GM varieties. The trilateral arrangement mandates that the “may contain” declaration only be triggered in cases, where the content of GM material is above a threshold of 5%, which the US has been pushing for in an international context. Consumer safety and environmental groups see this threshold level as too high, and as being counter to the precautionary intent of the Cartagena Protocol. By many accounts, this controversial agreement was negotiated by a representative of the Ministry of Agriculture and is not unequivocally supported by all government departments (interview with a CIBIOGEM member and Ministry of Economy official), reflecting ongoing conflicts over GM policy directions in Mexico.

GM maize imports from the US are set to increase even further, as all special exemptions for maize under NAFTA expired in January 2008. The importance of this burgeoning trade to Mexico has also been responsible for Mexican opposition at the global level, during Cartagena Protocol meetings, to strengthening documentation requirements for the GM commodity trade, as demanded by developing countries and the EU (Osava 2006).

As in Mexico, GMO policy in China too has been largely permissive in relation to GM varieties of cotton. Insect-resistant GM cotton varieties passed regulatory hurdles and were introduced in four provinces as early as 1997 (Hebei, Henan, Shanxi and Shandong), including the first and so far only foreign-owned GM plant variety, Monsanto’s Bt cotton. Because cotton is primarily grown for the domestic market and does not enter the human food chain, trade concerns did not stand in the way of rapid commercialization, involving an estimated 7.1 million farmers (James 2008).

With regard to other crops, in particular GM soybean, the threat of exclusion from international markets has been a driving force behind the tightening of China’s biosafety regime, as seen above. However, domestic demand for agricultural imports pulls in the opposite direction. Owing to rapidly growing domestic consumption and the liberalization of agricultural trade, China has now become the world’s largest importer of GM soybeans, mainly from the US, and domestic operators of crushing and processing plants, mainly in the Southern ports of China, rely heavily on such imports.

The introduction of new restrictive biosafety rules in 2002, only months after China entered the WTO, stipulated that every shipment of GM crops had to be issued a safety certificate based on risk assessment. Owing to the short timeframe within which the rules were introduced, US shipments of soybeans were held up temporarily, leading to a noticeable fall in US soybean exports (Rugaber 2002). The US government accused China of ‘back-door’ protectionism aimed at manipulating the burgeoning trade in soybeans and complained about the uncertain nature of the new biosafety rules, which in their view failed to give clear guidance on documentation requirements and allowed Chinese authorities to delay a decision for up to 270 days, the timeframe in the Cartagena Protocol (interview with official from US embassy in China). China eventually gave in to sustained diplomatic pressure from Washington and issued interim safety certificates to facilitate uninterrupted imports of soybeans before issuing formal three-year certificates in February 2004 (China Daily 2004). The climb-down by the Chinese authorities and shift from a restrictive to a permissive stance vis-à-vis GM soybean imports underscores the ongoing effort to strike a balance between domestic agricultural needs, biosafety and global trade imperatives.

In South Africa, some domains of GMO policy remain clearly permissive and aligned with a US regulatory approach. This is particularly evident for GM food labelling—South Africa currently does not require labelling of food with GM ingredients (Biowatch 2008). The Ministry of Health (a pro-biotechnology branch of government) relies upon the US-promoted notion of substantial equivalence of GM with non-GM food in dealing with this issue (interviews with representatives of the Health Ministry and civil society; Wolson

2007). The question of mandatory labelling has been a contentious point of debate with regard to the GMO Act and its amendments, but has also recently resurfaced in debates over a draft Consumer Protection Bill, presented to parliament in early 2008. This bill initially included a requirement for compulsory labelling of food with GM ingredients, but this was removed from the latest draft, partly as a result of opposition from the Ministry of Agriculture (Biowatch 2008).

In general, with the exception of the last year or so, the last two decades have been a period of intense activity in South Africa in the field of GM research and development, with a growing number of crops gaining approval and being grown commercially. Furthermore, while NGOs push for a restrictive policy, supporters of genetic engineering play an active role in seeking to influence policy directions. The dominant pro-biotechnology group, AfricaBIO, is heavily involved in capacity building in the region, often in conjunction with the US Agency for International Development (USAID) (Wolson 2006). US influence is prominent in regional capacity-building initiatives, seen by critics as a way to promote the US regulatory model.

In sum, GMO policies in Mexico, China and South Africa contain both permissive and restrictive elements. Contrary to expectations that key developing countries' domestic GMO policy choices would converge around either the US or EU regulatory model, policy choices in each of the three countries examined above continue to exhibit a significant degree of diversity, a diversity that belies suggestions that developing countries will inevitably have to embrace either a US or an EU regulatory approach. Furthermore, our analysis suggests that the peculiar mix of permissive and restrictive policy elements discernible in each of these three countries cannot be reduced to incoherence or even chaos in policy-making, but rather reflects an ongoing attempt to balance competing priorities and interests, within the domestic context but also at the domestic–international nexus.

It is worth noting that the three countries examined here have followed largely similar trajectories in developing their domestic GMO frameworks. They have gone from promotion of agricultural biotechnology under the Ministry of Agriculture in the early 1990s to the introduction of more restrictive elements by the late 1990s, coinciding with negotiation of the Cartagena Protocol and the EU moratorium, and contributing to a greater role domestically for the Ministry of Environment. Notwithstanding this shared trajectory, however, there is little discernible convergence within each of these countries towards either an EU or US model in domestic GMO policy choices. Instead, each of these countries displays different permutations of permissive and restrictive GMO policies in response to specific trade and domestic imperatives.

In the case of China, a concern with traditional exports to European and other Asian markets calls for a restrictive approach to GMO trade and production, while growing reliance on US imports has simultaneously created incentives for a more permissive approach. Neither of these two external influences has come to dominate GMO policy. Conflicting international influences are employed by domestic interest groups—within and outside the core state—to shape GMO policy, without either side gaining control over the regulatory process. China's biotechnology policy has thus come to include elements of both US- and EU-style regulation, and the political leadership is intent on maintaining a finely balanced approach that secures a significant degree of political choice within competing external constraints.

For Mexico and South Africa, trade with the US and other GMO producing countries also influences policy directions. A concern with losing EU markets for non-GM agricultural commodity exports is not as strong a countervailing force in these two countries as it is currently for China. One could then assume that the neoliberal thrust of economic and

agricultural policy would push both countries more unambiguously in the direction of openness in GMO research and trade, aligned with a US approach. As we see, however, this is not entirely the case. In Mexico, the key counter-force to an overall permissive policy is to be found in cultural attitudes to biodiversity, and particularly the perception of a unique relationship between Mexico and maize. As the analysis reveals, concerns over the cultural, social, ecological and health consequences of importing or planting GM maize force Mexico, too, to balance both openness and caution in its domestic policy. This is further stimulated by the fact that functioning democratic politics, now taking hold in Mexico, ensures that different voices are at least heard.

The democratization of risk governance can also be observed in South Africa, where an active NGO community critical of the country's approach to GMOs in agriculture has been going head to head with domestic constituencies supportive of biotechnology. This conflict has influenced domestic regulatory developments. Partly, this has been possible because of rights enshrined in the new South African constitution, and progressive right to information legislation, which allows citizen groups to hold regulatory authorities accountable for decisions they take. These groups have also, however, been able to evoke South Africa's obligations under the Cartagena Protocol as a way to further legitimize their push for a more restrictive approach. A more restrictive trend in South African policy can be attributed to these forces, together with key trade and economic concerns that do not pull in the direction of openness alone.

What we see, then, is not convergence to one of the two regulatory nodes of the US or the EU but rather a 'sustainable diversity' (Millstone and Zwanenberg 2003, p. 664) in GMO policy approaches in the South. Furthermore, our analysis suggests that this diversity is related not only, as Millstone and Zwanenberg posit, to interpretive flexibility of international obligations—such as those contained in the WTO SPS Agreement or the Cartagena Protocol—or to persisting scientific uncertainties and conflicts over safe use of GMOs, allowing for differing local interpretations and policy choices. It is related, more broadly, to how competing trade imperatives interact with domestic politics and priorities, with multiple domestic nodes of power and actor coalitions negotiating policy directions that combine both restrictive and permissive elements.

5 Conclusion: transatlantic regulatory polarization and diversity in southern GMO policies

We began this analysis by asking whether regulatory convergence in the area of GMO policy is discernible in key developing countries. Numerous studies of globalization have suggested that greater global economic and political integration is pushing countries towards regulatory convergence, and in the field of GMO politics, the idea of regulatory polarization around the US and EU regulatory models has gained ground. Our study has sought to shed light on the nature and limits of this convergence trend, and to investigate the ways in which international forces are transmitted into the domestic context of regulatory policies in the South.

Our findings reveal unambiguously that GMO policy-making in the South is indeed influenced by global economic and trade considerations. All three countries are encouraging new technologies in agriculture as part of their effort to promote economic liberalization and greater competitiveness in international markets. A key motivation underlying biotechnology policy in all three countries is fear of being left out of the next technological revolution, with its consequences for international competitiveness.

However, while global trade and economic imperatives are important, they do not push in one clear direction. As a result of the GMO conflict between the US and the EU, international market imperatives can have two different effects, often simultaneously: they may promote rapid adoption of agricultural biotechnology and reliance on a narrowly defined, ‘sound science’ based approval system of GMOs; or they may push towards a more restrictive, precautionary, approach that ensures biosafety as well as a future for non-GM exports.

As has become evident from these cases, international factors, such as trade links, bilateral relations and international regimes pose constraints but also enable domestic interests within and outside the state to pursue competing objectives. There is no straightforward transmission of international imperatives into domestic ones; their relevance in a domestic context depends on the mobilization of domestic interests, the creation of actor coalitions and the alliances formed with key representatives of state institutions. It is in this battleground of domestic politics that—despite differences in the political constitution of our three cases—transnational regulatory polarization plays itself out, with domestic institutional frameworks and interplay of actors providing a filter through which international influences pass. The net result of this complex international–domestic interaction is a more diverse field of regulatory policies and outcomes than is commonly acknowledged in debates on international regulatory polarization.

Finally, an intriguing implication of our analysis is that, rather than simply constraining policy choices, transatlantic regulatory polarization may well have empowering consequences for a diverse range of domestic actors. At the very least, the transatlantic GMO conflict has helped to stimulate a more comprehensive and inclusive domestic political debate on how to govern this contested new technology, in each of the three countries examined here. Because of its emphasis on enhancing importing country choice, the global regime of the Cartagena Protocol has contributed further to such a democratization of debate and broadening of domestic policy agendas (for specific analysis of the Cartagena Protocol’s influence, see Gupta and Falkner 2006). However, it is clear that the policy space for biotechnology choices that exists today in key developing countries is not without boundaries. Leading biotechnology countries in the South remain exposed to various external pressures and are constrained by dependence on export markets and commitment to international regime norms. It is therefore appropriate to think of developing country autonomy in forging policy directions more in terms of “bounded autonomy” (Newell 2007). This caveat is all the more important when we consider the position of smaller developing countries that are less advanced in biotechnology research or development of domestic biosafety regulations.

This notwithstanding, the above discussion reveals that accounts of globalization fuelling regulatory homogenization, convergence and polarization fail to capture the significant degree of regulatory diversity that currently exists in key developing countries. Globalization of agricultural biotechnology is progressing but it is far from producing convergence (binary or otherwise) in the South.

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