http://dx.doi.org/10.1080/14693062.2014.997658

climate policy

research article

Linkage of greenhouse gas emissions trading systems: learning from experience

MATTHEW RANSON[1], ROBERT N. STAVINS[2*]

[1] Abt Associates Inc, 55 Wheeler Street, Cambridge, MA 02138, USA
[2] John F. Kennedy School of Government, Harvard University, 79 John F. Kennedy Street, Cambridge, MA 02138, USA

The last ten years have seen the growth of linkages between many of the world's cap-and-trade systems for GHGs, both directly between systems, and indirectly via connections to credit systems such as the Clean Development Mechanism. If nations have tried to act in their own self-interest, this proliferation of linkages implies that for many nations, the expected benefits of linkage outweighed expected costs. In this article, we draw on the past decade of experience with carbon markets to examine why systems have demonstrated this revealed preference for linking. Linkage is a multi-faceted policy decision that can be used by political jurisdictions to achieve a variety of objectives, and we find qualitative evidence that many economic, political, and strategic factors – ranging from geographic proximity to integrity of emissions reductions – influence the decision to link. We also identify some potentially important effects of linkage, such as loss of control over domestic carbon policies, which do not appear to have deterred real-world decisions to link.

Policy relevance

These findings have implications for the future role that decentralized linkages may play in international climate policy architecture. The Kyoto Protocol has entered what is probably its final commitment period, covering only a small fraction of global GHG emissions. Under the Durban Platform for Enhanced Action, negotiators may now gravitate toward a hybrid system, combining top-down elements for establishing targets with bottom-up elements of pledge-and-review tied to national policies and actions. The incentives for linking these national policies are likely to continue to produce direct connections among regional, national, and sub-national cap-and-trade systems. The growing network of decentralized, direct linkages among these systems may turn out to be a key part of a future hybrid climate policy architecture.

Keywords: cap-and-trade; climate change; climate policy architecture; linkage

1. Introduction

Recent efforts under the United Nations Framework Convention on Climate Change (UNFCCC) to develop a global response to the risks of climate change have focused on two negotiation tracks. One – extending the Kyoto Protocol with a second commitment period – faced major challenges and resulted in limited participation. Not only are a number of key industrialized countries on the sidelines (Canada, Japan, Russia, and the US), but the Protocol has failed to set emissions targets for the large, rapidly growing emerging economies (principally China, India, Brazil, South Korea, South Africa, and Mexico).

■ *Corresponding author. *E-mail*: robert_stavins@hks.harvard.edu

Taylor & Francis
Taylor & Francis Group

A second track – negotiations based on the roadmap known as the Durban Platform for Enhanced Action – may eliminate the historical distinction in climate commitments between developed (Annex I) and developing (non-Annex I) countries. However, despite the Durban Platform's stated commitment to reach agreement on a new global climate regime by 2015, the history of international climate negotiations suggests that reaching a broad top-down international agreement to address climate change is likely to be extraordinarily difficult.

Given these challenges, the countries of the world have increasingly turned their attention in the UNFCCC negotiations to the possibility of a hybrid climate policy architecture for the 2015 agreement – one that would include top-down elements, for example, for monitoring, reporting, and verification, with a bottom-up pledge-and-review system, where each country would specify its own targets based upon domestic political feasibility. The most politically realistic mechanism for such a system to be cost-effective – and thus able to achieve more ambitious global emissions reductions – would be for it to facilitate decentralized linkages among regional, national, and sub-national climate policies (which in many jurisdictions have taken the form of emissions trading systems).

Such a system would require the ability of nations to form bilateral and multilateral agreements in which they would link their cap-and-trade systems by accepting each other's allowances or credits. In principle, the links could create cost savings and market liquidity for connected systems, while achieving the same aggregate reductions in GHG emissions. The linkage agreements could also provide mechanisms for countries to coordinate and harmonize their emissions caps, price controls, and other design features. Such decentralized linkage could augment and complement other elements of an international hybrid policy architecture.

One key question about this type of climate policy architecture is whether it can generate a sufficient quantity of GHG emissions reductions at reasonable cost (Heitzig, 2013). To help address this question, we draw on the past decade of experience with carbon markets to examine why systems choose to link, so that we can better assess the role that decentralized linkages may play in future international climate policy.

Two conclusions emerge about motivations for linkage. First, there exists a significant revealed preference for linking emissions trading systems. The last ten years have seen the organic growth of linkages between many of the world's cap-and-trade systems, both directly between systems, and indirectly via connections with credit systems such as the Clean Development Mechanism (CDM). This proliferation of linkages implies that for many nations the expected benefits of linkage outweigh expected costs.

Second, the decision to develop a link between two systems depends on a variety of economic, political, and strategic factors. Although it may seem obvious that the primary goal of linkage is to achieve the same level of emissions reductions at a lower cost, linkage is a multi-faceted policy decision used by political jurisdictions to achieve a variety of objectives. Many factors – ranging from geographic proximity to integrity of emissions reductions – influence decisions about linking. The evidence we present in this article is primarily qualitative, as the number of systems that have linked is not sufficient for reliable statistical analysis.

Because a global offset market is not emerging, achieving near-term cost savings through a system of indirect linkages is unlikely. Furthermore, delinking by New Jersey and Australia demonstrates that linkages can easily be undone, implying that linkages may not survive changes in domestic political support. Nonetheless, the many economic and political incentives for linking are likely to continue to produce direct connections among regional, national, and sub-national cap-and-trade systems. Although a bottom-up architecture may produce relatively modest global emissions reductions in the short term, it is likely to be more feasible politically than a stringent top-down agreement.

The remainder of this paper is organized as follows. Section 2 presents evidence of how economic, political, and strategic factors have influenced decisions about linkage. Section 3 evaluates the potential role of linkage in global climate policy architecture. Section 4 concludes.

2. Economic, political, and strategic determinants of linkage

Many jurisdictions have revealed their preference for linking their domestic cap-and-trade policies with those of other jurisdictions. As of May 2014, there were international, regional, national, or sub-national cap-and-trade systems operating or scheduled for launch in 36 countries. These include the European Union Emissions Trading Scheme (EU ETS), the Regional Greenhouse Gas Initiative (RGGI) in the northeast US, the AB-32 system in California, eight regional pilots in China, and emissions trading systems in Kazakhstan, New Zealand, Quebec, Switzerland, South Korea, and Tokyo (World Bank, 2014).[1] Most have established or proposed at least one linkage with another cap-and-trade or credit system (Table 1). More discussion of these linkages is provided in the online supplementary material, as well as of other forms of non-traditional linkage.

The existence of these linkages implies that for the participating jurisdictions, the expected economic and political benefits of linkage outweigh expected costs. Of course, there are also many pairs of systems that, to date, have implicitly demonstrated a preference for *not* linking with each other. California and Quebec have not linked with the CDM, and the EU ETS has not linked with any of the North American systems. Some of these unrealized links will become critical in the future. This motivates an important question: why do systems choose to link or not to link?

Although it may seem obvious that the primary goal of linkage is to achieve the same level of emissions reductions at lower cost, linking is a multi-faceted policy decision that can be used by political jurisdictions to achieve a variety of objectives (Flachsland, Marschinski, & Edenhofer, 2009). We consider many factors – ranging from geographic proximity to integrity of emissions reductions – that may influence the decision to link.

2.1. Geographic proximity

The single most significant predictor of systems linking may be geographic proximity (Table 1). The EU Member States are linked through the EU ETS; the northeastern US states are linked through RGGI; Quebec and California will link in 2014; and many aspects of New Zealand's cap-and-trade system were chosen for compatibility with Australia's (previously) planned system.

Analyses of negotiated trade agreements can provide some insight into this pattern, because one of the most robust findings from such analyses is that trade agreements are most likely between nations that are near each other (Tinbergen, 1962), a fact that is largely attributed to transportation costs and market information. Likewise, linkage could be facilitated if nearby jurisdictions also have similar environmental goals and economic conditions, a history of productive engagement on other issues, and familiarity with and connections between each other's regulatory and political systems. Linkages with neighbours may also be significantly more palatable to domestic audiences. Anecdotal evidence

Table 1 Linkages between emissions trading systems

					Prices at enactment		Caps ($MtCO_2$)			
System 1	System 2	Type of linkage	Enact. date	Effect. date	#1	#2	#1	#2		Notes and references
Linkages among cap-and-trade systems										
27 EU nations	(via the EU ETS)	Multi	2003	2005	None	NA	Varied	2299		1, 12
Norway	EU ETS	One-way		2005						10
Norway	EU ETS	Multi	2007	2008	€0	€20	15	2080		2
Iceland	EU ETS	Multi	2007	2008	None	€20	0	2080	[a]	2
Liechtenstein	EU ETS	Multi	2007	2008	None	€20	18	2080		2
Switzerland	EU ETS	Two-way	[b]							3
Australia	EU ETS	One-way	2013[b]	2014	AU$25	€7–€8	TBD		[c]	4, 11
Australia	EU ETS	Two-way	[b]	2018	AU$25	€7–€8	TBD	1852		4
Australia	New Zealand	Two-way	[b]				TBD			5
Australia	EU ETS, NZ	Delinking	2014	2014						24
California	Quebec	Two-way	2012/13	2014	$14	None	160	25		6, 14, 15
10 US states	(RGGI)	Multi	2005	2009	None	NA	Varied	168	[d]	7
RGGI	Any CAT system	One-way	2005	2009	None	€9/ EUA	168	2299	[e]	8
RGGI	Any CAT system	Delinking	2013	2014	$3	€5/ EUA	91	2299	[e]	9
New Jersey	RGGI	Delinking	2011	2012	$2	$2	21	150		13
Linkages from cap-and-trade systems to credit systems										
EU ETS Phase 1	CDM	One-way	2004	2005	€9	$5	2299	NA	[f]	1, 16, 17
EU ETS Phase 2	CDM	One-way	2004	2008	€9	$5	2299	NA	[f]	1, 16, 17
EU ETS Phase 3	CDM	One-way	2004	2013	€9	$5	2299	NA	[f,g]	1, 16, 22
EU ETS Phase 2	JI	One-way	2004	2008	€9	$6	2299	NA	[f]	1, 16, 18
EU ETS Phase 3	Non-LDC CDM	Delinking	2012	2013	€6	€4	2084	NA		26
Switzerland	CDM	One-way	1999	2008	None	$4–$7	NA	NA		17, 19
New Zealand	CDM, JI, RMU	One-way	2008	2008	None	€11	NA	NA		17, 20, 21
Australia	CDM, JI	One-way	2011	2012/15	None	€6	TBD	NA		4
RGGI	Any credit system	One-way	2005	2009	None	$5–8	110	NA	[e]	8
RGGI	Any credit system	Delinking	2013	2014	None	$5	165	NA	[e]	9
California	Acre and Chiapas	One-way	[b]					NA		25

Continued

Table 1 Continued

System 1	System 2	Type of linkage	Enact. date	Effect. date	Prices at enactment		Caps ($MtCO_2$)		Notes and references
					#1	#2	#1	#2	
Quebec	Acre and Chiapas	One-way	[b]					NA	25
Tokyo ETS	CDM	One-way	2008	2010	$142	$18	13	NA	[h] 23

Sources: 1, European Parliament (2004); 2, European Commission (2007b); 3, European Commission (2010); 4, Australian Government (2013); 5, Combet and Groser (2011); 6, CA ARB (2013a); 7, RGGI (2008); 8, RGGI (2013a); 9, RGGI (2013b), Mehling and Haites (2009); 10, Sopher and Mansell (2013); 11, European Commission (2012, 2013a); 12, European Commission (2007a); 13, NJ.com (2011); 14, CA ARB (2013b); 15, Québec MDDEFP (2013); 16, Sijm (2009); 17, UNDP (2009); 18, Allen Consulting (2005); 19, Sopher and Mansell (2013); 20, New Zealand Parliament (2008); 21, New Zealand Ministry of the Environment (2011); 22, European Commission (2013b); 23, EDF/IETA (2013); 24, ClimateWire (2013c); 25, EDF (2010); 26, European Commission (2011).

Notes: NA, not applicable; TBD, to be determined. [a]Per EEA Joint Committee decision 146/2007, Iceland did not submit a National Allocation Plan for EU ETS Phase II, because it had no installations large enough to be covered by the cap-and-trade system.[b]Indicates a proposed linkage.[c]Participants in Australia's system may use EUAs for up to 50% of their compliance obligations.[d]The RGGI states signed an MOU in 2005, and then each passed authorizing legislation between 2006 and 2008.[e]The original Model Rule included language in section XX-10.3(b)(1) that allowed the use of allowances from foreign cap-and-trade systems or credit systems (including Kyoto flexibility mechanisms) if RGGI allowance prices exceeded a 'two-stage price trigger event' that began at $10 in 2005 and increased by roughly 2% each year. The 2013 amendments to the Model Rule eliminated this linkage.[f]Credit price reflects pre-compliance offsets for which seller assumes risk.[g]Under recent proposed rules, EU ETS participants will be entitled to use international credits during the 2012–2020 period up to the higher of two limits: (1) the international credit entitlement specified in the national allocation plan for Phase 2 or (2) 11% of the free allocation of EU allowances granted to them in that period.[h]Use of CDM credits is allowed only if domestic prices exceed a threshold, and if Tokyo-based credits are used as well.

from California, where some legislators have expressed concerns about linking to 'far-flung jurisdictions' (ClimateWire, 2013a), is consistent with this.

2.2. Cost-effectiveness

The most important economic motivation for linking may be the anticipated cost savings that come from the reallocation of abatement effort between systems with different marginal abatement costs. The system with the higher marginal cost benefits from purchasing relatively inexpensive allowances from the other system, allowing it to achieve its emission reduction goals at a lower cost. Conversely, the system with the lower marginal cost benefits from selling its allowances at higher prices, resulting in an inflow of revenue.

The net welfare gains from linking can be substantial (Carbone, Helm, & Rutherford, 2009). The best existing example may be the link between the EU ETS and the CDM, which has allowed regulated EU firms to purchase offsets from developing countries. Trotignon (2010) suggests that, between 2008 and 2009, EU ETS installations saved at least €280 million by purchasing Certified Emission Reductions (CERs) instead of making higher-cost domestic emissions reductions. Future projections also suggest large potential savings: for example, Gavard, Winchester, Jacoby, and Paltsev (2011) estimate that, by linking to a Chinese system with a business-as-usual cap, the costs of a 30% reduction in US CO_2 emissions by 2030 would be cut by more than half.

However, for some jurisdictions, other concerns – such as the environmental integrity of offsets – may be more important than cost savings. For example, the EU ETS has effectively delinked from the CDM for the post-2012 period. Furthermore, many potentially cost-saving bilateral linkages have not occurred at all, such as California–RGGI and EU–California. Finally, it is possible that the macroeconomic welfare effect of linkage might be negative for some countries, for example, due to an interaction with a distortionary domestic tax system (Babiker, Reilly, & Viguier, 2004).

2.3. Distributional impacts

Although the social welfare gains from linkage are important, the distribution of welfare impacts across regulated entities is also likely to matter (Newell, Pizer, & Raimi, 2013). Not all regulated entities benefit from linkage, and whether individual firms are net losers or winners will depend on their marginal abatement costs, whether they are in the higher-cost or lower-cost linked system, and how allowances are initially allocated (via grandfathering or auctioning).

The relative political power of winners and losers could have strong impacts on governmental support for linking with another system. For example, the cost savings available from linkage may play well to regulated businesses in the higher-cost system, and high allowance prices may be popular with constituents that receive free allowances in the lower-cost system. On the other hand, large international revenue transfers may be a political liability in the system that makes payments. The interaction of allocation mechanisms and political incentives for linkage is a topic for future research. For example, while firms might oppose a cap-and-trade system with auctioned permits, after enactment such a system would provide regulated firms with financial incentives to support linkage to systems with lower allowance prices.

2.4. Market liquidity and price stabilization

In principle, by increasing and diversifying the number of buyers and sellers in a carbon market, linkage can provide the dual benefits of increased liquidity and reduced price volatility. This is particularly important for smaller cap-and-trade systems with few participants. In fact, nearly all of the smallest cap-and-trade systems have taken steps to link with other systems. For example, Norway created a one-way link with the EU ETS in 2005, and then joined the EU ETS in 2008, New Zealand's ETS and the Japanese voluntary ETS have established one-way links to the CDM, and Switzerland is negotiating a two-way link with the EU ETS.

Linkage does appear to have increased the overall liquidity of allowance markets in these small cap-and-trade systems, but its contribution to price stability has been mixed (Mundaca & Richter, 2013). Although linkage may have reduced day-to-day fluctuations in prices, it has also increased the exposure of small systems to systematic risk. For example, due to New Zealand's decision to allow unrestricted use of Kyoto credits, New Zealand Unit (NZU) prices largely tracked CDM prices, which are in turn dependent on EU ETS prices. The collapse of European Union Allowance (EUA) prices in 2011 and 2012 propagated through this indirect linkage and led to a similar decline in NZU prices (Figure 1).

2.5. Domestic opposition to cap-and-trade

Supportive domestic political leadership is a necessary condition for the adoption of a cap-and-trade system, and, by extension, the decision to link (or de-link) with another jurisdiction. Consider two

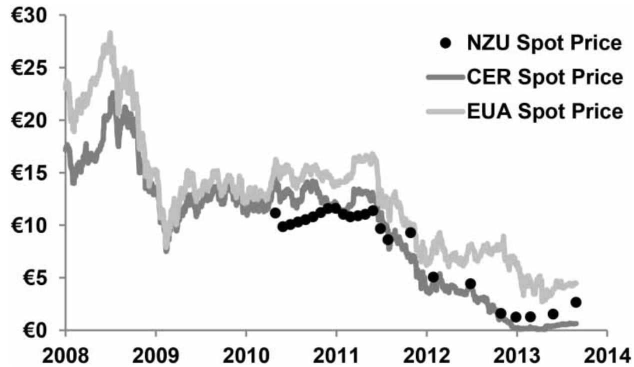

Figure 1 Spot prices for NZUs, CERs, and EUAs
Note: All prices are shown in nominal euros.
Sources: SENDECO$_2$ (2013); Carbon CommTrade (2013).

recent examples of elected politicians who have decided to eliminate their domestic cap-and-trade systems, thus effectively delinking from other emissions trading systems. First, in November 2011, Governor Chris Christie of New Jersey announced that he was issuing an executive order that would withdraw his state from RGGI (NJ.com, 2011). New Jersey's exit resulted in the retirement of 21 million short tons of CO_2 allowances (relative to a total RGGI cap of 150 million short tons).

Second, in July 2014, the newly elected Australian government, led by Prime Minister Tony Abbott, passed legislation to terminate Australia's plans to move to a cap-and-trade system (Taylor & Hoyle, 2014). This decision ended the previous government's negotiated deal for a one-way link with the EU ETS starting in 2014 and a two-way link starting in 2018.

2.6. International political strategy

Linkages are agreements between political jurisdictions, and, like other forms of international cooperation, they can involve strategic political behaviour. First, some nations may see linkage as a way to build support for international climate action by demonstrating leadership, coordinating policies, and developing mutual trust. The European Commission website states that:

> Linking the EU ETS with other cap-and-trade systems offers several potential benefits, including reducing the cost of cutting emissions, increasing market liquidity, making the carbon price more stable, leveling the international playing field and *supporting global cooperation on climate change*. (European Commission, 2013a; emphasis added)

Second, nations may be coerced into linkage as a condition for receiving other benefits. The eastern European Member States of the EU are a prime example. Many of these countries would have preferred not to join the EU ETS, but agreed to participate in multilateral linkage as a condition of receiving the 'club benefits' of EU membership (Ellerman & Buchner, 2007).

Finally, nations may use linkage as a 'carrot' to encourage the development of foreign emissions trading systems. In 2013, the EU ETS ceased accepting new offsets from CDM projects located outside of Least Developed Countries (LDCs), a decision that effectively excludes China and India (which together have produced 68% of CDM offsets to date) from selling CERs to the European market. This policy change is at least partially intended to encourage these two important emitters to develop their own cap-and-trade systems. The European Commission (2011) states that '[w]hile initially the use of international credits was allowed for cost-effective compliance, this has been complemented with the objective of actively using the leverage the EU possesses as the by far most important source of demand for international credits.'

2.7. Reduced integrity of emissions reductions

Linkage can mean accepting some uncertainty about the quality of allowances or credits that are purchased from a linked system. This problem is particularly acute for links with credit systems, which suffer from imperfect additionality, the challenge of determining whether a claimed emissions reduction would have occurred anyway in the absence of the offset programme. As the world's largest credit system, the CDM has come under particular criticism about the limited additionality of its offsets. At the extreme, early CDM offsets for the destruction of hydrofluorocarbons may have had the perverse effect of creating incentives to build additional refrigerant-producing factories solely for the purpose of destroying their HFC-23 emissions (Carbon Trust, 2009). This problem had a clear effect on linkage: in 2013, the EU ETS ceased accepting CDM offsets based on HFC-23 destruction.

Even direct linkages with another cap-and-trade system can lead to problems with integrity of emissions reductions (Jaffe, Ranson, & Stavins, 2010). The issue is leakage: the incentive for firms in the lower-price system to move their emissions-generating economic activity to an unregulated jurisdiction, to avoid paying the higher post-linkage allowance price. Australia's previous government, for example, had expressed reluctance to link to sub-national systems due to concerns about leakage, because firms in sub-national systems may find it particularly easy to relocate to an unregulated jurisdiction within the same country (Bushnell, 2013).

2.8. Domestic abatement incentives

One of the primary effects of linkage is to reduce the price of allowances in the system that originally had a higher permit price. However, there are some reasons why a lower allowance price may be undesirable. Some jurisdictions may use cap-and-trade to establish domestic price incentives for investments in low-carbon infrastructure or technological innovation (Calel & Dechezlepretre, 2012). The lower post-linkage price will reduce these investment incentives. Similar issues may arise for cap-and-trade systems that are based on some notion of moral responsibility – the idea that domestic firms 'should' reduce their own emissions, instead of paying foreign firms to make equivalent emissions reductions.

In practice, widespread limits on the use of offsets from credit systems appear to be motivated by the desire to establish domestic abatement incentives. Most cap-and-trade systems place relatively strict limits on offset use (Table 2). Except for New Zealand, no system allows more than 20% of emissions to be covered with offsets, and few allow more than 10%. Although this doubtless reflects concerns about additionality, it is also motivated by the stated goal in many systems of achieving emissions reductions domestically.

2.9. Legal compatibility

The legal frameworks that support most cap-and-trade systems are based on authorizing legislation that is implemented via regulations issued by an executive agency. For a link to be possible, the

Table 2 Limits on the use of offset credits

System	Period	Limit as percent of cap[a]
EU ETS[b]	2013–2020	Varies
EU ETS: Austria	2008–2012	10
EU ETS: Belgium	2008–2012	8.4
EU ETS: Czech Republic	2008–2012	10
EU ETS: Estonia	2008–2012	0
EU ETS: Finland	2008–2012	10
EU ETS: France	2008–2012	13.5
EU ETS: Hungary	2008–2012	10
EU ETS: Germany	2008–2012	12
EU ETS: Greece	2008–2012	9
EU ETS: Ireland	2008–2012	10
EU ETS: Italy	2008–2012	14.99
EU ETS: Latvia	2008–2012	10
EU ETS: Lithuania	2008–2012	20
EU ETS: Luxembourg	2008–2012	10
EU ETS: Netherlands	2008–2012	10
EU ETS: Poland	2008–2012	10
EU ETS: Slovakia	2008–2012	7
EU ETS: Slovenia	2008–2012	15.76
EU ETS: Spain	2008–2012	20
EU ETS: Sweden	2008–2012	10
EU ETS: UK	2008–2012	8
Swiss ETS	2008–	8
New Zealand ETS	2008–	Unlimited
Australia's Clean Energy Act[c]	2012–	12.5
RGGI[d]	2009–	3.3
California's CAT system[e]	2013–	8
Quebec's CAT system[e]	2013–	8

Sources: See text and European Commission (2007a, 2013b).
Notes:[a]The limits presented in this table apply per regulated entity.
[b]Under new proposed rules, EU ETS participants will be entitled to use CDM and JI credits during the 2012–2020 period up to the higher of two limits: (1) the international credit entitlement specified in the national allocation plan for Phase 2 or (2) 11% of the free allocation of EU allowances granted to them in that period.
[c]From 2012 to 2015, the government may impose a fee of AU$15 to AU$17 per credit. The 12.5% limit applies to Kyoto credits (ERUs and CERs).
[d]RGGI's limit rises to 5% if allowance prices exceed $7, and to 10% if allowance prices exceed approximately $10.
[e]Neither California nor Quebec recognize offsets from UNFCCC flexibility mechanisms, although California has recently completed an MOU with the goal of eventually allowing deforestation credits from the states of Acre, Brazil, and Chiapas, Mexico.

legislature must have the authority to link with a foreign jurisdiction, and the executive agency must have received authority to implement appropriate linking regulations.

Legal compatibility is particularly important for sub-national systems that may lack authority to negotiate treaties with foreign nations. The empirical pattern of linkage supports this hypothesis. There are many cases of linkages between sub-national states and provinces: the RGGI states are linked together; California and Quebec will link in 2014; and California is in the process of negotiating offset protocols with Acre, Brazil, and Chiapas, Mexico. However, we are not aware of any cases of a state or province establishing links with another nation or group of nations. As California Air Resources Board Chairwoman Mary Nichols has said, ‘for a state to link with a sovereign nation presents some legal challenges that would be difficult to work through’ (ClimateWire, 2013b).

2.10. Similarity of emissions targets and prices

Countries with very different emissions-reduction ambitions may find it difficult to negotiate a link (Burtraw, Palmer, Munnings, Weber, & Woerman, 2013). Differences of ambition can lead to substantial differences in allowance prices, which can cause large revenue transfers that may be unpalatable to the general public. However, in theory, different ambitions need not be an important obstacle, because systems could implement an ‘allowance exchange ratio’ when they link (Burtraw et al., 2013). For example, one system might allow its regulated entities to substitute 1.2 foreign allowances for one domestic allowance for the purposes of domestic compliance.

In practice, differences in ambition and prices appear to be significant barriers. For example, California has cited the collapse of EUA prices as a reason for not working to develop a link with the EU ETS (ClimateWire, 2013b). Similarly, Burtraw et al. (2013) argue that the absence of a link between RGGI and California is due in large part to the weakness of RGGI prices.

The understandable reluctance of many countries to engage in substantial revenue transfers leads to a climate policy irony: the linkages that could yield the greatest cost-effectiveness benefits – due to major differences in domestic allowance prices – may also be politically most difficult to implement. Conversely, the most politically feasible linkages are likely to have only modest cost-effectiveness benefits.

2.11. Loss of control over carbon markets and emissions targets

Establishing a link with another system can mean sacrificing some control over domestic carbon prices. For example, after a two-way linkage occurs, prices will be determined by the equilibrium of aggregate supply and demand for allowances in the two systems. Because allowance demand is determined by the caps set by both jurisdictions, each faces the risk that the other may choose a cap that could create negative economic effects.

In practice, most nations have been price takers in linked systems. Figure 2 compiles information about all existing or proposed decisions by any nation or sub-national state to establish a link.[2] For each decision, the figure calculates the ratio between the jurisdiction’s domestic cap and the combined post-linkage cap in the joined system. The figure shows that most jurisdictions enter into linkages in which their domestic cap accounts for less than 10% of the combined post-linkage cap, and in all but two cases, the ratio is less than 35%. The only exceptions are California’s planned link with Quebec, and the EU ETS’s planned (and now cancelled) link with Australia.

Not only does linkage require systems to give up some control over prices, it can also require them to relinquish some control over the ambition of their domestic emissions targets and to harmonize design features. For example, as part of the negotiations to link to the EU ETS, Australia had agreed to lower the maximum allowable domestic use of Kyoto units and to eliminate its planned price floor (Lancaster, 2012).

Despite the fact that linkage leads to loss of control over domestic carbon markets, many nations and sub-national jurisdictions have chosen to establish links, suggesting that control is not a determinative factor in countries' decisions.

3. Bottom-up architecture based on linkages

Could a bottom-up system of linkage become a fundamental part of a hybrid policy architecture to address climate change (Heitzig, 2013)? A two-part evolution of such a decentralized architecture is conceivable (Jaffe et al., 2010). In the short term, indirect linkages through a common credit system such as the CDM might provide cost-effectiveness and market liquidity benefits. In the longer term, greater numbers of direct two-way and multilateral links might emerge. These links would encourage greater coordination of legislation, regulation, and institutions, while preserving national autonomy. The links, if successful, would help to develop mutual trust among nations, thus possibly paving the way for meaningful emissions reductions commitments from a broad set of participants.

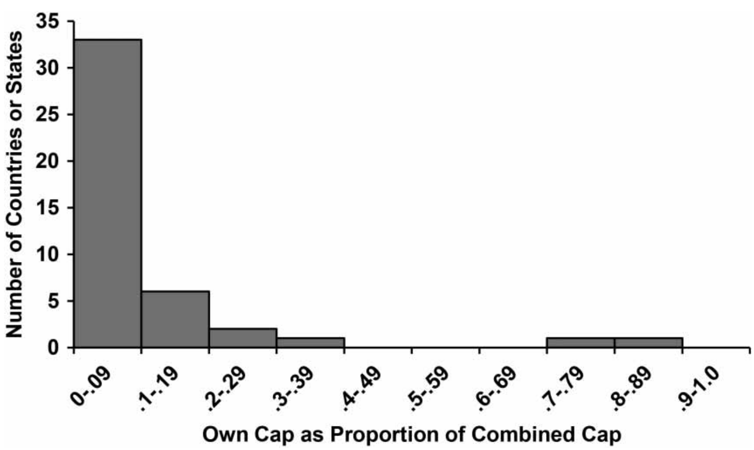

Figure 2 Histogram of ratio of emissions caps between linked systems
Note: Each observation represents the existing or proposed decision by a nation or state to establish a linkage. For bilateral and multilateral linkages, each partner is included as a separate observation. The outcome variable is the ratio between the nation or state's domestic cap and the combined post-linkage cap in the joined system.
Source: see Table 1.

Although some jurisdictions have exhibited a preference for linking their cap-and-trade systems, experience suggests that decisions about linking are affected by many economic, political, and strategic considerations. Therefore, a key question about a hybrid climate policy architecture with direct linkages is whether it could succeed in generating a sufficient quantity of GHG emissions reductions at a reasonable cost. In Section 3.1, where we evaluate the likely performance of linkage-based architecture on its own merits, the findings are not particularly encouraging, but when we compare such a bottom-up architecture with top-down alternatives in Section 3.2, a more positive prognosis emerges.

3.1. An architecture of linkages may achieve limited results

Based on recent experience, three challenges to the vision of a linkage-based policy architecture stand out. First, a robust global offset market can no longer be said to be emerging. From 2004 through 2012, the CDM provided indirect links between many of the world's cap-and-trade systems. Although CDM prices were largely determined by demand from the EU ETS, several other systems – including those in New Zealand, Japan, and Switzerland – relied on the CDM as a source of credits. Now, however, the CDM is losing its central role as a source of offsets for world carbon markets. Key factors for this decline include the EU ETS decision in 2013 to limit future CDM credits to projects from LDCs and the very low price of EUAs. Additionally, new cap-and-trade systems in California and Quebec have established their own protocols for certifying offsets and have shown little interest in accepting CERs.

A second challenge to a linkage-based architecture is the reality that, once established, linkages are by no means permanent (Pizer & Yates, 2013). Although the trend over the past decade has been one of increasing connections among GHG trading systems, there have been several major exceptions, including New Jersey's withdrawal from RGGI in 2011, the EU ETS's decision to stop accepting credits from non-LDC countries in 2013, and Australia's cancellation of its planned cap-and-trade system, which ended the nation's plans to link with the EU ETS. These three examples of delinking demonstrate that, like any other agreement, linkages can be terminated. These examples may also imply that linkage would not provide incentives for nations to commit to emissions reductions targets that are opposed by domestic constituents. Finally, whether delinking might have longer-term climate policy consequences – for example, by establishing lasting political precedents in Australia and New Jersey – is not clear.

The third challenge is how to foster linkages when they are most needed. Linkage is easiest between systems with similar allowance prices, or at least similar abatement ambitions, conditional on their relative levels of economic development. On the other hand, there is less reason for linkage when conditions are homogeneous across systems. As of spring 2014, allowance prices in the EU ETS were near €5 per metric ton, allowance prices in California were slightly above the auction floor price of US$11.34 per metric ton, and RGGI allowance prices were approximately $4 per short ton.

3.2. An architecture of direct linkages may perform better than the alternatives

In principle, a top-down agreement among the nations of the world could produce a first-best solution to the problem of climate change. Although abatement costs, GHG emissions, and climate change vulnerability all differ across nations, the logic of Coase (1960) suggests that there exists some distribution of abatement responsibilities and side payments that could reduce global emissions while leaving each nation at least as well off as it would have been in the absence of global action. The problem, of course, is that the hurdles to negotiating a successful top-down agreement for this ultimate global commons problem are exceptionally great.

Under the 1997 Kyoto Protocol, industrialized (Annex I) countries agreed to take on GHG emissions targets for a first commitment period, running from 2008 to 2012. Although the Protocol constituted a major milestone, it was never on track to produce meaningful reductions in global GHG emissions. As a consequence of Canada's withdrawal from the treaty, the decisions by Japan and Russia not to take on emissions targets for the second commitment period, and the non-participation of the US, the Kyoto Protocol currently sets emissions restrictions for industrialized nations responsible for less than 15% of global GHG emissions. Additionally, nearly all of the countries that have accepted targets under this second commitment period belong to the EU – and thus have already agreed to similar EU ETS targets.

The Durban Platform for Enhanced Action, negotiated during the 2011 Conference of the Parties in Durban, South Africa, has opened up the possibility that the world's large emerging economies could take on quantitative emissions targets (Aldy & Stavins, 2012). However, despite this potential step forward, the Durban Platform only establishes a new negotiation process that has the goal of reaching an agreement by 2015 to bring all nations under the same legal regime by 2020. The history of climate negotiations – and of other international negotiations on topics such as trade – suggests that reaching such a broad agreement will be extraordinarily challenging.

Given the drawbacks of the Kyoto Protocol and the difficulty of establishing a new global agreement under the Durban Platform, even the medium-term prospects for practical implementation of a top-down architecture appear modest at best. So, although a top-down architecture might be a first-best approach if its enactment and implementation were politically realistic, it does not compare favourably against bottom-up and hybrid approaches when real-world feasibility is considered.

Nations have strong revealed preferences for linking, and the incentives underlying those preferences are likely to continue to produce additional direct connections among regional, national, and sub-national cap-and-trade systems. Although a bottom-up system of linkage on its own would be an imperfect and incomplete response, there is no reason it cannot play a significant role as part of a comprehensive hybrid policy architecture.

4. Conclusion

Developing an effective international policy architecture to address climate change has proven to be exceptionally challenging. The Kyoto Protocol has entered what is probably its final commitment period, and now covers only a small fraction of global GHG emissions. Under the Durban Platform for Enhanced Action, negotiators may now gravitate toward a hybrid system. This would combine top-down elements for a process of establishing targets (or at least procedures for assessing targets) with bottom-up elements of pledge-and-review tied closely to individual national policies and actions.

Based on recent experience, the incentives for linking such national policies are likely to continue to produce direct connections among regional, national, and sub-national cap-and-trade systems. The growing network of decentralized, direct linkages among these systems may turn out to be a key part of a future hybrid climate policy architecture.

Acknowledgements

We are grateful for research assistance provided by John Agan, and helpful comments from Gilbert Metcalf, William Pizer, and participants at a presentation of the paper at the Nineteenth Conference of the Parties of the United Nations Framework Convention on Climate Change in Warsaw, Poland. The authors are responsible for any remaining errors.

Funding

This work was supported by a grant from the Harvard Project on Climate Agreements.

Disclosure statement

M. Ranson has no financial interest in nor will receive any benefit from the direct applications of this research. R.N. Stavins has no financial interest in nor will receive any benefit from the direct applications of this research.

Notes

1. Because some aspects of the design of China's pilot cap-and-trade systems were still unclear at the time this article was written, we do not examine potential of linkages involving these systems.
2. For the purposes of this analysis, we include each nation or state in a multilateral linkage as making a decision, but do not treat the system as a whole (e.g. RGGI or the EU ETS) as a decision maker. However, for bilateral linkages, we treat both partners as decisions makers (including, for example, the EU ETS decision to negotiate a link with Australia).

References

Aldy, J., & Stavins, R. N. (2012). *Climate negotiations open a window: Key implications of the Durban Platform for Enhanced Action*. Harvard Project on Climate Agreements. Retrieved from http://belfercenter.hks.harvard.edu/publication/22319

Allen Consulting Group. (2005). *Report to New Zealand treasury: The cost of tradable emissions units under the Kyoto Protocol*. Retrieved from www.treasury.govt.nz/publications/informationreleases/carbonprice/kp-acg-jun05.pdf

Australian Government. (2013). *Starting emissions trading on 1 July 2014: Policy summary*. Retrieved from www.climatechange.gov.au/sites/climatechange/files/files/reducing-carbon/carbon-pricing-policy/cef-policy-summary-moving-ets.PDF

Babiker, M., Reilly, J., & Viguier, L. (2004). Is international emissions trading always beneficial? *The Energy Journal*, *25*(2), 33–56.

Burtraw, D., Palmer, K. L., Munnings, C., Weber, P., & Woerman, M. (2013). *Linking by degrees: Incremental alignment of cap-and-trade markets* (RFF Discussion Paper 13-04). Retrieved from www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=22167

Bushnell, J. (2013, February 11). *A ton is never really a ton* (blog post). Energy Economics Exchange. Retrieved from http://energyathaas.wordpress.com/2013/02/11/a-ton-is-never-really-a-ton-2

Calel, R., & Dechezlepretre, A. (2012). *Environmental policy and directed technological change: Evidence from the European Carbon Market* (Working Paper No. 87). Centre for Climate Change Economics and Policy. Retrieved from http://personal.lse.ac.uk/calel/Calel%20and%20Dechezlepretre%20(2012).pdf

CA ARB. (2013a). *Air Resources Board sets date for linking cap-and-trade program with Québec*. Sacramento, CA: California Air Resources Board. Retrieved from www.arb.ca.gov/newsrel/newsrelease.php?id=430

CA ARB. (2013b). *Quarterly auction 2, February 2013. Summary Results Report* (June 5, 2013 update). Sacramento, CA: California Air Resources Board. Retrieved from www.arb.ca.gov/cc/capandtrade/auction/february_2013/updated_feb_results.pdf

Carbon CommTrade. (2013). *Price history: Spot NZUs*. Retrieved from https://www.commtrade.co.nz

Carbone, J. C., Helm, C., & Rutherford, T. F. (2009). The case for international emission trade in the absence of cooperative climate policy. *Journal of Environmental Economics and Management*, *58*(3), 266–280. doi:10.1016/j.jeem.2009.01.001

Carbon Trust. (2009). *Global carbon mechanisms: Emerging lessons and implications*. Retrieved from www.carbontrust.com/resources/reports/advice/global-carbon-mechanisms

ClimateWire. (2013a). *Legislature concerned about cap-and-trade links with other states, provinces*. Retrieved from www.eenews.net/climatewire/2013/03/05/stories/1059977279

ClimateWire. (2013b). *E.U. market troubles will prevent emissions trade linkage – Calif. air chief*. Retrieved from www.eenews.net/climatewire/2013/04/19/stories/1059979761

ClimateWire. (2013c). *New Australian government dismantling climate policies*. Retrieved from www.eenews.net/climatewire/2013/09/12/stories/1059987111

Coase, R. H. (1960). The problem of social cost. *The Journal of Law and Economics*, *3*, 1–44. Retrieved from www.jstor.org/stable/724810

Combet, G., & Groser, T. (2011). *Joint media release: Australia and New Zealand advance linking of their emissions trading schemes*. Retrieved from www.climatechange.gov.au/sites/climatechange/files/media/March%202013/MR20111205B.pdf

Ellerman, A. D., & Buchner, B. K. (2007). The European Union Emissions Trading Scheme: Origins, allocation, and early results. *Review of Environmental Economics and Policy*, *1*(1), 66–87. doi:10.1093/reep/rem003

EDF. (2010). *Tropical forests protection pact hailed for protecting climate*. New York, NY: Environmental Defense Fund. Retrieved from www.edf.org/news/tropical-forests-protection-pact-hailed-protecting-climate

EDF/IETA. (2013). Tokyo: The World's Carbon Markets: A case study guide to emissions trading. New York, NY: Environmental Defense Fund and International Emissions Trading Association. Retrieved from www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_tokyo_case_study_september_2013.pdf

European Commission. (2007a). *Emissions trading: EU-wide cap for 2008–2012 set at 2.08 billion allowances after assessment of national plans for Bulgaria* (26 October 2007: IP/07/1614). Retrieved from http://europa.eu/rapid/press-release_IP-07-1614_en.htm

European Commission. (2007b). *Emissions trading: Commission announces linkage EU ETS with Norway, Iceland and Liechtenstein* (26 October 2007: IP/07/1617). Retrieved from http://europa.eu/rapid/press-release_IP-07-1617_en.htm

European Commission. (2010). *Opening negotiations with Switzerland on linking emissions trading systems*. Retrieved from http://ec.europa.eu/clima/news/articles/news_2010110501_en.htm

European Commission. (2011). *Questions and answers on use of international credits in the third trading phase of the EU ETS*. Retrieved from http://ec.europa.eu/clima/policies/ets/linking/docs/q_a_20111114_en.pdf

European Commission. (2012). *Press release: Australia and European Commission agree on pathway towards fully linking emissions trading systems*. Retrieved from http://europa.eu/rapid/press-release_IP-12-916_en.htm?locale=en#PR_metaPressRelease_bottom

European Commission. (2013a). *International carbon market*. Retrieved from http://ec.europa.eu/clima/policies/ets/linking/index_en.htm

European Commission. (2013b). *Climate Change Committee approves proposed regulation on international credit entitlements for 2013–2020*. Retrieved from http://ec.europa.eu/clima/news/articles/news_2013071002_en.htm

European Parliament. (2004). Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004, amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms. *Official Journal of the European Union L 338/18*. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0101:en:NOT

Flachsland, C., Marschinski, R., & Edenhofer, O. (2009). To link or not to link: Benefits and disadvantages of linking cap-and-trade systems. *Climate Policy*, *9*, 358–372. doi:10.3763/cpol.2009.0626

Gavard, C., Winchester, N., Jacoby, H., & Paltsev, S. (2011). What to expect from sectoral trading: A US–China example. *Climate Change Economics*, *2*(1), 9–26.

Heitzig, J. (2013). Bottom up strategic linking of carbon markets: Which climate coalitions would farsighted players form? *Nota di Lavoro* 48.2013. Retrieved from www.feem.it/userfiles/attach/20135281552134NDL2013-048.pdf

Jaffe, J., Ranson, M., & Stavins, R. N. (2010). Linking tradable permit systems: A key element of emerging international climate policy architecture. *Ecology Law Quarterly*, *36*, 789–808. www.boalt.org/elq/documents/elq36-4-01-jaffe-2009-1209.pdf

Lancaster, R. (2012). Editorial. *Carbon Trading*, *1*(8), 1. Retrieved June 6, 2014, from www.carbon-tradingmagazine.com/wp-content/uploads/2012/09/Carbon-Trading-October-20121.pdf

Mehling, M., & Haites, E. (2009). Mechanisms for linking emissions trading schemes. *Climate Policy*, *9*, 169–184. doi:10.3763/cpol.2008.0524

Mundaca, L., & Richter, J. L. (2013). Challenges for New Zealand's carbon market. *Nature Climate Change*, *3*, 1006–1008.

Newell, R. G., Pizer, W. A., & Raimi, D. (2013). Carbon markets 15 years after Kyoto: Lessons learned, new challenges. *Journal of Economic Perspectives*, *27*(1), 123–146. doi:10.1257/jep.27.1.123

New Zealand Ministry of the Environment. (2011). *Emissions trading scheme review 2011: Issues statement and call for written submission*. Wellington: Emissions Trading Scheme Review Panel, Ministry for the Environment. Retrieved from www.climatechange.govt.nz/emissions-trading-scheme/ets-review-2011/issues-statement.pdf

New Zealand Parliament. (2008). *Climate change response (emissions trading) amendment act 2008* (Public Act 2008 No. 85). Retrieved from www.legislation.govt.nz/act/public/2008/0085/latest/DLM1130932.html

NJ.com. (2011). *Gov. Christie announces N.J. pulling out of regional environmental initiative*. Retrieved from www.nj.com/politics/index.ssf/2011/05/gov_christie_to_announce_nj_pu.html

Pizer, W., & Yates, A. (2013). *Breaking up may not be hard to do: Terminating links between emission trading programs* (Working Paper). Retrieved from www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/RPP_2013_12_Pizer_Yates(1).pdf

Quebec MDDEFP. (2013). *The Québec cap and trade system for greenhouse gas emissions allowances: Regulatory information*. Québec: Québec Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs. Retrieved from www.mddefp.gouv.qc.ca/changements/carbone/Systeme-plafonnement-droits-GES-en.htm

RGGI. (2008). *Regional greenhouse gas initiative model rule: 12/31/08 Final with Corrections. Part XX CO_2 Budget Trading Program*. New York, NY: Regional Greenhouse Gas Initiative. Retrieved from www.rggi.org/docs/Model%20Rule%20Revised%2012.31.08.pdf

RGGI. (2013a). *State statutes & regulations*. New York, NY: Regional Greenhouse Gas Initiative. Retrieved from http://rggi.org/design/regulations

RGGI. (2013b). *Summary of RGGI Model Rule changes, February 2013*. New York, NY: Regional Greenhouse Gas Initiative. Retrieved from www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_Summary.pdf

SENDECO_2. (2013). *CO_2 Prices: 2008–2013*. Lisboa: SENDECO_2. Retrieved from www.sendeco2.com/uk/precio_co2.asp?ssidi=3

Sijm, J. P. M. (2009). *Tradable carbon allowances: The experience of the EU and lessons learned* (p. 21). Petten: Energy Research Centre of the Netherlands. Retrieved from www.ecn.nl/docs/library/report/2009/e09078.pdf

Sopher, P., & Mansell, A. (2013). *Norway – the world's carbon markets: A case study guide to emissions trading* (pp. 1–2). Washington, DC: Environmental Defense Fund and International Emissions Trading Association. Retrieved from www.edf.org/sites/default/files/EDF_IETA_Norway_Case_Study_May_2013.pdf

Taylor, R., & Hoyle, R. (2014, July 17). Australia becomes first developed nation to repeal carbon tax. *Wall Street Journal*. Retrieved from http://online.wsj.com/articles/australia-repeals-carbon-tax-1405560964

Tinbergen, J. (1962). *Shaping the world economy: Suggestions for an international economic policy*. New York, NY: Twentieth Century Fund.

Trotignon, R. (2010). *Combining cap-and-trade with offsets: Lessons from CER use in the EU ETS in 2008 and 2009* (Working Paper 2011-03). Paris: Climate Economics Chair of Paris-Dauphine University. Retrieved from www.chaireeconomieduclimat.org/wp-content/uploads/2011/02/11-01-19-Trotignon-Use-of-Offsets-in-the-EU-ETS-CEC1.pdf

UNDP. (2009). *The Clean Development Mechanism: An assessment of progress*. New York, NY: United Nations Development Programme. Retrieved from http://assets.mediaglobal.org/documents/UNDP_Environment_and_Energy_Group_Report_The_Clean_Development_Mechanism.pdf

World Bank. (2014). *State and trends of carbon pricing 2014*. Washington, DC: World Bank. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0Carbo040Box385232B00OUO090.pdf