WPS6613

Policy Research Working Paper 6613

Greening Global Value Chains

Some Implementation Challenges

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The World Bank
Sustainable Development Network
Office of the Chief Economist
September 2013

Policy Research Working Paper 6613

Abstract

The paper aims to highlight some of the most important implementation issues associated with the greening of global value chains with special attention given to how public policies and business strategies can support each other in meeting the challenge, particularly in developing countries. This requires a systemic view of global value chains that includes downstream supply chains and explicitly takes into account the relationships between regular members (raw materials providers, component manufacturers, and assembly plants, notably) and their clean-tech suppliers. It also involves a careful description of the business landscapes of global value chains as well as reliable environmental metrics and data, carefully examining how these can be shared among global value chain members and their stakeholders. Certain incentives must be set within member firms and throughout the supply chain and this involves reviewing managerial practices—monitoring and auditing of environmental performance, compensation and rewards, transfer prices, task design and allocation, decision making processes, employee selection and training, and organizational culture—and framing outsourcing contracts appropriately. To be effective, however, these initiatives need to be encouraged by credible national policies (which include environmental but also social policies targeting informal businesses) and international agreements, revealing disclosure programs, and a vigilant civil society. On a global level, the coordination of business and public policies is crucial as the greening of a global value chain will certainly work best if its members and stakeholders move in tandem.

This paper is a product of the Office of the Chief Economist, Sustainable Development Network, and the Green Growth Knowledge Platform. The GGKP (www.greengrowthknowledge.org) is a global network of researchers and experts identifying and addressing major knowledge gaps in green growth theory and practice. It was founded by the Global Green Growth Institute (GGGI), Organisation for Economist Co-operation and Development (OECD), United Nations Environment Programme (UNEP), and World Bank and includes more than a dozen multilateral organizations and research institutes. This paper was presented at the GGKP Annual Conference, 4–5 April, 2013 in Paris. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The lead author, Bernard Sinclair-Desgagné, may be contacted at bsd@hec.ca.

GREENING GLOBAL VALUE CHAINS: SOME IMPLEMENTATION CHALLENGES

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JEL Classification Numbers: F23, F64, H87, L22, Q58

Keywords : Global value chains, environmental goods and services industry, outsourcing, incentives

Economic Policy (EPOL)

[1] The author wishes to thank Nick Johnstone, Giuseppe Nicoletti and Ronald Steenblik for helpful comments and suggestions. All remaining imprecisions and other shortcomings are the author's sole responsibility.

1. Introduction

Environmental regulation has a relatively long history. In his pathbreaking book on technological innovation in the Middle-Ages, for instance, Gimpel (1975) tells of a Royal decree of 1307 forbidding the use of sea coal in the London area. This type of coal was extracted just below the surface of some seashore areas in Durham and Northumberland counties and was abundant in those days. Its energetic performance was rather poor by modern standards; its smoke smelled badly and entailed significant health hazards. However, substitutes to sea coal, namely charcoal or higher-quality coal coming from Scotland, were rather expensive. A special enforcement agency had therefore to be created, in order "to find out all individuals burning sea coal in the city or its surroundings, to impose large fines on them right away, and to destroy their ovens in case of repeated offense." Meanwhile, on the other side of the Channel, the French Parliament ruled on 7th September, 1366, that slaughter houses and tanneries be located on the Seine River downstream of Paris. Brewers were among the most vocal supporters of this decree, for slaughter houses and tanneries strongly degraded water, their main input. Each year then, about 250,000 animals were killed in Paris; tanning and butchering accounted for hundreds of tonnes of hazardous organic waste being thrown in the river. The new rule was thus well received by the population in general, although it affected negatively the production of slaughter houses and tanneries (which were crucial to virtually all urban economies in those days) by sensibly raising their transportation costs.

These stories illustrate three major points about environmental regulation. First, historically, the ability of governments to enforce environmental regulation on polluters was not an issue. Second, polluters' costs to comply with a ruler's decree could largely be ignored (within reasonable bounds, of course). Third, the willingness of targeted firms to move ahead in limiting pollution was not expected nor required.

Clearly, these features do not match the present economic setting. All over the world, employment, development and competitiveness have now become imperatives for any responsible government, so the ability of firms to preserve environmental resources while still prospering and creating jobs can hardly be overlooked. In addition, ***the globalization of business is now putting several polluting activities out of reach of regulators, so in order to deal with environmental problems effectively governments must refrain from coercion and share the task of managing environmental resources with business firms.***

Taking stock of this landscape, economists and business scholars started three decades ago to investigate how environmental concerns could shape business strategy and be taken care of across business units. Their contributions are summarized and appraised in Reinhardt (2000), Gabel and Sinclair-Desgagné (2000), Sinclair-Desgagné (2005), and Johnstone (2007), among others. Current research is now increasingly focusing on global value chains (GVCs), as these largely make up the basic context in which most firms operate nowadays.

Making a global value chain greener raises specific challenges.[2] Who are the participants in such a chain, how do they interact with each other, and how do they respectively and collectively affect the environment? What incentives should be set across the chain in order to foster collective environmental performance while maintaining individual competitiveness? How can the chain's members coordinate their actions effectively? This note's objectives are to briefly cover state-of-the-art knowledge on these questions, and to point out certain relevant considerations that have received little weight so far. In accordance with the Green Growth Knowledge Platform's intended outlook, special attention will be given to how public policies and business strategies can support each other in meeting those challenges, particularly in developing countries.

2. Getting the right picture

Like any practical goal, the greening of GVCs first relies on information. This section will accordingly consider the generic components of a GVC, the milieu in which its activities take place, and the extent of environmental data each entity should have or generate.

- **Who is involved?...**

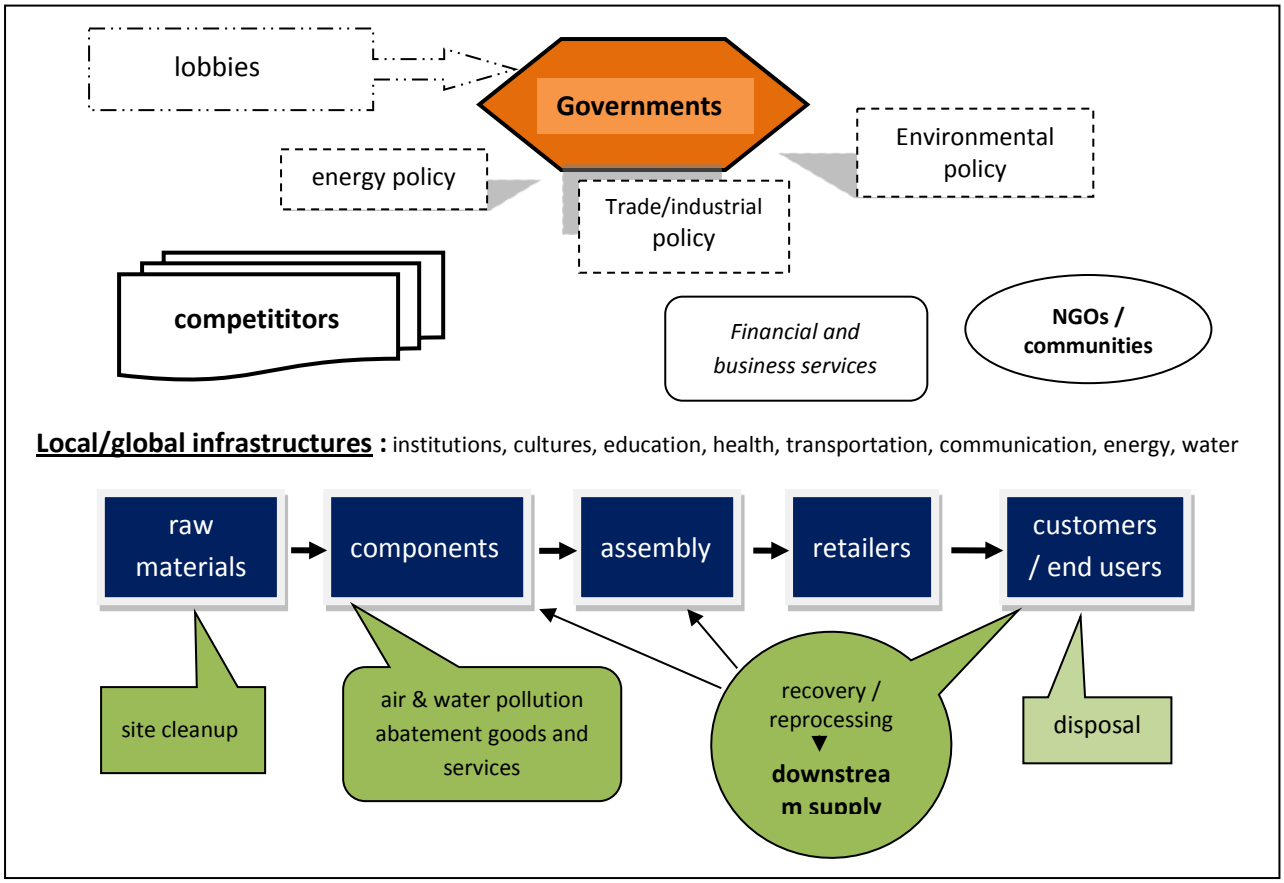
Building on Klassen and Vachon (2012), Abbey and Guide (2012) and the DCED (2012) document, Figure 1 provides a broad framework to consider greening a global value chain.

In most industries – electronics, automotive, agro-food, aerospace, etc. – the typical GVC is seen as a sequence of raw materials extraction, components making, assembly, retailing, and customer utilization and disposal. As far as production is concerned, these activities are *complementary*, so any constraint that is put on one of them will affect the others, be they located upstream or downstream. ***This calls for a systemic approach to greening supply chains.*** As Klassen and Vachon (2012, p. 269, 271) indicate: "(…) firms in a supply chain do not work in isolation; (…) greener supply chain management is defined as the strategic and transparent integration of material, information, and capital flows to achieve environmental and economic objectives through the systemic coordination of key inter-organizational business processes."

The considered system will naturally comprise a number of environmental tasks, for example: site cleanup, water treatment, air pollution abatement, cleaner production, resource recovery, refurbishment and manufacturing, and recycling. Nowadays, these tasks are often outsourced, in whole or in part, to specialized firms forming the so-called environmental goods and services (EGS) industry. Alas, this industry is often overlooked in environmental policy discussions. Some precisions on it seem therefore in order at this point.

[2] Global value chains are also transforming international trade, putting into question current trade data and the usual ways to assess trade policies. Taking on those issues goes beyond the scope of this paper. The interested reader may look at the recent studies by De Backer and Yamano (2012) and Van Assche (2012).

Figure 1. A general framework to consider greening a global value chain



In a landmark document published in 1999, the OECD and Eurostat jointly define the EGS industry as follows (OECD/Eurostat 1999, p. 9): "(…) the set of activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air, and soil, as well as problems related to waste, noise and eco-systems. These include cleaner technologies, products and services which reduce environmental risk and minimize pollution and resource use." Tables 1 and 2 below respectively provide data on revenues per segment and global trade flows for this industry. Many more figures and facts can be found in "EBI Report 2020" of Environmental Business International (2011), and in Durand and Sinclair-Desgagné (2012).

The EGS industry's global revenues totaled USD 858 billion in 2012. The United States and the European Union each account for 38% of this amount, Japan for 17%, China for 3,2% and India for 2,5%. Waste management, followed by potable water and wastewater management, were the most important activities, both in terms of income and employment. Despite the recent economic downturn, employment in EGS-related activities seems to have done rather well, with an increase of 3% from 2007 to 2008. The EGS industry now employs more than 1.7 million people and accounts for 2.7% of GDP in the United States and in Europe. International trade in environmental goods has also grown faster, on average, than trade in all merchandised products. Historically, developed countries have been net exporters of environmental goods and services, and developing countries net importers (Bahar et al., 2013). However, with the growth of exporters like Brazil, China and India, the trade is becoming more balanced.

Table 1. The global environmental market by segment (EBI 2011, p. 18-9)

Market Segment	2004	2005	2006	2007	2008	2009	2010	2011	2012
Equipment									
Water Equipment & Chemicals	52.0	54.2	56.4	59.3	63.2	60.7	62.5	65.0	67.6
Air Pollution Control	40.6	42.5	43.9	45.3	45.1	38.8	39.7	40.7	41.8
Instruments & Info Systems	7.6	8.2	8.6	8.9	9.3	8.9	9.2	9.6	10.1
Waste Mgmt Equipment	33.4	34.1	35.1	36.3	36.6	33.7	34.0	35.1	36.1
Process & Prevention Tech	3.6	3.7	3.9	4.1	4.4	4.5	4.5	4.6	4.7
Services									
Solid Waste Management	130.1	133.6	136.7	139.7	142.8	142.1	144.3	146.1	148.0
Haz Waste Management	21.4	21.8	22.2	22.6	22.9	21.7	21.5	21.7	21.9
Consulting & Engineering	36.1	38.3	40.1	41.7	45.2	44.7	46.8	48.2	49.6
Remediation/Ind'l Services	37.7	40.0	42.0	44.1	45.7	44.3	44.8	45.3	45.7
Analytical Services	4.7	4.8	4.9	5.1	5.3	5.2	5.3	5.4	5.5
Water Treatment Works	88.0	90.6	93.1	95.9	100.8	104.2	106.8	108.5	110.2
Resources									
Water Utilities	97.2	100.5	103.5	106.5	111.5	113.8	116.4	118.7	121.1
Resource Recovery	43.3	49.0	53.9	63.6	50.0	42.5	43.8	44.6	45.5
Clean Energy Systems & Power	30.5	40.3	59.2	76.9	99.1	111.0	123.3	136.1	150.2
Total	**626.3**	**661.4**	**703.5**	**749.9**	**781.9**	**776.2**	**803**	**830**	**858**

SOURCE: Environmental Business International, Inc., San Diego, Calif., units in US $bil revenues generated by private and public sector entities

Table 2. Global environmental industry trade flows (EBI 2011, p. 18-11)

By Region	2009 Market	Exports	Imports	Balance	Exports	Imports	2009 Industry
USA	292.1	40.5	27.5	13.0	13%	9%	305.1
Western Europe*	219.6	55.8	39.8	16.0	24%	18%	235.6
Japan	95.8	19.1	7.2	11.9	18%	8%	107.7
Rest of Asia	67.0	5.2	22.2	-17.0	10%	33%	50.0
Mexico	6.3	0.8	3.0	-2.2	18%	47%	4.1
Rest of Latin America	20.6	1.1	8.5	-7.4	8%	41%	13.3
Canada	19.7	2.8	3.1	-0.3	14%	16%	19.4
Australia/NZ	12.9	3.7	1.8	1.9	26%	14%	14.8
Central & Eastern Europe	15.0	0.9	6.2	-5.2	9%	41%	9.8
Middle East	18.5	0.6	7.4	-6.8	5%	40%	11.7
Africa	8.7	0.2	4.2	-3.9	5%	48%	4.8
Total	776.2	130.7	130.7	0.0			776.2

SOURCE: Environmental Business International, Inc., San Diego, Calif. units in $bil. *Note: each country within the region, not as a block: i.e. German sale to Italy is an export and an import

The above figures show a sizable and rapidly growing industry. ***A systemic approach to greener GVCs should clearly pay attention to firms in this industry and their relationship with producers, treating***

such firms as genuine members of the chain. This might turn out to be particularly important when attempting to 'close' the supply chain (Guide and Van Wassenhove, 2009; Abbey and Guide, 2012), which entails considering how products reaching the end of their useful life must go through the series of tasks – collection, inspection, sorting, disposal, reprocessing and recycling – that form the so-called downstream (or reverse) supply chain.

To be accurate and complete, however, one might have to also take into account those goods and services which are necessary for greening the supply chain but would be outsourced from firms that are not considered to be part of the EGS industry. The frontier establishing the EGS industry remains fuzzy, so many products that can be used in mitigating pollution (lime, for example) are often labeled as non-environmental (Steenblik et al., 2011). Furthermore, ***one should bear in mind that many greening activities, particularly those pertaining to the downstream supply chain in developing countries, are omitted from the above tables because they are actually carried out by some*** **informal** ***businesses***.

● … under what conditions?

Of course, GVCs do not operate in a vacuum, so certain contextual items deserve attention as well for their role in driving incentives and supporting coordination.

First and foremost, the legal and political institutions under which firms operate globally and locally will have a strong influence on their respective *business agenda*, with potential implications throughout the supply chain. Whether environmental regulation is properly enforced on firms in a given country, for instance, or ***whether certain activities carried out in the country lie in the*** **informal** ***sector, will have some bearing on the means firms located elsewhere can adopt to make the whole supply chain greener*** (see Johnstone, 2007, for some empirical evidence).

Other key background elements are the local employees' and populations' culture, and their education and health levels, which largely shape the way they put up with environmental issues. Transportation and communication infrastructures also matter for the environmental impact of a GVC, notably through their influence on the location of component manufacturers and assembly plants. The availability (ownership and price) of energy and water, finally, would normally determine individual firms' and GVCs' efforts to preserve these resources.

An additional key driver of firms' and GVCs' attitudes towards the environment is the character and strength of competition. A retailer whose advantage in a highly contested market rests in consistently proposing very low prices, for example, might turn out to be less receptive to selling greener but more expensive goods. Industry-specific standards, customers' attitudes, competitors' aggressiveness, and some suppliers' membership in several supply chains might slow or accelerate the adoption of greener practices (Klassen and Vachon, 2012). The empirical evidence presented in Johnstone (2007, p. 263) suggests that: "(…) facilities that saw competition on the basis of product quality as being more important than price competition [are] more likely to be environmentally proactive. (…) More generally, for solid waste issues, commercial and market conditions played a more important role than for air and water pollution, where policy influences were more important."

The agenda of GVC members is moreover conditioned by social pressure coming from non-governmental organizations (NGOs) and communities, as well as the active pursuit by some governments of energy, trade or industrial policies. The way certain policies are put to work can in turn have a decisive effect on buyer-supplier relationships and organizational structures (David and Sinclair-Desgagné, 2005; Sinclair-Desgagné, 1994).

Lastly, members of GVCs will rely on finance and other business services for funding, technical support, and advice. International business consultants can certainly help in spreading greener practices globally across national borders and supply chains. Lenders and insurers can also make a difference in controlling certain entities along the supply chain and sharing the risks of implementing process and product innovations.

● … and with what kind of environmental information?

Our description of a GVC would not be complete without addressing the matter of environmental information. ***Greening GVCs requires* traceability *and* transparency.** The former is necessary to track hazardous products and materials, allocate responsibilities and monitor environmental compliance. The latter is a precondition for achieving credibility, legitimacy, and fairness (which preclude green-washing, for instance, or shifting polluting activities to developing countries). This means each firm or plant in a GVC should be gathering and sharing data about environmental risks and impacts.

One hurdle here is that environmental information may not be comparable across firms and countries. This challenge has led to the development and promotion of standards, such as EMAS and the ISO 14000 norms, on how to conduct life-cycle assessment (LCA) and environmental audits. Other methods such as ecological foot-printing, eco-efficiency analysis, material flow analysis (MFA), SA 8000, and input-output analysis (IOA) are also available (Lifset and Boons 2012). As Klassen and Vachon (2012, p. 285) concede, however: "(…) research and practice must converge to develop rigorous environmental accounting systems that track a small number of key environmental metrics in supply chains, likely subject to impartial third-party audits." Governments and business associations can play a major role in achieving this, both directly through research grants, and indirectly through fostering environmental labeling, certification to standards such as Fairtrade in agricultural products and the Forest Stewardship Council (FSC) in harvesting timber, and encouraging participation in programs like the Global Reporting Initiative (GRI), the Toxic Release Inventory (TRI) in the United States, and the Regulation, and Evaluation and Authorization of Chemicals (REACH) in the European Union, so as to create demand for ***environmental accounting***.

Another obstacle to gathering and sharing environmental information is that ***many firms, particularly small and medium enterprises, may lack the necessary technology and expertise to collect and manage environmental data as it should be.*** To deal with this, large firms like Casino, a French food retailer, and Dupont-Pioneer, a seed maker, have developed ***simplified versions of LCA*** that they now convey respectively to their suppliers and customers.[3] Government subsidies to professional training, and its support (via public procurement, for example) of the analytical services

[3] There are clear advantages to the simplification of LCAs, but also disadvantages. One of the disadvantages is that some simplified versions might ignore the carbon footprints of capital goods used in production, thereby favouring capital-intensive producers in developed countries over many ones in developing countries.

and consulting & engineering segments of the EGS industry, might also contribute to making environmental data collection more widespread and affordable.

No entity within and around a GVC should be expected to know everything about everyone, of course. This would hardly be possible anyway, due to the presence of proprietary information and communication costs. The parties involved in greening a GVC will then be asymmetrically informed. This brings about incentive issues that we now turn to.

3. Setting proper incentives

Motivating heterogeneous entities endowed with differential information and diverging preferences towards a common goal is a generic challenge of any organization. As far as GVCs are concerned, this task must be jointly undertaken at the firm, supply chain, national and global levels, through managerial means and processes, buyer-supplier relationships, government regulation and global governance.

3.1 Within firms

Gabel and Sinclair-Desgagné (2000) highlight and discuss several managerial instruments that firms – large or small, formal or informal – can use internally to foster compliance with environmental objectives. These instruments include performance rewards, monitoring and auditing of nonfinancial objectives, task design and allocation, decision-making processes, employee selection and training, and improving the firm's culture. Large divisional corporations can also add transfer prices to this list.

▪ *Performance rewards*

According to Avila and Whitehead (1993), Dow Chemical's performance improvement review had a number of elements – among which environmental performance – built into its bonus scheme for employees. Whether such a scheme was optimal, however, is another question. ***Incentive pay is a double-edge sword: it can work very well in some contexts, but lead to disaster in others.***

An important feature to be dealt with here is that asking an employee to meet new environmental objectives amounts to expanding her usual agenda. Serious environmental programs being broad and complex, this might expose her to *informational overload*. Returns to extra managerial effort might then decrease rapidly, and the fate of the firm might end up resting on dangerous but time-saving habits, misleading but convenient heuristics, and deficient but cosmetic problem solving.

In addition to the threat of informational overload, it might be difficult to *balance incentives* between the pursuit of regular business activities and the reduction of environmental externalities. In a classical article on the subject, Holmstrom and Milgrom (1991) explain that:

> (...) when there are multiple tasks, incentive pay serves not only to allocate risks and to motivate hard work, it also serves to direct the allocation of the agents' attention among their various duties. (...) the desirability of providing incentives for any one activity

> decreases with the difficulty of measuring performance in any other activities that make competing demands on the agent's time and attention.

Since linking environmental results to a manager's specific effort can be relatively hard, particularly when considering long-term environmental risks, the upshot might then well be an overall reduction of incentives on some legitimate (and easier to appraise) business functions. This might create a dilemma for the firm, unless of course a compelling business case can be made for the achievement of environmental objectives.

▪ *Monitoring and auditing*

Over the last two decades, the practice of monitoring and auditing environmental activities has spread among business firms. In small or informal enterprises, such appraisals will be mostly holistic and subjective. In large corporations, they have often become standardized, owing to the introduction of international norms and techniques (ISO 14010, EMAS, etc.). An obvious benefit of these practices is the careful review of the firm's management of environmental resources – a necessary condition for greening its operations.

The information obtained could also feedback on incentives. As it was expressed early on in The Economist (8th September, 1990), "Audits allow chief executives to set goals for subsidiaries: get your reported emissions down to such-and-such level, or lose a bit of your bonus." Gabel and Sinclair-Desgagné (1999), moreover, have proposed the following scheme in order to overcome the above dilemma and reconcile typical business duties with environmental assignments.

> Let the common business activities be routinely monitored, as they usually are, and suppose that environmental activities are audited when business-as-usual performance is high. Furthermore, let the manager be penalized if an audit finds that environmental performance is below expectations, but make the manager's average compensation greater when there is an audit than when there is none.

Clearly, a manager subject to this kind of scheme will seek to be audited. She will then work harder on the regular business activities in an attempt to boost results and trigger an environmental overview. But since there is little benefit in doing this if the environment was neglected, she will also pay due attention to environmental goals.

▪ *Transfer prices*

For the same reason that governments can impose taxes on polluting emissions, a large divisional firm could adjust the internal or transfer prices its divisions are using when they trade goods with each other, so that such prices incorporate the costs of environmental damages. Several companies have employed this means to improve their environmental performance. A European chemical manufacturer, for example, is imputing all measured environmental costs (like the legal fees incurred or expected and the insurance premia charged) to the responsible products and processes. With their product margins altered in such a way, division managers' incentives to trade environmentally friendlier goods increase.

▪ *Task design and allocation*

Holmstrom and Milgrom (1991) recommend that activities which are easier to monitor and those which are harder be assigned to different people subject to respectively strong and weak monetary incentives. The intuition goes as follows. Greater financial incentives tend to be associated with activities that are more accurately monitored. When a manager is made accountable for two activities, one of them easy to appraise and the other not, she might then be induced to give too much attention to the former at the expense of the latter. It would be preferable in this case to assign each activity to a different person.

Since the appraisal of environmental activities is often difficult, this suggests that ***regular profit-and-loss objectives should remain the responsibility of a specific employee with strong incentives, while caring about environmental impacts should be assigned to another one*** with a fixed salary. This advice actually matches some commonly observed business practices. Firms often have employees with profit-and-loss responsibility working under strong incentive salary plans based on financial metrics, while others dealing with environmental matters get salaries independent of operating profit.

▪ *Decision making processes*

Decision-making is often centralized in order to control people's behavior. For example, a European firm in the agrochemical business recently set the following standardized operating procedure: some specified pesticides should not be sold into certain markets and to specific buyers, unless the company is assured that they would be used safely.

In a related context, Beckenstein and Gabel (1985) have analyzed a situation wherein managers' decisions are made under uncertainty about their legality and probability of prosecution. The firm can then affect the quality of those decisions in two ways. It may ***provide better information*** to employees and monitor what they do. Alternatively, it may centralize decision-making, either by having key decisions be taken at higher hierarchical levels or by imposing predefined ***standard operating procedures*** that lower an employee's discretion. Both avenues reduce the probability of non-compliance, but their respective costs are quite different. Information and monitoring lessen the likelihood an employee violates the law *and* overlooks good prospects, while centralization decreases further the probability of the first mistake but raises the chances the second one happens.

Leadership also seems indispensable to implement a firm's environmental strategy, as the basic arguments underlying such a strategy often appeal not to people's greed or fear but to their sense of fairness towards future generations (Blais and Sinclair-Desgagné, 2002). Leadership – good leadership – allows leaders to economize on planning, structure, and control. For it harnesses the intrinsic motivation of individuals rather than relying on explicit contracts: people then derive their satisfaction from endorsing and working along their leader per se, not just in reaction to explicit carrots and sticks.

▪ *Employee selection and training*

In addition to making their technology and physical capital friendlier to the environment, firms may also invest in 'greening' their human capital. More than two decades ago, the so-called 'Winter Model' (Winter 1988) described several means to be used by firms in order to enhance their employees' ability to cope with growing environmental pressure. These include staff motivation and in-house training, selective promotions and recruitment, appropriate working conditions, and even environmental counseling for employees' households.

Employees will be interested in their firm's environmental performance if they are themselves environmentally concerned and if they have a stake in the company's future. The former is enhanced through environmental awareness, the latter through in-house firm-specific training.

▪ *Improving organizational culture*

Seeking a green organizational culture, finally, has often been invoked as an indispensable means, particularly in some industries – like the chemical or the waste management industries – that must cope daily with the risk of deadly accidental pollutions. A firm's policy statements are necessarily broad and do not explicitly recognize all possible contingencies. What an autonomous employee should do in particular circumstances is therefore often suggested by the firm's history and current atmosphere (what we call here 'organizational culture') rather than by explicit rules or contract clauses. ***It is indeed the role of a firm's culture to complete policy intentions with a consistent mindset.*** Having a strong internal culture in line with its objectives allows a firm to economize on control of its employees and communication to other stakeholders.

3.2 Within chains

The above-mentioned managerial systems can also be implemented (with some adjustments, of course) at the chain level. Additionally, outsourcing allows somewhat more freedom in selecting and terminating business relationships, framing buyer-supplier contracts, and using market incentives.

▪ *Selecting and terminating business relationships*

Downstream companies that commit to greener practices can select or terminate their procurement relationships accordingly. Doing recurrent business with such companies will normally give their suppliers strong incentives to satisfy their desiderata. De Marchi (2011, p. 76) reports, for instance, that:

> IKEA developed a Code of Conduct, IWAY – the IKEA Way on Purchasing Products, Materials and Services – that summarizes its environmental and social requirements. (…) In order to make business with IKEA, potential suppliers have to comply with pre-conditions indicated in IWAY that, as far as environmental conditions are concerned, requires the prevention of severe environmental pollution and safety hazards. (…) IKEA does not require suppliers to environmentally upgrade all of a sudden, but employs

> rather a stepwise approach, starting with requests of minimum environmental (and social) conditions (…). Even if not automatically, non-compliance to IWAY and the subsequent action plan co-developed with IKEA auditors, will eventually end up with termination of business, even if all other aspects such as cost and quality are met, as happened with 10 suppliers in 2009, the 19% of the overall cessations globally.

In small or medium-sized downstream enterprises, organizational culture and leadership will likely substitute for explicit standards.

▪ *Designing effective contracts*

The argument that contract framing can have an impact on value creation was recently made by Weber and Mayer (2011). They use the terms 'prevention frame' and 'promotion frame' to denote 'minimalist' and 'maximalist' frames respectively. In their own words (p. 54):

> A prevention frame leads to an interpretation of a goal as minimal (something that must be met), which induces high-intensity negative emotions if the goal is not achieved and low-intensity positive emotions if the goal is met. (…) Conversely, under a promotion frame, parties view the same goal as maximal (something that would be ideal if reached). If a maximal goal is missed, low-intensity negative emotions are experienced, whereas if a maximal goal is reached, high-intensity positive emotions are induced. Thus, in an effort to reach the maximal goal and avoid sins of omission, parties display more flexible and creative behavior.

Clearly, ***promotion frames agree better with the objectives of greening GVCs and fostering green innovation.*** Within such frames suppliers are more likely to consider offering *'augmented' products* (a suggestive term introduced in industrial marketing by Lindgreen and Wynstra, 2005) that systematically deliver beyond the buyer's expectations.

▪ *Taking full advantage of market incentives*

Market competition can also constitute a powerful means to make GVCs greener, particularly when dealing with suppliers of abatement goods and services.

The sheer number and diversity of EGS producers makes it likely that several firms will be capable of delivering the appropriate means to meet an environmental target. Making them compete for a contract is thus a smart thing to do. Not only will this keep costs under control, but it will harness the EGS suppliers' diversity and creative potential. Recently, for instance, a U.S.-based chemical plant that needed to control its volatile organic compounds (VOC) and odor emissions launched a *bidding process*. After a thorough technical evaluation of the received proposals, it selected a consulting engineering firm and had a customized catalytic oxidization system installed. Not only did the firm benefit from the ongoing destruction of VOCs and odors – in compliance with regulations and

corporate environmental objectives – but the changes also helped reduce operation and maintenance costs.[4]

Firms producing for GVCs that need pollution-abatement technologies should note, furthermore, that market competition gives suppliers of such technologies a strong stake in creating value for their customers. Since the 1990s, environmental regulation has relied more and more on market instruments (such as tradable permits) instead of command-and-control mechanisms. Initially, this trend led to a crisis in the EGS industry because clean-tech suppliers could no longer assume that regulation would always force polluters to use pre-identified abatement goods and services. Some trade associations and consultants then recommended working at preventing polluting emissions instead of just delivering end-of-pipe remedies. This, they said, would lead to a reassessment of a customer's whole operations, revealing new ways to enhance its competitiveness. ***By helping out their clients in the competitive game, clean-tech suppliers would make them prosper and create the conditions for their own expansion.*** Box 1 presents three illustrative cases of this.

Such a new mindset suggests that pollution abatement suppliers have switched from a 'goods logic' to a *'service logic,'* meaning that they now place their clients' core activities at the heart of the transaction. Grönroos (2010, p. 2) defines the two logics as follows:

> According to a traditional manufacturing approach, following what could be labeled a *goods logic*, the supplier, for example producing and selling a production machine, would concentrate on how well the machine fits the customer's production process – on what can be called *operational efficiency*. (…) It remains the responsibility of the customer to make sure that it can make effective use of the resource so that value can be created out of the resource purchased.
>
> A service business, i.e. a firm that has adopted a *service logic*, would take a much further-reaching responsibility for a customer's everyday practices and how they ultimately support the customer's business. (…) The core customer process (e.g. a production process) is supported by the core of the supplier's market offering (e.g. a production machine), whereas the customer's business is supported by the entire extended offering, including the machine and support to other customer processes important to the business.

A key challenge now is to sustain this frame of mind. As the previous paragraph suggests, regulators will play a key role here.

Box 1. Three cases of polluter-abater value-creating relationship

● A commercial bakery in California, *Gold Coast Baking* of Santa Ana, wanted an emission abatement system that would make its new production line comply with VOC emission regulations. The company then asked its abatement supplier to build a catalytic oxidizer as *an integral component* of the new bakery oven. The unique design – incorporated as part of the operation process, not as an end-of-pipe

[4] This example and those presented in Box 1 are extracted from the case studies conducted by the Institute of Clean Air Companies (ICAC), a nonprofit U.S. association of firms working in the control and monitoring of stationary-source air pollution.

system – resulted in substantial time and money savings. For instance, making the heat circulate into the oven eliminated the need for an additional heat exchanger and lowered fuel consumption by 25%.

● Engineers at a major manufacturing plant in California needed to replace a faulty wet venturi scrubber operating on a waste-wood-fueled boiler. They wanted a system that would drastically lower flyash output, operate efficiently on the variable fuel, and resist fires. This system had to be engineered, fabricated and installed within eight months. The company looked at various ways it could clean the stack emissions generated by its fixed-grate stoker boiler, including fabric filters and dry electrostatic precipitators (ESP). A pilot study conducted on site by a control technology supplier, however, convinced the manufacturer that a wet ESP would meet their requirements. Thanks to the acquired information, the supplier then designed, engineered, and installed an air pollution control system that is keeping emissions well below current regulatory thresholds. The company thereby ensured to maintain a competitive edge over other manufacturers as regulation becomes tighter.

● A manufacturing company selling an array of flexible packaging to customers across the U.S. needed to control its VOC emissions and treat a wide range of solvents (its plant was located in a residential section of town with a hospital across the street). Its 15-year-old carbon-bed recovery system required a lot of maintenance work and consumed a large amount of fuel. The system also yielded unrecyclable solvents that resulted in significant monthly disposal fees. In addition, the restricted solvent diet that the system could handle was limiting manufacturing flexibility. To address the problem, a regenerative thermal oxidizer (RTO) was built offsite and trucked to the packaging facility in close collaboration with engineers from an industrial equipment installation firm. Stack testing of the installed oxidizer produced an actual destruction efficiency of 98.9% - more than enough to satisfy the regulatory agency. Compared to the old solvent recovery system, the new system eliminated disposal fees and brought important savings in operating costs, with fuel consumption reduced by 80%. The RTO also eliminated the need for 9,000 pounds of water previously used for daily steam downs. Finally, the plant has been able to put the people in charge of the old solvent recovery system maintenance back into
value-adding activities. By considering its cleantech supplier a partner rather than some arm's-length dealer, this company was able to convert environmental compliance into a process of value creation.

Source: Author's reading of the Institute of Clean Air Companies (www.icac.org)'s website information

3.3 Within national borders

While public pressure and the activism of environmental NGOs are certainly growing, ***governments still remain the main source of incentives to protect the environment within national jurisdictions.*** Some environmental public policies – taxes, technology standards, inspections, legal liability, etc. – will significantly influence the efforts individual firms and branches of GVCs situated on national territory will devote to pollution prevention and the reduction of environmental risks (Johnstone, 2007).

As suggested in the introduction, ***in order to succeed nowadays, environmental public policy first needs to be endorsed (if not led) by industry***. Table 3 below lists a number of government actions (beyond coercion) that might enhance the individual and collective participation of business firms.

Table 3. Institutional arrangements for firm-government collaboration

GOVERNMENT						
Method of ensuring participation:	Coersion	Pressure	Persuasion	Encouragement	Facilitation	No involvement
Concrete action:	Informs	Consults	Co-operates	Advises	Monitors	Observes
Implementation responsibility of:	Examples:					
Each individual or firm	Government sets an environmental standard with little or no prior consultation with affected firms.	Government holds public hearings before setting a standard.	(Rare, because of high transaction costs.)	Government establishes "best practice" guidelines.	Government provides standard format for firms to report on activities.	Individuals engage in unreported voluntary activities.
			Voluntary, co-operative action by industry			
Groups of individuals or firms (collectively)	Government sets total emission quota for industry, which then allocates firm-level quotas.	Industry negotiates a formal covenant with Government obliging the former to achieve a specified level of performance.	Government and industry agree to share responsibility in implementing programme.	Government provides advisors to work with voluntary groups within industry.	Association collects information on members' activities and reports to Government.	Groups engage in unreported voluntary activities (*e.g.*, establishing code of best practice).
INDUSTRY						
Concrete action:	Is informed	Advises	Co-operates	Consults	Informs	Self regulates
Legal obligation:	Compulsory	Semi-compulsory		Co-operative		Non-compulsory

Source: OECD (1998), p. 13.

One policy that clearly stands out as explicitly targeting GVCs and promoting reverse supply chains is extended producer responsibility (EPR), which holds producers responsible for the costs of managing their products at end of life. In many developed countries, consumer electronics, home appliances, tires, and even cars are subject to such a policy. Its implementation can be mandatory, negotiated or voluntary; it might involve taxes on purchases and return subsidies.[5]

An important point here (which is generally ignored, however) is that ***the way policies are set influences not only the size of the market for environmental remedies but also the price-elasticity of demand for abatement goods and services*** (David and Sinclair-Desgagné, 2005). A polluting firm subject to a mandatory standard, for instance, will be less sensitive to the price charged by its providers than if it can choose between paying some extra fee versus further lowering its waste by acquiring certain technologies. It follows that an oligopolistic EGS industry will typically use its market power to charge higher markups under the former policy than under the latter. The choice and design of environmental policy instruments can thus affect significantly the prices of environmental goods and services, hence the resulting profits of clean-tech suppliers. On the one hand, prices that are too high will hamper polluters' competitiveness (while possibly making the goals of environmental policy unachievable in the first place); on the other hand, prices that are too low will deter entrepreneurship and innovation within the EGS industry.

[5] For a thorough discussion of how EPR policies are implemented in different countries using various instruments, see the OECD (2004) study cited in the bibliography.

This said, many non-environmental public policies could also affect the relationship between polluting firms and their clean-tech suppliers within GVCs. This is obviously the case for policies that focus on infrastructures (as defined in Figure 1). Additionally, since the production of environmental goods and services increasingly matters for environmental protection, employment and international trade, several governments (notably in Europe, the United States, China and India) are now actively and openly promoting their national EGS industries. When these initiatives consist in non-discriminatory and enabling measures, such as public funding of environmental R&D, the economic intelligence necessary to identify and enter foreign markets, the design of public procurement, the advent of business alliances and partnerships between private firms and public research institutes, and the availability of venture capital, they will encourage entrepreneurship and competition in the EGS industry.[6]

Taking stock of the examples of the previous section, ***competition should be further managed in such a way that value creation (more than regulation) continues to be essential for survival in the EGS industry***. Subsidies and programs inviting new participants in downstream supply chains certainly go in the right direction and should be pursued, if not incremented. At the same time, *competition policy* must apply vigorously to the EGS industry, considering the growing market concentration in certain segments (in the solid waste treatment and air pollution abatement ones, notably). ***Regulatory uncertainty should also be lowered as much as possible***: by increasing the initial capital necessary for a firm to self-protect against future rules, it generates significant entry barriers for new entrepreneurs. Rarely mentioned but as important for the expansion of cleantech activities would be ***governmental actions aiming at countering corruption*** (which often plagues the construction sector and solid-waste management in certain countries). This would not only benefit the environment by improving compliance with rules and regulations, it will also foster professionalism and expertise in the delivery of environmental goods and services.

As stressed in the DCED (2012) report, finally, some ***government interventions in the social sphere*** could help lift certain impediments to greening GVCs, notably in developing countries. Two illustrative examples, having to do with ***fostering inter-generational property transfers and re-training***, are given in Box 2. Policies seeking to ***harness informal entrepreneurship, particularly the informal businesses which seem to prevail in the downstream parts of GVCs in low-income countries,*** might also be beneficial. Government intervention here faces a dilemma, however (Sinclair-Desgagné, 2012). On the one hand, the informal sector often constitutes a testing and training ground for innovative or inexperienced entrepreneurs, so they can increase their skills, confidence and knowledge. On the other hand, informality may not allow a talented entrepreneur to achieve his or her full potential. After reducing red tape and enforcing property rights, public authorities might therefore concentrate on result-enhancing measures (such as product take-back policies) rather than coercive actions aiming to deter all informal business.

[6] In certain countries, unfortunately (notably in the renewable-energy segment), government support has rather served the interests of well-connected firms (see the recent study by Bahar et al., 2013).

Box 2. Two cases of social policies that would foster greener supply chains

● **Greening the global cocoa chain, Ghana**: One of the underlying root causes for low productivity of cocoa and hence deforestation has been identified to be the land tenure system. Due to earning only a share of the profits, neither the owner nor caretaker have enough incentives to increase productivity. Facilitating inter-generational contracts to give young people access to land, combined with modern organic farming, enterprise and skills development would attract young people to engage in the current low-productivity cocoa sector. Additionally this would alleviate rural-urban migration. Slash and burn methods practiced by older generations would cease due to intensification and productivity increases. Additional income could be generated from economic diversification into cocoa honey, eco-tourism, carbon credits and other food and cash crops, so as to ensure a sustainable global value chain for the multinational chocolate sector.

● **The national dairy value chain with a green lens in India:** Cow dung drives a shadow economy of national importance employing, most informally, half the number of workers in the dairy sector. While a buffalo can produce up to 15 litres milk daily, it also produces 30 kg of dung, equivalent to 3 litres of crude oil. Due to its high energy and nutritional value, dung is used for the production of biogas, electricity and fertilizer. The full integration of dung into a 'Dairy Dung-Energy' policy could foster socioeconomic development, providing basic energy needs and helping tackle key dairy quantity and quality bottlenecks in India, though increased income and biogas sterilization. Throughout India a total of 1.9 million additional full time jobs could be created. Though 400 000 jobs might be lost in low-productivity dung cake making, with the right just transition policies in place for those affected – mostly women workers making dung cakes – they could be retrained and re-employed in the production of organic fertilizer from the slurry of the biogas plants.

Source: DCED (2012)

3.4 At the global level

Like the incentives provided by national governments, those set at the global stage are meant to enhance firms' and GVCs' efforts to become greener. To be sure, an additional objective would be to ***dissuade arbitrage between jurisdictions and environmental dumping across countries.*** The available means to do so include:

► ***International environmental agreements***, like the *Basel Convention on the control of transboundary movements of hazardous wastes and their disposal*. The aims of this Convention are: "(i) the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous waste, wherever the place of disposal; (ii) the restriction of transboundary movements of hazardous waste (…); and (iii) a regulatory system applying to cases where transboundary movements are permissible." It is noteworthy that some programs in the Convention seek to provide advice and training to firms and governments. Between 2003 and 2008, for example, the Mobile Phone Partnership Initiative developed complete guidelines for the management of obsolete mobile phones, which are being used in the concerned GVCs.

► ***Agreements aiming to lift tariff and non-tariff barriers to trade in environmental goods and services***, following paragraph 31(iii) of the Doha Development Agenda and the recent APEC initiative on trade in environmental goods. This would contribute to set the right competitive landscape for value creation in the EGS industry.

► ***Green technology transfers***, which can be enhanced, for instance, by treaties such as the Clean Development Mechanism of the Kyoto Protocol (Glachant, 2013).

► ***NGOs***, which have undeniably emerged as key players in global governance, acting as watchdogs of multinationals and their suppliers. Previous campaigns by NGOs against some multinational firms (for example, Greenpeace's campaign against Nestlé for using palm oil produced without regard for rain forests) have turned out to be quite costly to the latter. Acknowledging this threat, several business firms (such as Lafarge, a cement and concrete producer) have entered strategic alliances with environmental NGOs (the World Wildlife Fund, in this case), seeking thereby to prevent damaging campaigns and make their commitment to greener processes and products credible and effective.[7]

► ***Disclosure programs and worldwide media***. Such programs are illustrative of the so-called 'third wave' of environmental regulation, which followed the successive command-and-control and market-based approaches (WRR, 1992; Tietenberg and Wheeler, 2001). Since many firms – global firms in particular – value their public image, mandatory, voluntary or third-party disclosures provide additional incentives for improving environmental results. In certain developing countries, moreover, they have been found to reinforce regulatory institutions.

But what chiefly matters at the global stage is also the effective co-ordination of initiatives within GVCs and between governments.

4. Moving jointly and effectively

Considering the world's variety of local institutions, standards of living and environmental issues, ***it would be neither possible nor even efficient to adopt and enforce the same norms and regulations simultaneously and everywhere.*** Yet, the systemic approach which seems indispensable in order to green GVCs requires the unfailing involvement of all stakeholders.

Given that GVCs are often headed by some leading firm, one proposal is to first start by incentivizing these firms. In consumer-oriented chains, such a firm will be a major retailer (such as WalMart or Toys R' Us); in producer-oriented chains, it will be a large manufacturer (such as Lenovo or Embraer). Thereafter, this firm could play a key role in coordinating efforts to become greener, through product design and specifications, the codification of business processes, supporting audits, knowledge transfers, co-innovation, etc. (De Marchi 2011). The ultimate governance structure will depend on a number of factors listed in Table 4.

[7] There have been a few bad cases of NGO-multinational alliances, however: for example, the one between the Sierra Club and Clorox (a household cleaning-products manufacturer), which was essentially motivated by funding, led to a strong backlash.

Table 4. Governance structures for the greening of value chains

	Standard-driven	Relational-driven
Lead firm's main tools	Standards & certifications, supplier selection, (supplier development)	Design, (supplier development)
Prevalent interaction	Monitoring and controlling, (supporting)	Cooperating on innovative activities, (supporting)
Intensity of co-innovation	Low	High
Monitoring mode	Formal	Informal
Supporting mode	Formal	Informal
Suppliers' costs	(Machinery & equipments), managerial	(Machinery & equipments), R&D
Suppliers' incentives	High volumes, (learning), (secure demand)	Reputation, (learning), (secure demand)

Source: De Marchi (2012), p. 108

Since firms that currently lead GVCs most often originate from developed countries, this puts specific responsibilities on these countries' regulators to move ahead in promoting greener supply chains. The downside, however, is that this might prevent smaller firms, notably (but not exclusively) in developing countries, to innovate on their own, and provide dominant firms with yet another way to secure their dominance. This brings us back to the matter of incentives, and the role national and global regulations, competition between GVCs, and pressure from environmental NGOs can play in eluding this outcome.

5. Concluding remarks

This paper covered what we deem to be the most important implementation issues associated with the greening of global value chains.

First of all, one must have the right picture. This calls for holding a systemic view of GVCs which includes downstream supply chains and takes explicit account of the relationships between regular producers and their (formal or informal) clean-tech suppliers. This also necessitates a careful description of a given GVC's business landscape. One finally needs reliable environmental data and metrics, and must examine how these are shared between GVC members.

Secondly, incentives must be set right, both within member firms and throughout the supply chain. This involves reviewing managerial practices, framing outsourcing contracts appropriately and, as far as the procurement of cleaner technologies is concerned, considering approaches beyond those that routinely apply end-of-pipe solutions. To be most effective, however, these actions need to be supported by credible national policies (which include environmental but also social policies targeting informal businesses) and international agreements (concerning in particular the transboundary

movements of waste, the trade liberalization of environmental goods and services, and technology transfers), revealing disclosure programs, and a vigilant civil society.

Finally, the greening of GVCs will certainly work best if members and their stakeholders move in tandem. This does not mean that all firms and nations should simultaneously adopt and enforce the same blueprint. Effective co-ordination towards greening a GVC can often be achieved by relying on a well-motivated, able and closely watched leading firm.

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