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1. INTRODUCTION

Global value chain (GVC) analysis is an analytical tool that has been widely used, especially in the past decade, to explain the dynamics of economic globalization and international trade. It is based on examining discrete 'value chains' that are explicitly governed, to different degrees, by one or more groups of 'lead firms'. Value chains represent the full range of value-adding activities that firms, farmers and workers carry out to bring a product from its conception to its end use and beyond. In development studies, GVC analysis has been employed to understand the wide variation of benefits accruing from participation in different value chains and end markets. Overall, this literature suggests that while participation in GVCs can offer handsome rewards, these may come at a high cost in terms of increased risk and greater vulnerability. Two analytical issues have attracted particular attention in development studies-oriented GVC analysis: how upgrading takes place along GVCs; and what types of GVC governance are more likely to facilitate successful upgrading.

In GVC analysis, the term *upgrading* has been used to highlight paths for developing country producers to 'move up the value chain'. The upgrading process is examined through the lenses of how knowledge and information flow within value chains from lead firms to their suppliers (or buyers) (Gereffi, 1999; Gibbon & Ponte, 2005), sometimes in combination with horizontal interactions in clusters (Humphrey & Schmitz, 2002; 2004; Giuliani,

Pietrobelli & Rabellotti, 2005; Murphy, 2007). A recent literature has also been exploring the interactions between economic and social upgrading (Barrientos, Gereffi & Rossi, 2011; Rossi, 2013) and between economic and environmental upgrading (De Marchi, Di Maria & Ponte, 2013). Due to space limitations, we will focus on economic upgrading in this article.

The concept of *governance* in GVC analysis is based on the observation that value chains are rarely coordinated spontaneously through market exchange (Gereffi, Humphrey & Sturgeon, 2005; Gibbon, Bair & Ponte, 2008; Ponte & Sturgeon, 2014). Instead, they are governed as a result of strategies and decision-making by specific actors, usually large firms that manage access to final markets, but also at regional and national/local levels. GVC governance analysis highlights the practices and organisational forms through which a specific division of labor between lead firms and other actors arise and is managed. So far, GVC analysis has focused mainly on governance mechanisms internal to the value chain, treating the institutional framework (including state regulation) within which these value chains operate as 'background'. In this article, we continue a focus on internal governance mechanisms and how they relate to upgrading trajectories. At the same time, we also highlight the role that regulation and public sector support can play in facilitating upgrading. In separate work (Jespersen et al., 2013), we examine a wider set of institutional framework actors and factors[1] and how they interact with value chain governance.

In the rest of this article, we analyze selected aquaculture value chains originating in Bangladesh, China, Thailand and Vietnam and terminating in the EU. Aquaculture is one of the fastest growing agro-food sectors globally – a phenomenon often referred to as 'the Blue Revolution', following an eponymous article in The Economist (9-15 August, 2003).[2] The four selected Asian countries are among the top ten world producers. The EU, together with the US and Japan, is a top import destination. In Section 2, we expand the discussion on upgrading and governance, laying out our analytical approach. In Sections 3 and 4, we

provide some background analysis of aquaculture and discuss our methodology. In Section 5, we examine the upgrading trajectories we observed in aquaculture value chains for the selected countries and species. In Section 6, we examine what aspects of GVC governance can help explain these upgrading trajectories – including types of predominant coordination mechanisms, and types of lead firms and related levels of driving. In Section 7, we reflect on the role of domestic regulation and public sector support in promoting upgrading, before turning to a set of conclusions in Section 8.

2. UPGRADING AND GOVERNANCE

The GVC literature has developed a well-known classification of (economic) upgrading based on four categories (Humphrey & Schmitz, 2002; Schmitz, 2006): (1) *product upgrading*: moving into more sophisticated products with increased unit value; (2) *process upgrading*: achieving a more efficient transformation of inputs into outputs through the reorganisation of productive activities; (3) *functional upgrading*: acquiring new functions (or abandoning old ones) that increase the skill content of activities; and (4) *inter-chain upgrading*: applying competences acquired in one function of a chain and using them in a different sector/chain.

Initially, GVC scholars expected that developing country firms would follow a 'high road' to upgrading, one eventually leading to performing functions in a value chain that have more skill and knowledge content (functional upgrading) (Gereffi, 1999). But much of the more recent literature has highlighted a more complex set of upgrading (and downgrading) trajectories (Gibbon, 2001; Giuliani, Pietrobelli & Rabellotti, 2005; Schmitz, 2006; Gibbon & Ponte, 2005; Ponte & Ewert, 2009; Mitchell & Coles, 2011; Cattaneo; Gereffi & Staritz, 2013).

In order to provide more nuance to the established upgrading trajectories, our analysis in this article is based on two points of departure: (1) analyses of *product upgrading* should include effects on product quality that do not necessarily lead to higher value added; conversely, there may be strategies related to the product itself (forward contracts, volume premia) that can have beneficial effects without changing anything in the nature of the product itself; and (2) *process upgrading* needs to include 'improved' practices that do not necessarily make processes more 'efficient', but that can allow developing country players to improve their position in value chains or even just maintain it in periods of restructuring. These include: matching strict logistics and lead times (time-to-market), delivering supplies reliably and homogeneously time after time (a major challenge in agro-food products), being able to supply large volumes (improving economies of scale), being able to supply a variety of qualities (improving the economies of scope), and complying with environmental management, food safety and sustainability standards.

As a result of these reflections, in this article (see Section 5) we examine upgrading trajectories in two broad categories (see also Bolwig et al., 2010):

(1) Improve product, process, volume and/or variety (in the same value chain node). This group of trajectories is about 'doing things better or bigger' through improvements in technology and/or management. It can include 'defensive' strategies devised to retain an established position in the chain, such as responding to lower prices through cost reductions. Combining strategies related to process, product, volume and/or variety (of both products and end-markets) can be mutually reinforcing -- for example, increasing volume may enable investment in processing equipment needed to raise quality.

(2) Change and/or add functions (up- or downstream; in several nodes). This group includes the more 'traditional' trajectory of functional upgrading, but can also be carried out through taking on a new function in the value chain that is considered of lower-value added, whether

it is upstream or downstream from where they operated originally. It also includes instances where actors decide to abandon one function in order to focus on a new one, instead of incorporating the two functions through vertical integration.

But what can explain different trajectories of upgrading? The existing literature has highlighted the links between different forms of GVC governance and the possibilities for upgrading, particularly functional upgrading. Much of the discussion has been focused on linking various forms of coordination along a value chain, or at least the dominant forms in key nodes of the value chain, and upgrading trajectories. The forms of coordination are generally those developed by Gereffi, Humphrey & Sturgeon (2005), also building on previous work (Humphrey & Schmitz, 2004; Schmitz, 2006). Five forms of coordination are commonly distinguished in the literature, which arise from a matrix of three independent variables: the complexity of the information and knowledge required to carry out an exchange; the ability to codify and transmit such information between buyer and seller; and the level of capability in the supply base in relation to the requirements of the transaction. Gereffi, Humphrey & Sturgeon's (2005) matrix provides five possible forms of coordination: (1) *Market*: low informational complexity, ease of codification of information, and high supplier capabilities; (2) *Modular*: high informational complexity, ease of codification and high supplier capabilities; (3) *Relational*: high informational complexity, low ability to codify information and high supplier capabilities; (4) *Captive*: high informational complexity and ease of codification but low supplier capabilities; and (5) *Hierarchy*: high informational complexity, difficulty of codification and low capabilities amongst independent suppliers.

The literature linking upgrading to specific forms of coordination suggests that in chains characterized by captive relationships (elsewhere also characterized as 'quasi-hierarchical'; Humphrey & Schmitz, 2004), significant product and process upgrading by 'local producers' takes place, often with an active engagement from buyers. At the same

time, in captive relations, functional upgrading is either discouraged or limited to some functions but not others (Schmitz & Knorriga, 2000; Bair & Gereffi, 2001; Gibbon, 2001; 2008; Giuliani, Pietrobelli & Rabellotti, 2005; Schmitz, 2006; Mitchell & Coles, 2011). Thus, the 'high road' to upgrading, when followed at all, is only partial and its rewards are either unevenly distributed or have a limited timeframe (see Bair & Gereffi, 2003; for an exception, see Tokatli, 2007). In chains characterized by market transactions, functional upgrading is more likely to take place, together with the transfer of new capabilities to different value chains (Tewari, 1999; Bazan & Navas-Aleman, 2004; Schmitz, 2006). The knowledge for this to happen (market, customer preferences, design), however, seems to accrue in relationships with smaller buyers and/or domestic markets, and in emerging economies rather than in developing countries. Finally, in relational and modular value chains (Humphrey & Schmitz, 2004 call them 'network-based' chains) all kinds of upgrading can indeed take place, but actors in low-income countries rarely find themselves in these chains.

In this article, we speak to this debate through the analysis of the links between GVC governance factors and the observed upgrading trajectories in relation to: the different forms of coordination explained above; and different types of lead firms and degrees of driving from inside the value chain (see Section 6). Finally, we examine the role of domestic regulation and public sector support on upgrading (see Section 7).

3. THE BLUE REVOLUTION IN ASIA: BACKGROUND

Worldwide, production of aquatic resources (excluding aquatic plants) has grown rapidly in the past few decades – from 125 to 156 million tonnes between 2001 and 2011 alone. However, only about 7 percent of that growth can be attributed to growth in capture fisheries, while the aquaculture sector has continued to grow at an average annual growth rate of 8.1 percent between 2001 and 2011, what is known as the 'Blue Revolution'. The contribution of

aquaculture to total fish production has increased from about 28 percent in 2001 to 40 percent in 2011 (FAO, 2013). About 85 percent of this quantity is for human consumption, providing an average of 18.8 kg per capita supply per annum (live-weight equivalent) (FAO, 2012). China has remained the top producer in the aquaculture sector although its share in world's aquaculture production has reduced slightly from 66 percent in 2001 to 62 percent in 2011. At the same time, the share of production of other Asian countries grew from 22 percent in 2001 to 27 percent in 2011.

Trade in aquatic resources has also grown significantly, with global exports increasing at an average annual rate of 4.1 percent between 1999 and 2009 in terms of volume, and as much as 7.9 percent per annum in terms of value (FAO FishStatJ, 2013). About 37 percent of world exports originated from Asian countries in 2009 (both in volume and value), an increase of over 70 percent in terms of volume compared to 1999, and a doubling of its value to 33.4 billion USD.

Historically, the main importers of seafood have been the US, Japan, the EU, and China (FAO, 2012). However growth in imports has been more rapid in China and the EU than in the US, while imports have remained more or less stable in Japan between 2000 and 2010 (FAO, 2012). Markets have also diversified over the past decade. For example, volumes of shrimp imports have increased steadily in both the EU and US, keeping up with the overall growth in shrimp trade. Among other importing countries, however, some have experienced major increases in import volumes in the period 2004-2009, such as Russia, Morocco, the United Arab Emirates and Mexico; others saw sharp declines relative to the volume traded (Japan, China, Indonesia, Malaysia, Singapore, Iceland and Norway). Overall, this resulted in more diversification in global trade – with the share of the top 10 ranked importers declining from 80 percent of total imports in 1994 to 69 percent in 2009 (FAO, 2012). Within the EU, Spain, Denmark, the UK, France, Italy, Belgium, and the Netherlands together account for

about three-quarters of the EU-27 imports by volume, while in terms of value the UK and France overtake Denmark in the ranking (European Commission, 2012).

The above trends in aquaculture trade show that despite the proliferation of food safety and sustainability standards, production and trade in fish has increased – and Asian producers and processors have increased their share in world fish trade. However, the aggregated Asian figures conceal major differences between countries in the region. The four countries covered in this article are among the top ten aquaculture producing countries, with China producing 36.7 million tonnes, Vietnam 2.8 million, Bangladesh 1.5 million and Thailand 1 million tonnes (2011 figures; FishStatJ, 2013). They supplied more than half of total seafood exports from Asia in 2009, and 20 percent of world exports. They play a predominant role in production and trade of the species selected for this study: in 2009, 40 percent of globally traded shrimp and prawns originated from these four countries, with Thailand as the largest exporter; China dominated the international market for tilapia, supplying 87 percent of world exports; and Vietnam dominated the international pangasius market, with a 98 percent share (FAO FishStatJ, 2013). In terms of export earnings, however, shrimp and prawn in the four countries combined contributed more than tilapia and pangasius. Overall, imports of shrimp, prawn, tilapia and pangasius into the four countries are insignificant.

4. METHODOLOGY

Primary fieldwork in the four countries was carried out by two of the authors in 2010 and 2011, as part of a large EU-funded project (Grant Number 222889). This project was focused on export-oriented seafood value chains from Asia to Europe. Therefore, we do not present material on domestic and regional value chains in this article. Four countries (Bangladesh, China, Thailand and Vietnam) and four species, Pangasius (*P. sutchii* and *P. hypophthalmus*);

Prawn (*Macrobrachium rosenbergii*); Shrimp (*Penaeus monodon* and *Litopenaeus vannamei*);[3] Nile Tilapia (*Oreochromis niloticus*) and its hybrids, were selected for this article. The four countries are important aquaculture producers and exporters but represent different farming systems and different stages of operational and institutional sophistication in the value chain (with Thailand at the high end, Bangladesh at the low end, and Vietnam and China in between). The target species are those that are systemically important in terms of seafood exports in the four countries. We also researched shrimp in Vietnam, another key export, but due to space limitations and given that it is covered in two countries already, we do not examine it in this article (see Ha and Bush, 2010; Jespersen et al., 2013; Kelling et al., 2013; Tran et al., 2013 for more information on this value chain). While the value chains for these species have their technical specificities, they are all part of a broader global value chain for seafood products – many of the key importers, re-processors and retailers in importing countries in the global North handle all or most of these species.

In Asia, fieldwork was conducted in slots of 2-3 months between September 2010 and December 2011, for a total of 11 months. In addition to gathering secondary data, most of the fieldwork consisted of semi-structured interviews. Respondent selection was carried out to cover all key actors in the value chain and relevant policy makers and other 'influencers' (such as NGOs). Interviews in Asia were conducted through a translator or in English when possible. Between September and December 2011, fieldwork was also undertaken in the EU, focusing on Germany, the United Kingdom and France, given their relative importance in terms of consumption of the target species from the four Asian countries, as well as Belgium and the Netherlands because of their role as import hubs.

Eighty-four interviews were carried out in Bangladesh, 32 in China, 75 in Thailand, 56 in Vietnam and 36 in the European Union.[4] The selection of key informants was based on their specific roles in the value chain and relied on snowball sampling. A range of firm sizes

was included to capture variations in operational practices. It proved difficult to gain access to processors and to obtain reliable data from them, especially on costs and other factors that are considered key for competitive advantage. In Vietnam, this was further hampered by the portrayal of pangasius as 'unsustainable' in the press and by an international NGO at the time of fieldwork.

5. UPGRADING TRAJECTORIES

In this section, we present a summary version of in-depth and fieldwork-based analyses of upgrading trajectories in the selected aquaculture value chains (for more details on each individual case study, see (Kelling et al., 2013). We examine two key value chain nodes where possible upgrading trajectories can take place: the processing plant and the farm (see a simplified mapping of the selected aquaculture value chains in Figures 1 to 4). In each study, we read the empirical material through the lenses of the two groups of upgrading trajectories we highlighted above: (i) improve product, process, volume and/or variety (of products and/or end-market); and (ii) change and/or add functions. The results of this matrix are summarized in Table 1.

(a) Bangladesh: shrimp/prawns

Upgrading in the Bangladesh context has not been examined in the literature, although there is a small body of research on standards in importing countries, particularly environmental standards, which have essentially restricted Bangladesh products from certain high-end markets. Islam (2008) points out that standards set in importing countries can bring opportunities, but also have important consequences for the access of farmed seafood products originating from developing countries to international value chains. Ito (2004) also argues that changes in the institutional framework of the freshwater prawn chain, under

pressure to meet food safety standards, have resulted in marginalization of small farmers in Bangladesh due to their reduced access to finance.

Our research found that upgrading in the Bangladeshi value chains for shrimp and prawns is marked by severe economic, technical and knowledge limitations at both the processing and farm levels. Despite investments in the Bangladesh shrimp and prawn chain by *processors* (at the factory level), by the government (in supplying antibiotic testing machines) and by NGOs (training of producers), quality control is one of the most limiting factors to upgrading trajectories, and the industry faces challenges meeting international food safety standards. Process upgrading has taken place in factories through improved equipment, training and hygiene practices. But delays in providing quality control documentation remain. In terms of product upgrading, the majority of Bangladesh shrimp and prawn exports to the EU are primarily lower value products with fewer quality demands. A compounding factor is lack of volume upgrading due to uneven and insufficient supply.

Figure 1. Configuration of selected aquaculture value chains from Bangladesh

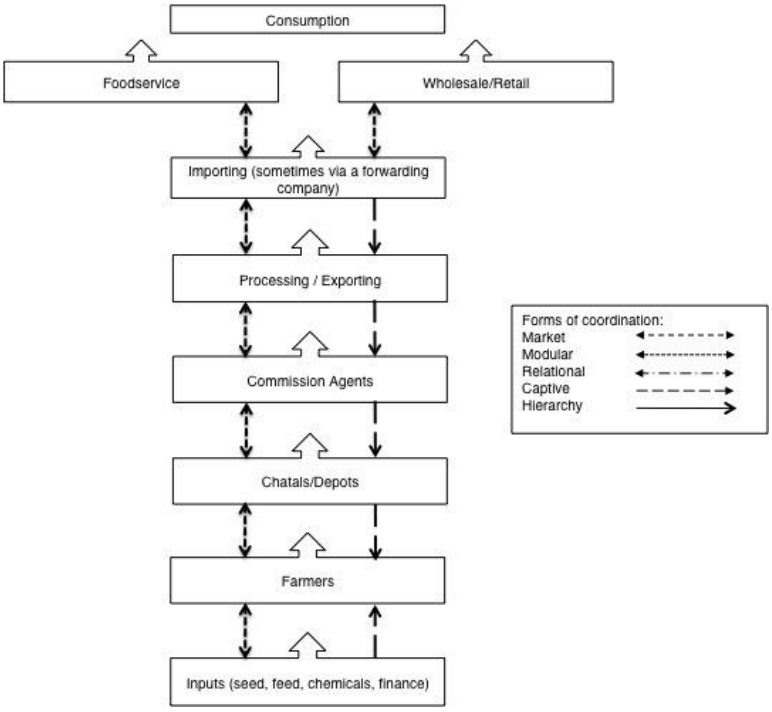


Figure 2. Configuration of the tilapia value chain from China

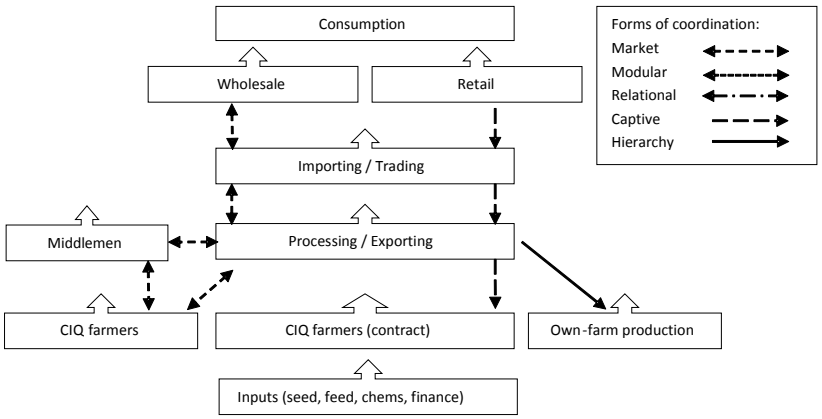


Figure 3. Configuration of shrimp and tilapia value chains from Thailand

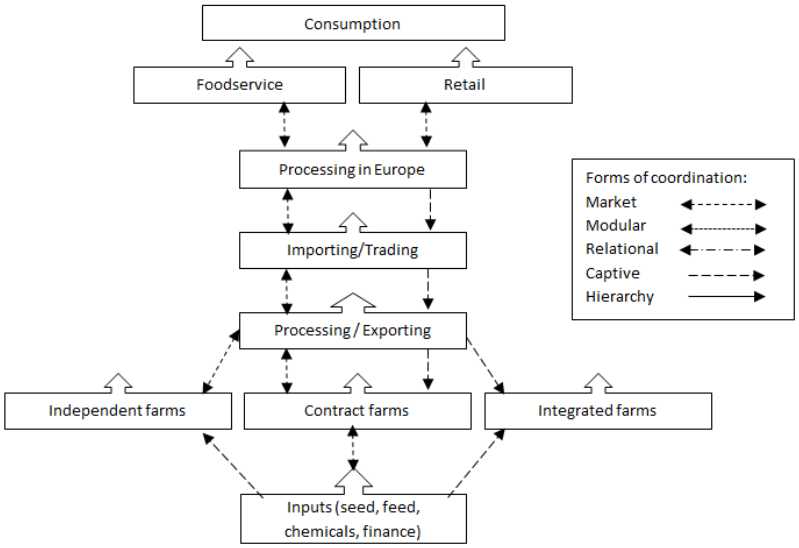
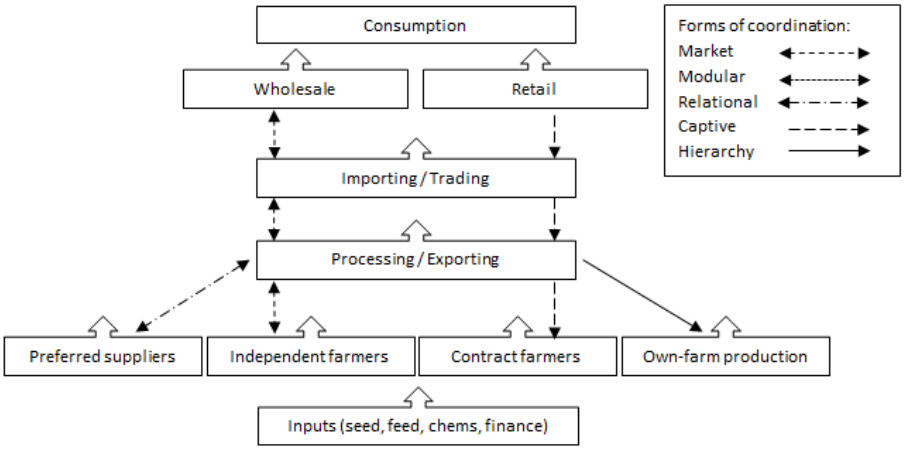


Figure 4. Configuration of the pangasius value chain from Vietnam



Inadequacies in cold-chain infrastructure between farms and processing plats, such as a lack of refrigerated trucks and insulated boxes, as well as contamination risks from ice production and handling, are affecting both volumes and quality. At the same time, there are signs of attempts to improve *variety*: some exporters have started offering chilled shrimp and particular cuts (such as "butterfly"); and end-market diversification is also taking place, with the emergence of new, less quality-demanding, markets – predominantly Russia, but also Middle Eastern countries. Finally, the large numbers of farmers operating in this value chain, producing small amounts of shrimp and prawn, could provide an incentive for processors to integrate new functions in order to guarantee availability, volume and quality. However, no attempts at vertical integration were found at the processor level in Bangladesh.

At the *farm* level, process upgrading has been attempted with the assistance of NGO programmes focusing on farm management, quality management, training in management of water quality, marketing and post-harvest handling. Farms have also undergone registration with the assistance of UNIDO, but chain of custody traceability is still virtually non-existent. In addition, there is little record kept of inputs, outputs and prices by farmers or depots. Product and volume upgrading have faced particularly difficult challenges as well, due to poor feed ingredients (Islam, Khan & Reza, 2009) and high mortality and poor quality of post-larvae stocks. No variety upgrading was observed at the farm level, while examples of adding functions were limited to a minority of farmers who have become part-time post-larvae traders.

Overall, the picture of shrimp and prawn value chains in Bangladesh is one of failing to upgrade – not as a defensive strategy or a tactical one related to building economies of scale for a lower quality product, but one signaling the inability of industry and government to improve (see Table 1). This is exacerbated by government subsidies that allow processing

plants to continue to operate far below their capacity and provide no incentive to invest, and high levels of dependence on external donor funds.

(b) China: tilapia

Despite the vast size of Chinese aquaculture both in terms of volume and value, the industry has received much less attention from international value chain research than the widely researched sectors of the other three Asian countries. Writing on the Chinese aquaculture industry as a whole, Li et al. (2011) argue that although progress has been made in terms of aquaculture technology development, considerable challenges remain in areas of water quality (affecting productivity, product quality and possible risks to consumers), disease control and skills and techniques. Importantly, the authors highlight that the provinces where aquaculture has made significant progress are those with access to foreign markets.

Our research suggests that the upgrading trajectories pursued by Chinese actors in the value chain for tilapia involve all groups of upgrading trajectories, including traditional attempts to improve products and streamlining production processes, as well as more general strategies related to organization, management, marketing and building confidence. *Processors* have sought to improve products, processes, volume and variety through, inter alia, training workers, optimizing processes and matching standards. In addition, they are diversifying markets and buyers, which implies supplying higher quality products to supermarkets and chain restaurants in the US and EU, as well as lower quality products to less demanding destinations. The domestic market is also becoming important for the further development of the industry (Hanson et al., 2011). Processors are also adding upstream functions (such as input provision and fish farming) in an attempt to increase control over the raw material through own-farm production.

At the *farm* level, the increased scrutiny of chemical residues in export markets has made this one of the main areas in which farmers attempt to upgrade production practices. Against a background of diminishing profits, farmers also attempt to improve water quality management and intensify production to increase volume. Except for a few cases of own-farm feed production, functional up-/downgrading has been limited (see Table 3).

Overall, the upgrading trajectories pursued by Chinese actors in the tilapia value chain are more related to building and deepening capabilities at the same node of the value chain than to 'moving up the value-added ladder'. The impetus for improving capabilities derives from exposure to different end-markets and increased requirements of customers in some of these markets. As Chinese seafood suppliers tend to follow a marketing strategy of supplying higher quality products to supermarkets and restaurants in the US and EU, as well as lower quality products to less demanding customers, capability building is necessary to maintain or gain access to high-positioned customers. This strategy may generate financial rewards by allowing suppliers to tap into higher-paying market segments, but improving production procedures and supplying products with 'better intrinsic qualities' do not generate higher prices as such. Rather, the decision by most processors to 'keep a foot in both camps' seems equally related to spreading risk and increasing sales volumes by diversifying markets and buyers. Another strategy employed by processors to maintain market access and manage risk is to increase control over raw material (and inputs) through own-farm production or vertical integration. This stabilizes access to raw material (of a specified quality) and ideally provides stable outlets or reduced exposure to risk for farmers linked to processors. However, as the farm gate price is negotiated at each exchange, the fluctuating nature of the market implies that price uncertainty is passed on to farmers, with limited room for maneuver.

(c) Thailand: shrimp and tilapia

Thai seafood value chains, like a number of other value chains elsewhere, have been under scrutiny for working conditions in processing plants, especially among the large proportion of migrant workers in the sector (Solidarity Center, 2008). These challenges also offer upgrading opportunities and the recent literature has considered the need for cooperative effort, through farmers associations in particular, to negotiate fairer distribution of benefits and risks (Lebel et al., 2008), alongside improved vertical relationships that could contribute to learning from buyers (Lebel et al., 2009). Extensive investment by both the private sector and government at all nodes along the value chain, and especially through processors' considerable investment in technology and R&D (Goss, Burch & Rickson, 2000), has led to upgrading trajectories in Thai value chains that have involved strong efforts to improve products in terms of quality, value-addition, innovation, certification and an increasingly sophisticated portfolio of products.

In the Thai *processing* industry, process upgrading has primarily occurred through strict quality control requirements and investments in improved factories and equipment. Improved quality control is enforced from production onwards and focused on ensuring a robust cold chain and maintaining freshness and quality through reduced travel times between harvest and processing. Producing new product forms and innovating to create new products in order to increase unit values are both areas of focus and growth in Thailand. Processing plants have invested substantially in value-added research and development, particularly in the shrimp value chain with the development and marketing of ready-to-cook and ready-to-eat products destined to retail chains worldwide. Tilapia, on the other hand, is mostly sold as frozen fillets in the EU and there is little product upgrading. Still, minimum standards for export introduced by the Thai government have contributed to better quality and traceability. Increasing volume, however, is not currently seen as an important strategy in the industry, while substantial product variety upgrading has taken place. Exports have been decreasing to

Thailand's largest shrimp market, the US, as well as the EU, but exports by both quantity and value to Asian, Japanese and Chinese end-markets have been increasing. These new market opportunities are arising in reaction to changing tariffs (in the EU), countervailing duties (in the US), higher standards in these markets, and as a result of the ongoing economic crisis. Finally, numerous processors have added new functions: they have become involved in R&D in both shrimp and tilapia (on breeding programmes, oxygenation techniques, data collection by computer software and auto feeders); they have incorporated feed and seed production to ensure high quality inputs; and some have developed new marketing, branding and customer service functions.

Upgrading at the *farm*-level has included meeting mandatory minimum certification requirements for export, improved post-harvest handling, and the use of quality seed and feed. Some integrated large-scale farms have improved production through investment in equipment such as aerating and feeding machinery, which can be calibrated to precise levels in order to ensure optimal production. Shrimp can be graded and packaged on ice immediately after harvest and the processor may provide labor at harvest time in order to safeguard quality. The outcome of such improvements has been higher product quality. The potential impact on volumes has been mitigated by the incidence of MSGS (Monodon Slow Growth Syndrome). Private companies are also pursuing research on diversified species such as 'blue shrimp'. Functional upgrading has been more widespread amongst tilapia farmers than shrimp farmers, with the former combining hatchery/nursery functions with grow-out.

The Thai experience is one of successful upgrading both at the processing and farm levels. However, it can only be understood properly in connection to appropriate regulation and public sector support (see section 7). It is also not a smooth story, as the shrimp industry, for example, almost collapsed in the 1990s due to the impact of various diseases.

(d) Vietnam: pangasius

Of the country/species combinations examined in this paper, the only one where there is a rich existing literature on upgrading is pangasius in Vietnam. Much of it approaches upgrading through analyses of how processors and farmers respond to increasing demands of overseas buyers and markets. Several studies find on-going consolidation and vertical integration within the aquaculture industry in Vietnam, driven by demands placed by international food safety, quality and sustainability standards and certification schemes (Bush, Khiem & Sinh, 2009; Khiem et al., 2010). According to Khiem et al. (2010) and Pham et al. (2011), pressure from buyers in the EU and US related to food safety and sustainability of farmed seafood has prompted value chain upgrading, but recent uncertainty due to unfounded claims and media attention regarding the environmental, social and food safety aspects of pangasius aquaculture may undermine the viability of the industry (Bush & Duijf, 2011; Little et al., 2012). The literature also highlights other barriers to further upgrading, such as lack of explicit economic incentives (improved market access or increased price), limited access to capital to invest in improved management practices, and lack of appropriate skills for smallholders – in light of the economic risks associated with market volatility and quality regulation faced by aquaculture farmers in global markets (see also Bush & Belton, 2012).

Our own fieldwork on the Vietnamese value chain for pangasius suggests that upgrading has comprised a wide set of strategies and efforts (see Table 3). In the *processing* industry, there have been attempts at developing value-added products. However, the majority of product upgrading has taken place within the category of frozen fillets, which constitute the vast majority of exports. The main ways in which processors try to increase the value of frozen fillets have been by matching demands on color, size/weight and treatment (glazing and soaking). Process upgrading has taken place mainly by improving efficiency through a combination of better production and management practices –especially by

increasing yields through manual filleting combined with optimizing conditions and processes in the factory more generally. As is the case in China, being able to provide a portfolio of related products with different qualities and specifications (higher grade/quality and/or sustainably certified products as well as standardized, non-certified or medium/lower grade products) to a wider variety of buyers and end-markets has been an important part of processors' upgrading strategies. Other crucial efforts to improve processors' position in the value chain have been through adding functions (fish farming, and seed and feed production) to obtain greater control over supply and farming practices and to meet increasingly stringent food safety and quality standards in export markets (see also Khiem et al., 2010; Bush & Belton, 2012).

Attempts to maintain or improve *farmers*' position in the value chain are influenced by their limited room for maneuver. Against a background of shrinking or negative profits at the time of fieldwork, the main objective of upgrading efforts was to increase rewards through supplying products with better intrinsic qualities, such as color, appearance, size and absence of chemical residues. This was achieved through improved management of water quality, feed and chemicals and the matching of standards (see also Khiem et al., 2010). Moreover, as securing a position in the value chain is increasingly a question of volume and economies of scale, and as margins in the chain are extremely narrow, improving yields/increasing volume played an important role in farmers' upgrading efforts. In terms of changing/adding functions, this involved pangasius farmers combining grow-out and nursing or moving in and out of production altogether.

In sum, the upgrading strategies employed by processors and farmers in the pangasius value chain in Vietnam revolve around attempts at increasing rewards in the short-term and reducing exposure to risk in the long-term (see summary in Table 3). In the short term, these actors continually seek to maintain or increase rewards by producing products with better

Table 1. Summary of upgrading trajectories in selected aquaculture value chains in Asia

Node	Upgrading trajectories	Bangladesh	China	Thailand	Vietnam
Processing	Improve process	Some improvements especially in equipment, training and hygiene, but poor quality control, logistics and traceability remain a problem	Improved processes (incl. matching standards) through optimization and training of workers	Extensive industry investments in R&D, factories and equipment, quality control, chain of custody certification and processing technology	Improved production and management practices; increased process efficiency (yields)
	Improve product	Low quality exports and very limited value addition	Limited value-added, but product upgrading of frozen tilapia fillets	Developed high quality, value-added and certified products	Product improvement mainly through matching demands on colour, size and processing treatment
	Improve volume	Uneven and insufficient supply remains the norm	Improved volume through optimization and diversifying markets	None	Improved, and has been a key factor of market diversification as well (see below)
	Improve variety	Some signs of product variety diversification; clearer moves to diversify end markets to target destinations with lower quality demands	Diversification of quality range to a larger variety of markets and buyers	Improved variety by developing ready-to-cook and ready-to-eat products; increased focus on Asian markets	Expanded portfolio of related products with different qualities to an increased variety of markets and buyers
	Change and/or add functions	None	Added new functions: raw material production and input supply	Added functions: R&D; seed and feed production; some processors developed own brands	Increasing involvement in fish farming and input provision

Table 1 (cont.). Summary of upgrading trajectories in selected aquaculture value chains in Asia

Node	Upgrading trajectories	Bangladesh	China	Thailand	Vietnam
Farm-level	Improve process	Farms were registered, but little progress on documentation and chain of custody traceability	Improved chemical management, water quality, fish size, CIQ standards; increased production efficiency	Improved post-harvest handling, the use of quality feed and seed and mandatory minimum certification requirements for export	Process improvement of management practices (water quality and inputs), matching BMP standards
	Improve product	None	Improved intrinsic quality (absence of chemical residues) and product size	Improved intrinsic quality	Improved colour, appearance, product size and absence of chemical residues
	Improve volume	Limited by high mortality and poor quality post-larvae	Increased volumes through management of water quality and use of new technology	Limited by incidence of Monodon Slow Growth Syndrome	Efforts to improve volume/increase yields through management practices (e.g. water quality)
	Improve variety	None	Limited expansion of product categories	Limited, although some research is exploring diversification of shrimp species	Limited expansion with existing product categories
	Change and/or add functions	Some farmers operate as part-time post-larvae traders	Limited to some cases of own feed production	Limited in shrimp; integration of hatchery/nursery in tilapia	Examples of farmers nursing fingerlings and moving in and out of grow-out.

intrinsic qualities though improved production processes and practices. This can also be achieved via matching standards or through adding functions – key ways of controlling and improving quality. However, these are also important means of reducing exposure to risk (lack of access to raw material, quality failure and damage to reputation) in the long term. But the strained financial situation of many smaller farmers at the time of fieldwork drove them to pursue higher prices per se in the short-term.

6. LINKS BETWEEN GOVERNANCE AND UPGRADING

In this section, we examine the complex relations between governance and upgrading in the selected Asian aquaculture value chains. First, we analyze the links between different forms of coordination and upgrading trajectories; then we look at different groups of value chain lead firms and degrees of driving on the one hand, and upgrading trajectories on the other. Space limitations do not allow us to delve into the details of the predominant forms of coordination in each value chain node (for more details, see Jespersen et al., 2013). These are indicated by the different kinds of arrows illustrated in Figures 1 to 4.

(a) Forms of coordination and upgrading

Market coordination mechanisms dominate all value chain nodes between importers in the EU and farmers in *Bangladesh* (see Figure 1), with captive relationships present when debt and credit linkages create 'lock in' mechanisms. Captive relationships have not led to product and process upgrading, as expected in the literature, due to long-term credit dependency and market-type transactions have not opened possibilities for functional upgrading, due to lack of knowledge and investment.

The partitioning of value chains in *China* according to end-market and product quality is reflected in the presence of different coordination mechanisms in the same nodes of the

value chain (see Figure 2). The node between farmers and processors is characterized by market or captive relationships, depending on whether farmers supply one or several processors, and hierarchical coordination in cases of processors' own-farm production. The node between processors and importers is dominated by market-type relationships, but increased focus of high-end customers on food quality, safety and sustainability are moving the overall value chain towards more captive forms of coordination. Unlike in Bangladesh, the presence of captive relationships in Chinese value chains has been associated with product and process upgrading by both farmers and processors. Market-type coordination in the node between processors and importers also coincided with functional upgrading in the sense that processors have engaged in upstream functions. Overall, the changing dynamics in the types of coordination mechanisms observed in Chinese value chains, with movements from captive to hierarchical, and from market to captive, are closely linked to the upgrading trajectories that the existing literature would expect to happen.

In *Thailand*, a combination of captive and modular coordination exists between importers and processors, with modular relations arising when highly competent processors are able to provide high quality and/or value-added products (see Figure 3). Further upstream, captive coordination mechanisms dominate the relationships between processors and independent and contracted farmers, similarly to the case of China. However, if contracts are not honored by farmers, relationships assume the characteristics of market-type coordination. The prevalence of captive relationships between farmers and processors and between processors and importers seems to have stimulated significant product and process upgrading outcomes for Thai actors. Whether encouraged by buyers or not, modular relationships between processors and importers have led to functional upgrading by some highly competent Thai processors into downstream activities – such as R&D, product development and market research. The route pursued by Thai processors comes closest to the 'high road'

to upgrading described by Gereffi (1999). However, the ability of the industry to respond to the demands of overseas buyers has to a large degree been made possible through a strong regulatory framework (see discussion below) and investment by the industry.

In *Vietnam*, in the node between farmers and processors, market, relational, captive and hierarchy forms of coordination are all present, depending on which channel the farmer supplies (see Figure 4). The node between processors and importers is characterized by market and captive relationships, again depending on the type of end-market supplied. The particular coordination features of the Vietnamese value chain mean that parts of the industry are characterized by substantial efforts to upgrade products and processes, while other parts of the industry are under less pressure to improve. Generally, the former category applies to processors' own farm production sites and to contracted farmers, while the latter includes independent, generally smaller farmers. These are integrated into processors' supply chains through hierarchy/relational/captive and market coordination relationships respectively, leading to different demands for product and process upgrading.

To summarize, the relation between forms of coordination and upgrading trajectories is not straightforward in the aquaculture value chains we examined. Limited upgrading in Bangladesh coincides with the presence of market and captive coordination; bifurcate upgrading trajectories in China and Vietnam are accompanied by coordination mechanisms that are moving from market towards captive/hierarchy and, in some cases, relational coordination. Successful upgrading in Thailand is associated with captive and modular coordination. As there are multiple coordination mechanisms at work in any value chain node, and as mechanisms may differ between different nodes, it is not possible to generalize the relation between types of coordination and upgrading trajectories. Nevertheless, it does appear that most captive forms of coordination in our case studies have fostered some degree of product and process upgrading (except in the case of Bangladesh) and that market and

modular coordination have led to some functional upgrading at the processing level (in China and Thailand).

(b) Types of lead firms, levels of driving and upgrading

In *Bangladesh*, aquaculture value chains are characterized by low levels of driving by overseas importers (see more details on the overall governance traits of the selected value chains in Jespersen et al., 2013). Bangladeshi shrimp and prawn value chains are confined to low-end foodservice and wholesale markets in the EU, and are characterized by low levels of driving by importers and few demands on Bangladeshi suppliers to improve products or processes. In *China*, levels of driving vary according to which market channel a value chain serves, with higher levels applied in value chains serving retailers and restaurants where high quality, certified raw material for high-end customers is demanded. In *Thailand*, value chains are characterized by high levels of driving by European retail chains, high-end foodservice, brand manufacturers and importers, who place exacting and changing demands for premium quality, value-added/innovative products and certification. Thai suppliers have to continually upgrade to improve or even to maintain their position in the value chain. In *Vietnam*, different degrees of driving are observed depending on which end-market the value chain caters for, but the general trend is towards increasing levels of driving. The actual upgrading trajectories pursued by Vietnamese value chain actors to a large degree depend on which types of buyers they aim to supply. Although most processors use a diversification strategy of supplying low- as well as high-end buyers and markets, specific processors prioritize one channel over the other and upgrade to meet demands for quality and certification. More generally, value chain actors aiming to access high-end European retail chains in the four Asian countries have invested considerably in upgrading. Others have had to upgrade to meet basic food quality and safety requirements, but this only enabled them to access less demanding end-markets and market segments, where they tend to be 'locked in'.

To summarize (see Table 2), types of lead firms and related levels of driving have played an important role in shaping the upgrading trajectories for Asian aquaculture value chain actors. One of the key factors in shaping upgrading is what type of buyers are in a lead firm position. In the four case studies, this ranges from importers supplying low-end wholesale markets with shrimp and prawns from Bangladesh, to retailers, foodservice, brand

Table 2. Types of drivers, levels of driving and upgrading trajectories in selected aquaculture value chains in Asia

Node	Upgrading trajectory	Types of drivers and levels of driving	
		Retailers, Foodservice, Brand manufacturers, Importers serving high-end markets (high level of driving)	**Importers serving low-end markets (low level of driving)**
Processing	Improve process, product, volume and variety	++	+
	Change and/or add functions	+	0
Farm-level	Improve process, product, volume and variety	++	+
	Change and/or add functions	+	0

Note: The number of + denotes the degree of influence of different types of drivers and levels of driving on upgrading, with 0 denoting no influence.

manufacturers and importers supplying high-end markets with Thai shrimp and tilapia. China and Vietnam occupy a position somewhere in between due to the quality bifurcation of their value chains (see details in Jespersen et al., 2013; Kelling et al., 2013). This is paralleled by a continuum of different degrees of value chain driving ranging from low in Bangladesh to high in Thailand, again with China and Vietnam occupying the middle with different degrees (but tendentially increasing) degrees of driving. A similar pattern can be observed in the upgrading trajectories of the of the four countries' value chains themselves: no upgrading in Bangladesh, substantial upgrading in Thailand, and China and Vietnam occupying a middle position – with considerable upgrading (but also exposure to higher risks) taking place in value chain strands supplying high quality products to retailers and restaurant chains and less

upgrading (but also lower risks) occurring in value chains supplying low-end buyers and markets.

7. THE ROLEs OF DOMESTIC REGULATION AND PUBLIC SECTOR SUPPORT

Before turning to the conclusion, in this section we briefly examine upgrading outcomes in relation to different degrees of regulatory and public sector support. These aspects, when analyzed at all in global value chain studies, are generally placed under the institutional framework surrounding a value chain. Here, we examine their impact on upgrading in the context of the governance factors examined above (for a more comprehensive analysis of the interactions between institutional frameworks and governance, see Kelling et al., 2013).

In *Bangladesh*, a lack of upgrading can be explained not only by limited quality demands from lead firms (importers) and low levels of driving, but also by weak national regulatory capacity, specifically related to a poor history of compliance with food safety standards. Three factors are involved here. The first is that domestic legislation lacks sufficient scope in order to improve food safety standards. Examples include lack of regulation on feed contamination and on ensuring disease free brood-shrimp. The second is that existing laws are poorly enforced, due to the large number of ministries involved in different aspects of the aquaculture industry, inefficiencies in communication and implementation, and the strength of industry lobbying. The third is ill-designed government incentives that undermine product quality: export tax breaks and subsidies to build processing plants, for example, resulted in over-investment in factory infrastructure, but has made no difference to the quality or quantity of actual production.

Domestic regulation in *China* has been tightened in response to export market closures, loss of access to value chains in some OECD countries, increased scrutiny by importing countries, decline in consumer demand and negative publicity following a series of food safety incidents in the late 2000s in the US and EU. More specifically, the Chinese government has introduced new regulations and implementation plans targeting aquatic product safety, including administrative provisions for traceability, food inspection, certification and labelling. Despite initiatives to improve the regulatory framework for aquatic food safety, public institutions responsible for their enforcement are challenged by the rise in exports and associated growth of food processing companies (see Liu, Kerr & Hobbs, 2012).

The government of *Thailand* has been very proactive in legislating for the aquaculture industry with a long history of regulation and policy support that has resulted in a mature and highly-disciplined industry. Regulation has become standardized and stricter, in line with strengthened governance in resource allocation and environmental integrity, stringent food safety and quality standards, and market expansion from local to national and international markets. Early investment by the government in public infrastructure such as transport and electricity, alongside free-of-charge testing, analysis and auditing, led to increased sanitary measures that support product upgrading – in particular, value addition and certification. Furthermore, quality inputs such as seed and feed are highly regulated in Thailand, thus supporting product upgrading. The government has provided public services such as technical extension services, free-of-cost training, testing and auditing services, as well as internet-based information services and market facilitation. Research, carried out by the industry, the Department of Fisheries and local academics, has stimulated the introduction of new aquaculture technologies. These have all been contributing factors to Thailand building a good reputation in international seafood markets, particularly boosted by government control.

A minimum standard for export, introduced by the Thai government, has also improved overall feed, seed, water and chemical quality. Post-harvest documentation such as movement documents that support traceability has provided a solid base for third-party certification in the industry. The Thai government has also introduced standards that imitate international principles of quality management and are directed at Asian markets that do not currently insist on verification by a third-party. Finally, government and industry are actively involved in developing solutions to prevent early mortality syndrome in shrimp.

In *Vietnam*, regulation of the aquaculture industry has been tightened in response to food safety incidents, labelling issues and negative publicity in key export markets. At the same time, the Vietnamese government has turned to private governance arrangements, including sustainability certification schemes developed in partnership with NGOs, retailers and intergovernmental organizations (see Bush, Little & Sinh, 2009). The government's attempt to promote national mandatory codes for Good Aquaculture Practices and Better Management Practices has experienced limited implementation due to poor enforcement and lack of economic incentives (Pham et al., 2011). While tightened government regulation and private governance initiatives have led to considerable product and process upgrading, the industry as a whole has yet to truly benefit from multiple forms of upgrading.

To summarize (see Table 3), domestic regulation and public sector support have had an important influence on some kinds of upgrading, but not on others.

Table 3. Domestic regulation, public sector support and upgrading trajectories in selected aquaculture value chains in Asia

Node	Upgrading trajectory	Domestic regulatory framework and public sector support
Processing	Improve process, product, volume and variety	+
	Change and/or add functions	0
Farm-level	Improve process, product, volume and variety	+
	Change and/or add functions	0

Note: + indicates a degree of influence of domestic regulatory framework and public sector support on upgrading; 0 denotes no influence.

A strong regulatory base is the foundation on which product and process upgrading can take place at both the farm and the processing level, as demonstrated by a robust legal framework in Thailand and the effects of tightening the legal basis in China and Vietnam. Without sufficient breadth, depth and enforcement of legislation, these upgrading dynamics are stifled, as exemplified by Bangladesh. At the same time, regulation and public sector support do not seem to have had a clear role in stimulating the addition or changing of functions.

8. CONCLUSION

Value chain upgrading refers to opportunities for developing country producers to 'move up the value chain' and is specifically concerned with trajectories that can lead to 'a better deal' for developing country actors. In this article, we have provided conceptual and empirical contributions to the literature on value chain upgrading. Our conceptual contributions are two-fold. The first is a call for more nuanced understandings of upgrading trajectories beyond the now 'classic' four categories of process, product, functional and inter-chain upgrading. By adopting an entry point on process, product, volume and variety, we engage with upgrading factors that are distinct but also inherently connected; and by examining the addition, substitution or abandonment of functions, we facilitate a less normative take on functional upgrading – which has tended to be translated into policy-making and strategy as necessarily involving the adoption of higher value added functions. The second conceptual contribution concerns the relation between governance and upgrading – the existing literature has concerned itself with either the relation between forms of coordination and upgrading, or with types of lead firms/levels of driving and upgrading. We argue not only that these aspects need to be examined together, but also that domestic regulation and public sector support

need to be incorporated in a comprehensive framework linking GVC governance, institutional frameworks and upgrading (see Ponte & Sturgeon, 2014).

Empirically, first we examined the upgrading trajectories of selected aquaculture value chains in Bangladesh, China, Thailand and Vietnam through the lenses of improving process, product, volume and variety; and changing and/or adding functions. Our results show that 'moving up' the value chain is only one of the possible trajectories of upgrading, and that upgrading can also involve implementation of different managerial models, supplying different end markets, improving efficiency, and meeting social and environmental standards – without necessarily increasing the value of the product. Second, we analyzed the relation between two elements of value chain governance and upgrading trajectories. We found that the dominant *type of coordination* mechanism operating at key nodes of the value chain does not have unequivocal relations to the different upgrading trajectories we observed. An exception is captive coordination, which seems to have fostered some degree of upgrading linked to improving product, process, volume and variety (except in Bangladesh) and downstream functional integration (but only in Thailand). More influential in shaping upgrading trajectories have been the *types of lead firms* that operate in the value chain, and related *degrees of value chain driving*. Highly-driven value chains led by retailers, foodservice, brand manufacturers and importers serving high-end markets stimulated all types of upgrading (but with a lesser degree in relation to changing or adding functions). In low-driven value chains, where importers supply low-end wholesale markets, we observed little or no upgrading, except for limited improvements in volume and variety.

Finally, we observed that the strength of the *domestic regulatory framework* and of *public sector support* has had an important influence on upgrading trajectories, both at farm and processing levels. A robust legal framework in Thailand and tightening the legal basis of quality control in China and Vietnam are yielding important results. In Bangladesh, in

absence of sufficient breadth, depth and enforcement of regulation, upgrading attempts have been stifled. However, the impact of regulation and public sector support was mostly limited to stimulating improvements in product and process, volume and variety, with little or no impact on changing or adding functions.

Finally, our analysis of selected aquaculture value chains suggests important lessons for understanding the potential and limits of upgrading the 'Blue Revolution' in Asia. One of the most critical factors of aquaculture value chain upgrading has been demand from buyers for more sophisticated/higher quality products. Without these demands, there is little incentive for improving chain efficiencies or product quality. Lead firms that have important reputations to protect drive high-end value chains by demanding food safety and quality certification from processors, and increasingly also sustainability certification at the farm level. High-end value chains may have greater value addition potential and command greater price premiums, but participation in them also involves greater risk, and lack of traceability will render certification impossible. In importer-driven chains, typical of 'emerging end-markets' (such as Russia and the Middle East) and lower-end chains in high-income countries, quality demands are far less demanding. Still, upgrading strategies of China and Vietnam in aquaculture have included supplying these types of value chains in addition to high-end ones, resulting in increased yields and volumes, and in a more cautious distribution of end-market risk.

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NOTES

[1] These factors include regulation (national, international and regional) and private or hybrid standards and certification systems on food safety, 'good aquaculture practices', social conditions of production and environmental sustainability.

2 The term ‘blue revolution’ was first used by Bailey (1985) and referred to the deleterious impacts of the introduction of new marine capture technologies on fish harvests and fishing communities. The use of the same term in aquaculture has a different connotation, as it refers to the overall increase in the availability of fish for human consumption that the growth of aquaculture has brought.

[3] The FAO has attempted to establish clear-cut distinctions for these terms where ‘prawns’ refer to freshwater creatures while shrimp refer to their marine and brackish water relatives. Common usage has often resulted in reference to large shrimp as prawns and to small shrimp as shrimp regardless of the salt content of their habitat. The latter applications are deeply embedded in the common and scientific usage.

[4] Fieldwork was carried out by two distinct PhD researchers in two countries each. While these projects were part of one main overall programme, individual funding mechanisms varied, as did their disciplinary attachment and country of institutional affilation. For these reasons, the timing, category and number of interviews in the four countries differed, although the overall analytical framework which underpinned the fieldwork in the four countries was broadly common.