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Small Farm Upgrading in GVC: a Strategic Perspective

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Keywords: Global value chain (GVC), interchain upgrading, subordinate firms' strategies, agro-industrial firms, biomass energy, biogas, agriculture, joint products.

Abstract

This article considers the analysis of upgrading strategies, focusing at the level of subordinate firms themselves. This approach develops the concept of “strategic upgrading”. We study the institutional environment of subordinate firms, and we analyze subordinate firms' strategies through concepts from industrial economics, such as differentiation, diversification, and specialization. We thus reexamine the category of inter-chain upgrading, i.e., the improvement of the position of actors of a GVC by integrating a new GVC. We confront this proposal with a territorialized case study on the development of biogas production by farmers in the Ardennes. We observe that these farmers are part of the emerging GVC of biomass energy based on their experience as “captive” actors in the agro-industrial GVC. In particular, they have sized their biogas production units to be autonomous regarding agro-industry. This new activity also has feedback effects on their positioning in the agro-industrial GVC.

Introduction

A key debate today relates to the ability of subordinate firms to improve their position in the global value chain (GVC) where they operate. The topic is often covered in Global North-Global South relationship literature and has given birth to a construct known as “upgrading”. This construct is defined as all of the efforts (better products; improved production process; new value chain functions) that subordinate firms might make to grasp the opportunities afforded by situational rents or a better management of risk. The goal for these firms is to improve their position, i.e. to use new knowledge and know-how to change what they are currently doing in their GVC. At the same time, it is still very unclear how feasible it really is for subordinate firms to change their situation by strengthening their bargaining position and earning a greater share of the total value-added generated within their GVC.

In seminal global value chain literature, notably Gereffi (1999), GVC is analysed in light of a governance process that coordinates diverse and diffuse activities and implies to include in the analysis the study of which parties in a given value chain are better remunerated than others. An explicit relationship was established between the process of upgrading and the distribution of value along the chain, with dominant firms deemed to have played a leading role in these dynamics. Then, the studies that came after Gereffi began to focus more on the different modes of upgrading and the conditions in which they materialise, notably as a result of local specificities (Tokatli, 2007; Pipkin, 2011; Ponte and Sturgeon, 2014). An implicit connection was made between governance and the distribution of power and wealth, under the assumption that improving one's value chain position should necessarily lead to greater bargaining power and an increased share of the total value-added. This latter corpus was

underpinned by the hypothesis that the learning abilities of (mainly Global South) suppliers depends directly on actions taken by their (mainly Global North) buyers¹. Upgrading in this case is best analysed in light of the choices made by dominant firms, the net effect of which is to leave upgraded firms with little room to manoeuvre, potentially leading to their immiserization (Mohan, 2016). The observation questions the assumption that too many observers have made, namely that a systematic connection exists between improving their position, improving their power and increasing their share of the total value-added. Note that other studies have also highlighted the importance of local factors (notably clusters and the Marshallian externalities they enable)² – along with institutional heritage and downgrading strategies - when analysing suppliers' ability to "freely" change their organisational modes and products in order to improve their bargaining position and share of the total value-added within their GVC (Bazan and Navas-Aleman, 2004; Pickels et al, 2006; Gellert, 2003; Gibbon and Ponte (2005); Neidik and Gereffi, 2006; Rothstein, 2005; Thomsen, 2007).

Few articles envision subordinate firms' positioning in anything other than a Global South context³. Nevertheless, the issues in question could feed into a broader reflection by focusing on a firm's ability to take advantage of the technical, organisational and institutional opportunities in their socioeconomic environment in such a way as to increase its power in the coordination chain that connects it to the other firms participating in its value-added creation process. The difficulties that French livestock breeders have faced in the global agro-industrial GVCs where they operate is clearly part of this discussion. The farmers in question have invested for 30 years nonstop without this translating into a more beneficial distribution of productivity gains that continue to be largely captured by their industry's downstream players (Veysset et al, 2017). The social compromise dilemma currently afflicting the Common Agricultural Policy (CAP) - the main mechanism that guarantees farmers' income –and the reinforcement of the competition that ensues, has made agricultural income very insecure (Trouvé et al, 2016). This dilemma has also strengthened the bargaining power of agro-industrialists and large retailers by progressively weakening price, trade (tariff) and production volume-related regulation mechanisms. In its efforts to manage price volatility, the CAP may have enabled the formation of private coordination tools such as crisis reserves, contractualisation incentives, mutualisation funds, private insurance and futures markets, but the regulating effects of these instruments are still determined at the regional level (Dervillé, 2017). French livestock breeders have therefore been forced to reconsider their positioning in an agro-industrial GVC whose governance depends less and less on the CAP.

As a tool for identifying (i) dominant actors, (ii) modes of inter-firm coordination, and (iii) subordinate actors' strategies to improve their position, the GVC concept makes it possible to qualify the strategies that the farmers have been using to try and ensure their conditions of

¹ See on this topic case studies about manufactured or agricultural products in Latin America and East Asia (Bair and Gereffi, 2001; Giuliani, Pietrobelli and Rabellotti, 2005).

² Note that these studies enable an amalgamation within a single discussion of two corporuses that have looked at upgrading, to wit, GVC studies and cluster studies – with the latter construed here as a catalyst for GVC upgrading actions (Labory and Prody, 2014). The opposite holds true as well, however, with cluster literature (and its focus on social-spatial dynamics) also highlighting the role played by global buyers' learning effects as one determinant of upgrading processes within clusters (see Murphy, 2007).

³ Exceptionally, Agostino et al (2013) have studied the totality of input and work factor productivity in the case of Italian industrial suppliers. More specifically, they demonstrated significant heterogeneity in suppliers' productivity, depending on their capacity for upgrading and the type of GVC to which they belong.

reproduction. By re-focusing the upgrading concept around issues such as how power is captured within a GVC and how the value-added generated is shared, the concept seems useful for analysing the strategies employed by farmers seeking to improve their position in both respects within the agro-industrial GVC where they operate.

The present article seeks to qualify farmers' upgrading strategies based on the four upgrading categories identified in literature: (i) product adaptation, (ii) new production process development, (iii) new value chain functions pick-up and (iv) interchain production⁴. Based on a territorialised case study of ten out of the thirteen farmers from France's North-East Ardennes department to have invested in energy-producing single-farm biogas units (SFBUs), the paper demonstrates that this comprises an interchain upgrading investment covering two different GVCs (agro-industrial and biomass-energy). To achieve this, the farmers have twinned their interchain logic with a whole series of process and product upgrading strategies in a bid to achieve greater autonomy within their agro-industrial GVC. This finding differentiates "upgrading" - construed as an up-levelling forced upon subordinate firms by their dominant counterparts (and referred to here as "forced upgrading") – from "strategic upgrading", being the variant that subordinate firms conceptualise themselves in an attempt to take power and value-added away from their sector leaders. The distinction takes a new look at the importance of interchain upgrading strategies, neglected far too often in literature but that can be a major driver behind efforts to capture greater power and value-added through the mobilisation of a variety of specific resources.

The paper starts with a discussion of the upgrading concept, specifically mobilising its strategic upgrading variant to highlight subordinate firms' ability to increase their autonomy from their dominant counterparts (Blažek, 2016; Sako and Zylberberg, 2018). They achieve this by adapting to institutional change, by modifying their market behaviour and by developing market entry and exit strategies for different activities within a given GVC or even several different GVCs (see Section 2). This territorialised case study is then used to highlight the combination of three strategic upgrading actions undertaken by Ardennes livestock breeders who own SFBUs (see Section 3). Section 4 concludes by re-situating the upgrading concept within a Global North/Global North perspective. More specifically and despite current doubts as to the continued validity of the European Union's CAP policy, French farmers (unlike their Global South counterparts) are able to rely on a robust institutional background enabling them to propose institutional change in two GVCs (agro-industrial and biomass-energy/waste) and by so doing stabilise the power accrued during the course of their strategic upgrading processes.

2. Upgrading in global value chains

The upgrading concept mainly refers to "leader" firms' influence on the organisation of inter-firm production. Starting with this observation, a distinction can be suggested between forced and strategic upgrading (a). What this reveals is that strategic upgrading offers a framework enabling analysis of subordinate firms' ability to increase their autonomy from the constraints that dominant firms try to impose on them, thereby augmenting their power and value-added within the GVC. A literature review will emphasize three dimensions of upgrading firms'

⁴ Unlike product-based upgrading, this is rooted in the development of a new product that does not belong to the original GVC. Interchain upgrading is also sometimes referred to as inter-sector upgrading in literature.

autonomy strategies: (b) mobilisation of the institutional environment; (c) adaptation of market behaviour; and (d) the decision to enter or exit a particular activity or even the GVC itself.

(a) From forced upgrading to strategic upgrading: structuring the debate around subordinate firms' GVC positioning

The upgrading concept originally emphasized the fact that depending on the objectives defined by leader firms, subordinate companies could - via an innovation process - obtain a greater share of the total value-added. Indeed, the focus in Gereffi's seminal studies (1999) was on the fact that firms' ability to acquire characteristics enabling them to access new market segments depended on the know-how and knowledge that the leader firms transmitted. A similar idea has been developed in cluster literature where the most economically robust firms are the ones that ensure this function through their horizontal relationships. All in all, literature on clusters and GVCs have developed an upgrading classification broken down into four categories (Humphrey et Schmitz, 2002; Schmitz, 2006):

- (1) Product upgrading, which consists of a firm moving towards products that are more sophisticated and therefore generate greater value-added;
- (2) Process upgrading, which enables a more efficient transformation of inputs into outputs through a new organisation of activities and use of better technology;
- (3) Functional upgrading, based on the acquisition of new functions (and/or abandonment of old ones) to enhance the technical and human competencies associated with the activities exercised within a given GVC;
- (4) Interchain upgrading, which consists of mobilising in one GVC competencies acquired while fulfilling a function in another GVC.

These four upgrading categories are ways to qualify "up-leveling" methods. Determined by inter-firm modes of governance and coordination, they also define certain activities' degree of integration (Gereffi et al, 2005; Tozali and El Hadad-Gauthier, 2007). While recognising the heuristic usefulness of this kind of typology, it seems worthwhile to delve more deeply into the determinants of the upgrading process, and to do this by looking beyond inter-firm coordination issues that tend to underestimate subordinate firms' autonomy in GVC. Hence the present paper's use of the qualifier "forced upgrading" to refer to this way of analysing subordinate firms' displacement up and down a GVC. This re-qualification echoes certain authors' critiques of how possible it really is for subordinate firms to fight for their interests via an upgrading process. Several studies have made the empirical observation that up-leveling efforts translating into productivity gains up and down a value chain do not necessarily re-define how the value-added is being shared (Ponte and Ewert, 2009). The upgrading process seems to mainly respond to leader firms' need to constantly improve their competitiveness by getting their subcontractors to innovate. For some authors, this way of looking at upgrading can lead to something called "immiserizing upgrading" (Mohan, 2016), which is when subordinate firms are unable to appropriate the value-added generated by the productivity gains stemming from their innovations, despite the costs they incurred implementing these changes.

Other authors, however, have noted that subordinate firms' inability to capture value-added during a forced upgrade situation can also lead them to develop alternative upgrading strategies that will help them capture greater power and value-added. A number of these downgrading strategies have been identified, alongside analogous diversification,

specialisation, differentiation and volume-related product upgrading strategies (see Ponte and Ewert, 2009). Three basic points tend to be discussed in this more strategic upgrading corpus:

- The need to account for the role that the institutional environment plays in the process, irrespective of the modalities applied.
- The importance of associating upgrading with other concepts drawn from industrial economics, including supply diversification, product differentiation, economies of scale and volume vs. quality strategies.
- The importance of reinforcing the functional and interchain upgrading concept since the two modes allow a more direct analysis of alternative power capture strategies yet are often ignored by authors working in a forced upgrading perspective.

Strategic upgrading is the term that will be used here in reference to an analytical perspective that tries to account for subordinate firms' desire to increase their power and value-added for any of the four aforementioned modalities. Each of the three aspects of this analytical perspective will be studied in turn.

(b) Role of the institutional context and its evolution as a result of subordinate actors' efforts to gain more power and increase their value-added

(i) An endured institutional environment: examples of forced and strategic product upgrading

Irrespective of the modality, upgrading does not always lead to an increase in sold products' unit prices. This can be explained by the fact that it sometimes exposes the upgraded firm to new risks that depend on the institutional context. For example, in Ponte and Ewert's 2009 wine market study, the improvement in quality may have been concomitant with changes in customer preferences that, as a social construct, were always apt to change (Barrère, 2016)⁵. Subordinate firms' efforts to respond, for instance, to leader firms' new specifications would sometimes do no better than to preserve their existing market share. In this case, upgrading was little more than an adaptation imperative reflecting anticipated changes in consumer preferences, or else a strategy encouraged by the leader firm, but which did not generate any extra added value for the subordinate firm. Of course, changing tastes means that consumers may also consider a bottle that closes with a cork (as opposed to a screw cap) is outdated, if only for design reasons. The change may occur at the very moment that a subordinate firm has been invited to respond to new specification requiring bottles with corks - in which case the firm may choose to ignore the new standard⁶ or else negotiate a higher unit price with the principal to reflect the bottle's new design.

The idea here is that the leader firm is not the only party who can game institutional change in such a way as to implement a strategy that will influence the rest of the GVC. Subordinate firms' ability to develop strategies reflecting their institutional context – independently of what the leader firm may want – must also be given consideration. Whereas changing customer preferences in the first instance leads to forced upgrading without any real effect on the subordinate firm's value-added, in the second case it enables strategic upgrading/

⁵ The change may be due to consumers' improved knowledge following certain learning effects, with one recent example being the growing market for gastronomy (TV shows, books, gastro-restaurants, etc.)

⁶ The strategy for anyone who has already adopted the new standard may, in a downgrading logic, consist of reverting to screw caps.

downgrading that, without necessarily giving the subordinate firm greater power within the GVC, does allow it to increase its value-added, at least for a while.

(ii) A chosen institutional environment: the example of a strategic upgrading process

The institutional environment within which farmers choose (individually or collectively) to operate can become a significant factor driving the implementation of a product or process strategic upgrading. This may involve, for instance, a decision to join a cooperative, to build connections with a local Agricultural Chamber, trade union or public research body (like INRA in France). The kind of advice that these latter entities offer farmers can help them to improve their knowledge of vegetable variety selection methods depending on factors like a particular farm soil or climate conditions. Developing this sort of strategy can be crucial in increasing product quality hence the possibility of operating in a product niche that improves the farmer's bargaining position vis-à-vis wholesalers. The recent restructuring of the farm consultancy market, marked by the introduction of a number of private sector actors, has revealed how potentially important a body like INRA can be in determining small farmers' competitiveness (Labarthe and Laurent, 2013). A similar outcome has also appeared with the implementation of new environmental management practices, often proposed by an entity operating outside of a GVC (like ADEME in France). Lastly, the existence of an innovation cluster can enable strategic upgrading based on the presence of a variety of companies or, to the contrary, a high degree of specialisation in a given geographic space (Parrilli and Zabala-Iturriagoitia, 2014; Coe and Yeung, 2015)⁷.

(c) Strategic upgrading: instrumentalising methods drawn from industrial economics

Porter (1985) showed how important product portfolio management is to intra-firm strategy. Based on an analysis centred on production costs, pricing policy, quality and competitive advantage, multi-product firms constantly re-position themselves in markets where they are the most competitive. This supply diversification strategy can result from strategic upgrading/downgrading (Fujita, 2011; Navas-Alemán, 2011; Sato, 2011). Sato (2011), for instance, has analysed the example of Indonesian motorcycle suppliers who found themselves in an asymmetrical power relationship with their Japanese buyers. They first responded with forced functional upgrading to improve their production management but this did not increase profits. They then developed a strategic functional upgrading based on a supply diversification logic and created their own brands to specifically target the Indonesian market. By so doing, they were able to increase their value-added without getting into a direct conflict with their buyers since the own-brand motorcycles were not being sold in Japan.

This form of functional upgrading-related diversification can sometimes lead to an integration of firms operating upstream or downstream, or to the contrary, to certain activities being externalised (i.e. outsourced). In this case, firms may engage in functional upgrading temporarily (or permanently) by outsourcing their lower value-added activities (Blažek, 2016).

⁷ On this particular point, the "global production networks" (GPN) construct (Ernst and Kim, 2002; Henderson et al, 2002) offers a vision more geared towards the variety of actors contributing to the production process instead of the diversity of geographic, political and institutional factors affecting their competitiveness and more broadly their ability to seize opportunities to re-position themselves in the GVC. The focus in GPN (like GVC) literature is not on analysing subordinate firms' strategies individually but on a more regional perspective covering the whole of a territory or cluster (Sako et Zylberberg, 2018).

In the Rumanian textile sector, for instance, several firms have outsourced part of their low value-added activities to poorer countries outside of the European Union. Turning to subcontractors allows them to cut costs, notably labour costs, while avoiding labour shortages for these functions. The firms are then free to concentrate on other activities (Plank and Staritz, 2015). Integration may also be an upgrading strategy that enables greater power and value-added within a GVC. At one extreme, this kind of upgrading – leading to a direct confrontation with other GVC actors – may cause a major shift in power. The industrial production of biomass plants offers literature (Hansen et al, 2016) the example of Delta, a Chinese firm originally founded in 2004 to supply the sector but which became its global leader, notably after acquiring two Danish companies. These acquisitions and the associated transfers of knowledge and competency meant that Delta acquired the ability to develop inhouse plant designs and drive technological innovation throughout the sector.

Diversification can also refer to the various degrees of quality associated with a given product, culminating in a differentiation strategy⁸. Certain GVC studies have highlighted subordinate firms' ability within a GVC to implement differentiation approaches and by so doing reduce the risk of excessive specialisation in one quality product (Ponte et al, 2014). In this way, forced product upgrading can be offset by strategic product downgrading, which consists of maintaining lower quality production while simultaneously developing a higher quality product. The reasoning here is based on the profitability gap between two quality levels for one and the same product, in other words, on an analysis of the price elasticity of demand associated with the two levels of quality. Coupled with the institutional environment choices (see Section 2.b.ii about the possibility of joining a producers association or a cluster), this “multi-range” strategy can be a way of capturing power and increasing value-added. For farmers forced to raise product quality, keeping a midrange product - and working collectively through a producers cooperative to ensure everyone's ability to supply wholesalers with sufficient volumes - can be a good way of increasing an activity's profitability even when a powerful leader firm makes stringent quality demands (Mohan, 2016). Some firms have even decided to specialise in a single midrange product, turning their backs on a commercial relationship with their sector's originally dominant firm.

A productive specialisation logic can also culminate in functional strategic downgrading relating notably to the kind of commercial strategy pursued by a supplier unhappy with its current margins or market share⁹. This type of company may decide to re-focus on a market segment where it can take full advantage of its core competencies and increase profitability. Herrigel (2004), for instance, did a study on the German automotive parts manufacturer Keiper who stopped producing complete car seats to concentrate solely on seat structures.

Lastly, a productive specialisation-based functional downgrading strategy can result from a loss of power within a GVC caused by an unexpected change in the institutional environment (see 2.b.i). The fall of the Berlin Wall, for instance, gave certain Eastern European firms a competitiveness problem when they had to integrate their respective GVCs. Their response was to fall back on the production of spare parts or to engage in assembly work where they

⁸ Within a large domestic context, economies of scale offer a good argument for concentrating production among a limited number of firms operating both near their local market and in export markets (Krugman, 1980).

⁹ For a literature review of functional upgrading/downgrading, see Choksy et al (2017).

had a competitive advantage, instead of trying to compete on a whole range of finished goods¹⁰.

(d) Interchain upgrading: a strategy for subordinate firms

Despite being part of four different modalities, interchain upgrading has only been rarely analysed in literature, with one frequent example being Taiwan firms' transition from the production of television to computer screens (Schmitz, 2006). It is worth noting that the first researchers to critique this issue (Ponte and Ewert, 2009) decided not to apply it in their analysis of the South African wine GVC. There were probably two reasons for this. The first was methodological, reflecting the fact that researchers suggesting GVC-centered analysis often face serious data compilation and analysis problems, causing them in turn to limit the scope of their studies to whichever GVC they are examining¹¹. It is also likely to be the same difficulties that explain why researchers tend to confuse functional and interchain upgrading. Examples of the latter usually involve firm abandoning a function without dropping out of its original GVC (for example, when a domestically targeted production shifts to an export focus). The second reason is more theoretical in nature, stemming from the fact that subordinate firms turning their back on a core activity are intentionally removing themselves from leader firms' sphere of influence. This situates the upgrading concept from the very outset in its strategic dimension, one that tends to be neglected in literature (see above).

Furthermore, interchain upgrading is usually viewed as a transfer of the knowledge and competency acquired in one GVC to another GVC. This calls for three comments. The first is the reductionism of the idea that interchain upgrading only pertains to intangible assets. In reality, it can also involve a physical product, one example being when the existence of joint products resulting from a firm's original GVC's production process convinces it to implement strategic interchain upgrading and use the products in an entirely different GVC (see Section 3's example of agricultural waste used to produce energy). The second comment relates to the fact that entering a new GVC is from the very outset likely to induce a firm – notably due to the nature of the function that it has chosen to perform there – to seek a larger share of the value-added compared to what it got in its original GVC. The third comment is that literature does not envision any feedback effects that the interchain upgrading may have on the original GVC. Joining a new GVC can increase a firm's freedom to manoeuvre in its original GVC by ensuring the economic viability of its decision not to differentiate a product or undertake productive diversification but instead to engage in specialisation – or vice versa (see above). This process is a vector for productivity gains that are harder to identify hence to appropriate by dominant firms since they result from a strategic upgrading that is external to their GVC.

(e) Section 2 conclusion

Given the minimal profits and the risks associated with up-leveling process (i.e. forced upgrading), literature has concentrated on the avoidance strategies pursued by the weakest

¹⁰ See notably Pavlínek (2008) for the Czech automotive sector and Plank and Staritz (2015) for the Rumanian apparel sector.

¹¹ To overcome this difficulty, the paper has opted to analyse one specific GVC actor. The approach is not exhaustive as far as analysis of the two GVCs (agro-industrial and biomass-energy) being studied is concerned. But since the main issue here is upgrading and not GVCs per se, it seems more effective to start with the actors who are actually being subordinate, in this case Ardennes livestock breeders, and the strategies they developed.

actors, who use this process as a lever for re-positioning themselves in their GVC. The present text has highlighted the role that institutional change – either endured or initiated - has played in the dynamics associated with subordinate firms' capture of greater power and value-added. Mobilising strategies drawn from the field of industrial economics is a second vector that enhances subordinate firms' ability to add to their market power while engaging in strategic upgrading. Lastly, interchain strategic upgrading can theoretically be a source of additional power and value-added in a company's new GVC as well as in its original one. Section 3 will use a case study from France's Ardennes department to demonstrate the ability of livestock breeders operating there to develop some of the strategic upgrading that has been studied above to minimise the negative aspects of the position they occupy in their current agro-industrial GVC.

3. Biogas units: Ardennes farmers' strategic interchain upgrading

Since the early 2000s, a number of farmers have developed an energy production activity based on the use of biogas units (BU). This activity consists of producing biogas via an industrial process that occurs when the absence of oxygen causes micro-organisms found in certain organic materials to degrade (in a so-called anaerobic environment). The biogas produced in this way is a source of energy that can be used in different ways. In France, for instance, most farms transform biogas into electricity that they then sell to the grid, with 251 out of the 267 agricultural BUs inventoried in 2016 in France that implemented a cogeneration approach (and every farm in the Ardennes context) (ADEME, 2017). The electricity production process also generates heat as a joint product used for farm buildings or houses.

Other ways getting value from biogas are being developed, starting with its transformation into bio-methane (with the official French target being for 10% of this energy source in the gas mix by the year 2030). Bio-methane can either be injected into the grid directly if a farm lies near a connection or else be bottled and hauled by road. Biogas can also be transformed into bio-NGV automobile fuel or into hydrogen for industrial and transport purposes¹². Besides from biogas, BUs also produce digestate, a rich wet organic material that can be used for fertiliser.

The biogas production process, as described above, is a renewable energy production solution recognised by the European Union and which has, in certain cases, involved public subsidies used to develop wet biomass energy (WBE) industry ¹³. The sector has been expanding with something like 50 additional biogas units being added in France every year (ADEME, 2017). Note the decision taken by the country's Minister for the ecological and inclusive transition in February 2018 to establish a national workgroup to accelerate the sector's expansion.

(a) Empirical methodology

Some Ardennes livestock breeders started as far back as 2004 to invest in innovative biogas unit technologies, at a time when subsidies were not as attractive as they are today (see Section 3.c). To understand why they did this, a survey was carried out based on semi-

¹² For further details on biogas production and its expansion in France, see ADEME (2017).

¹³ Regarding the use of biomass to produce energy, there are three main branches: WBE (the topic of the present paper); energy from wood; and biofuel (in the form of oil or alcohol).

directive interviews with ten of the thirteen Ardennes department farmers who own a biogas unit. This was supplemented by interviews with members of relevant local associations. These are the materials underpinning the present case study. The semi-directive interview followed a protocol ensuring that the questions were open-ended, something encouraging interviewees to share their thoughts more fully. Questions were very precise but the researcher rarely asked them in a pre-defined order, remaining flexible and re-orienting discussions as needs be. The interviews lasted two hours on average and went through three stages. The first compiled farm data by visiting equipment used solely for agricultural purposes. The second stage involved an inspection of the biogas units, with interviewees talking about them at the same time. The final stage fleshed out farmers' business model, by looking at their co-management of the two activities in question. This entailed compiling as much economic data as possible relating to the equipment's energy efficiency, revenues, legal structure and profitability.

The survey was structured in such a way as to identify all of the institutional and economic factors that livestock breeders – heretofore subordinate in the agro-industrial CGV - might mobilise to achieve strategic upgrading and capture greater power and value-added. A case study situated in a single geographic territory was considered appropriate here because it enabled a deeper study of complex social phenomena that had yet to be characterised – and which were difficult to dissociate from the context in question (Yin, 2013). The phenomenon in question here was strategic upgrading - and more specifically, the strategies associated with interchain upgrading.

(b) Socioeconomic context

France's Ardennes department is sparsely populated (277,000 inhabitants according to the 2015 INSEE census, or 53 inhabitants/km²). It has been in economic crisis since the mid-1970s due to decline of the local metallurgy industry. As a result, agriculture - which accounts for 60% of all land in the area and is comprised of something like 3,000 farms - represents 15% of all Ardennes companies today (featuring 3,800 farm owners, 1,650 family farms and 600 full-time employees). This equates to 5% of all jobs in the department. Two-thirds of Ardennes farms engage in livestock breeding activities. As a result, permanent agricultural grassland (PAG) accounts for a large percentage of the area's total 306,500 hectares of farmland. There are 122,000 hectares of PAG in the department, with the remaining 184,500 hectares being arable land (AL). Using 2012 data from the Ardennes Agricultural Chamber, local farms average a total cultivated area of 126 hectares, with 49 hectares PAG and 77 hectares AL. Dairy farms average 54 milk cows, cattle ranches 45 suckler cows and sheep breeders 190 head. All in all, the Ardennes district is characterised by its livestock diversity. At the same time, it is also neighbours with the Marne department, which hosts many grain growers¹⁴ and other important players in this specific agro-industrial sector¹⁵. Geographic proximity is a key element when analysing the WBE industry's development, which depends first and foremost on easy access to agricultural and agro-industry waste, which is biogas units' main raw material.

¹⁴ The Marne department is France's leading producer of grains (wheat, barley) and dehydrated alfalfa; second leading producer of industrial beets, protein peas, starch potatoes and rapeseed; and fourth leading producer of fresh potatoes, carrots and onions.

¹⁵ Which includes France's leading dehydrated alfalfa producer (France Luzerne); Europe's largest grain cooperative (VIVESCIA, ex Champagne Céréales); France's leading sugar cooperative (Cristal Union); and the world's number one malt exporter (Malteurop) and biggest alfalfa silo.

(c) Interchain upgrading: livestock breeders' wish for greater power

The Ardennes may have been a trailblazing district for biogas production in France but this was mainly a reflection of the particular institutional environment and economic context. The first GAEC *Groupement d'Exploitation en Commun* farm partnership to invest in a BU involved a dairy farmer reacting to his industry's growing fragility, caused by changes since 2003 in the management of milk prices (leading to falling prices endangering his farm's operational viability). At the same time, the district saw the birth of an environmental protection association called ALE08 whose managing director since 2002 had a PhD in Chemistry, having specifically studied biogas production. From 2002 onwards, the association had been organising information meetings introducing local farmers to the idea. Then, one group of livestock breeders got the association's support to organise visits to farms already using biogas units in Germany, which is not very far from the Ardennes. France's first single-farm biogas unit (SFBU) started operations in 2005. The farmer's decision to progress was partially explained both by the financial reasoning and by his personal environmental sensitivities. Interviews with the nine other farmers to follow in his footsteps showed that their motivations were mainly strategic. All ten of these first SFBU farmers have said that the main reason for their investment was the desire to generate income from a source other than their normal farming activity - with the second reason being a desire to "gain greater autonomy from the agro-industrialists"¹⁶. In other words, starting in an economic context that they had had to endure, the farmers were able to mobilise their institutional environment (here, ALE08) in a way that helped them develop strategic interchain upgrading. Other Ardennes livestock breeders were then able to leverage their colleagues' initial experiences to also invest in SFBUs, again with the help of ALE08. Each said that they had systematically visited at least two other SFBUs in the Ardennes before finalising their project. In other words, a Marshallian externality mechanism was operative here, explaining how the number of Ardennes department farmers who owned an SFBU had risen in a decade from one to thirteen.

Farmers use the joint products from their primary activity – breeding effluents (manure and dung) and crop residues – as the main raw materials for their cogeneration biogas units. The energy produced in this way had no direct connection to their agro-industrial GVC but was a staple product in the emerging WBE industry. The interviews showed that, within the new value chain, farmers were intentionally looking to have a better position in terms of their power and ability to coordinate in the new value chain compared to their position in the agro-industrial GVC. In fact, from a purely technical perspective, an SFBU can rely on a wide range of raw materials to produce methane. Household waste along with agricultural and grain industry residues are important feedstock for biogas units and as aforementioned, they were particularly copious in the Ardennes because it was neighbours with the Marne department¹⁷. However, with the exception of one farmer, all interviewees explained that the main objective

¹⁶ The term that most farmers used. Discussions below will reveal how this objective is key to understanding how biogas unit capacities are calculated in the Ardennes.

¹⁷ Technically, raw materials can also not be residues in the sense that farmers might decide to produce energy crops specifically made for SFBUs. This practice is widely developed in Germany, where it is accepted by the institutional system (and even positively encouraged before certain 2012 reforms). In France, government incentives do not encourage the practice, with a higher subsidised feed-in tariff being offered for electricity sales in those situations where accounted for at least 60% of the raw materials put into the biogas unit. Note the limitation on dedicated energy crop imports, set at 15% of the total crop used.

was to be totally autonomous in deciding their SBFU inputs, sizing the units with this one goal in mind. The only farmer choose a larger sizing for his BU is using, in addition to his own manure, his neighbour's manure. This was organised by means of a totally informal contract in which he shared with the neighbour some of the digestate he produced as well as residues from his father's grain farming activities.

The relatively modest size of the BUs in the Ardennes department (averaging 175 kW) translated farmers' perfectly self-aware strategy of maintaining their autonomy vis-à-vis any and all agro-industrialists. During the interviews, the farmers systematically expressed the fact that the strategy reflected their previous experiences with agro-industrialists' asymmetrical power, particularly on the downstream side of the agro-industrial GVC. The fear they expressed was that upstream WBE agro-industrialists might unilaterally increase the price of the residues they sold farmers, undermining biogas's profitability over the long run.

In parallel to this, the ALE08 Association wanted to encourage farmers to create a residues purchasing cooperative. Much like what is already happening in Switzerland, this would decrease the asymmetrical risk while allowing the farmers to increase biogas unit capacities. The project never concluded, however, probably because farmers' desire for autonomy was greater than their interest in cooperation. Nevertheless, the strategic desire to manage inputs did cause some of the farmers interviewed to occasionally purchase residues from agro-industrialists - depending on the price - in order to build up their reserve stocks. Two farmers also mentioned the fact that they sometimes made this kind of purchase simply because they wanted to provide service to the agro-industrialists (for instance when a truck containing residues broke down while driving to the treatment centre) - the purpose being to subsequently negotiate advantageous prices when purchasing animal feed (see 3.d and the feedback effects on the agro-industrial GVC). The fact that they viewed participation in the WBE industry – where agro-industrialists were quite obviously important stakeholders – through the lense of their previous experience in the agro-industrial GVC shows that the farmers equated the SFBU with interchain strategic upgrading. The idea for them was to increase their autonomy vis-à-vis WBE agro-industrialists¹⁸ compared to the asymmetrical power from which they were suffering in the agro-industrial GVC, both upstream and downstream¹⁹. It would, however, be wrong to consider that by acting in this way, the livestock breeders had successfully transitioned from being a subordinate firm in the agro-industrial GVC to a dominant firm in the WBE industry. In particular, SFBU profitability (see Appendix 1) currently depends on the existence of a subsidised electricity feed-in tariff, with France's Enedis National Grid having since 2016 paid a fixed price of 20 to 22.50 euro cents per kWh²⁰ for biogas units that get 60% of their inputs from breeding effluents, versus the non-subsidised price of 6 euro cents. Towards the industry's downstream side, power asymmetry issues (hence potential questions about the conditions in which value-added is shared) were masked behind public renewable energy policy debates. The subsidised tariff involved a 15-year contract with Enedis, with the price negotiated set to decrease over the contract's final five years. This current comfortable

¹⁸ Agro-industrialists can also supply farmers on the GVC's upstream side, as shown by the deal where residues are swapped for animal feed.

¹⁹ Using the topology developed by Gereffi et al (2005) this agro-industrial GVC governance modality might be described as captive both upstream and downstream. It is characterised by significant power asymmetry making it necessary for farmers to accept the decisions of other key actors, like suppliers and customers.

²⁰ The exact number depends on the size of the biogas unit and was specified in a French State decree dated 13 December 2016.

position of the livestock breeders who had invested in biogas production is therefore a temporary situation.

(d) Interchain upgrading feedback effects materialising in new upgrading and strategic downgrading opportunities in the agro-industrial GVC

Interchain strategic upgrading as analysed above had affected livestock breeders' positioning in the agro-industrial GVC. They were then able to initiate strategic functional and process upgrading in the agro-industrial GVC due to the characteristics of the methane production process.

The first strategic upgrading actually involved a functional downgrading coupled with a process upgrading. This relates to the use of digestate as crop fertiliser. Integrating fertiliser production activities into farming operations - as the joint product of an energy production activity - is akin to functional downgrading. Livestock breeders using digestate were simultaneously reducing the need for chemical fertilisers, meaning that process upgrading was at work here. Replacing manure – henceforth used for biogas production - with digestate (and all its nutritional qualities) turned out to be more efficient in per-hectare yield terms. This strategic functional downgrading, coupled with a process upgrading, was something that the breeders had already identified when developing their biogas plant projects. When thinking about SFBUs investments, they had anticipated how digestate could reduce chemical fertiliser purchases and lower milk and meat production costs. Of course, they might have preferred selling the digestate and buy a greater quantity of chemical fertiliser, hoping in this way to offset the loss of the manure that was now going to the biogas plants. The greater autonomy enabled by the use of digestate was a key motivation explaining their choice. The farmers interviewed had also spoken about how using digestate facilitated their relationships with neighbours because it was less smelly than spreading manure across the fields. This argument is particularly significant since the installation of an SFSU often encounters resistance from neighbours worried about odours. The use of digestate helps to attenuate this (ADEME, 2018).

The second upgrading was also functional in nature. A biogas cogeneration process creates a second joint product in addition to the digestate - namely heat. This can be used to heat farm sheds but also houses. When the first SFBUs were installed in the Ardennes, subsidies for this kind of investment depended on the use of heat. There was an incentive for livestock breeders to build local heat networks (and include the cost in their investment calculations). This district heating would serve all the houses in the area²¹ in addition to farm buildings, especially silos. In this way, farmers could improve their grain storage, hence their production process, while engaging in functional upgrading. The five farmers to have invested most recently in an SFSU – and who were no longer subject to requirement regarding the use of the heat generated – all decided to continue in this vein. In their view, coupling functional upgrading with a process upgrading was entirely strategic. This reflected both learning effects

²¹ It is worth noting that two of the three farmers who had set up a heat network for neighbouring houses preferred to only service ones belonging to family members. In other words, they were not looking to generate any extra income through some kind of commercial contract but instead to increase their wider family circle's energy autonomy. Only one farmer took advantage of this opportunity to generate significant revenues complementing what he earned through his main farming activity.

associated with Marshallian externalities and actors' desire to cut production costs and achieve productivity gains by changing the production process.

The third strategic upgrading implemented in the agro-industrial GVC (and enabled by interchain upgrading) was a change in the nature of livestock breeders' work. Seven of the ten interviewees had been involved in both the meat and dairy business before investing in a SFBU – meaning that this sub-group was engaging in a form of process/product downgrading when they chose to specialise in either milk or beef production. This can be explained by the fact that SFBUs offered them a stable income (see Appendix), allowing them to eschew a productive diversity logic while continuing to protect themselves against meat or dairy market fluctuations. SFBUs required relatively little work, estimated at about three hours a day once the productive process was under control. This was much less than the number of hours spent daily on breeding activities. Reducing work time in this way increased hourly productivity.

All of this strategic upgrading made it possible to lower meat and dairy production costs, offering farmers operating an SBFU an advantage over those who did not. Since dairy and meat prices remain largely determined by the global market and given that the agro-industrialists operating on the downstream side of the agro-industrial GVC were unable to detect the functional and process changes implemented by the farmers, the latter were able to keep the value-added generated by all of these organisational and productive modifications. The different forms of strategic upgrading enabled by the arrival of biogas production therefore caused a clear improvement in farmers' situation, at least temporarily.

4. Conclusion

The present case study is an original way of studying upgrading, one focused on the strategies pursued by subordinate firms and not on GVC coordination, which tends to dominate much contemporary literature. By focusing on subordinate firms' "positioning", current studies only analyse some of the modalities that they have used to capture value-added and increase power. The present study adds to that corpus.

From a theoretical perspective, three aspects are developed here in order to render the upgrading concept operative from a "strategic" analytical perspective. Firstly, a distinction must be made between forced upgrading imposed by a GVC and strategic upgrading decided autonomously by subordinate firms seeking to enhance their ability to capture power and increase value-added. Secondly, the usefulness of concepts drawn from the field of industrial economics concepts has been noted here, with examples including product diversification, productive specialisation, integration and externalisation, all of which can help in analysing and understanding subordinate firms' strategies. Thirdly, the present paper characterises strategic interchain upgrading which is a sub-topic that is under-weighted in GVC literature since it focuses on the GVC rather than on the firms themselves.

Empirically speaking, this perspective enables scrutiny of a unique example of interchain upgrading, notably where this occurs in the context of subordinate firms operating in the developed world. In this setting, studying French Ardennes department livestock breeders' upgrading strategies reveals a population that decided to develop biogas production activities for strategic reasons: to capture value in a new chain; and to increase their autonomy from the agro-industry. In addition, firms' interchain upgrading strategy helped them to up-level

within the agro-industrial chain, based notably on a reduction in production costs involving the use of digestate (to fertilise the soil) and heat (to dry grain). Both of these items can be obtained through the biogas production process.

Nevertheless, analysing subordinate firms' choices does not suffice in and of itself, given how very dependent their strategies (and the consequences thereof) are on the specific institutional context and its changes over time. Depending on this latter aspect, upgrading akin to the kind observed in the Ardennes can produce very different outcomes. Specifically, where cooperatives have a local presence there is a different relationship to the one found in the agro-industry. This other relationship might cause farming interests to suffer a new kind of dependency on the agro-industry, based on factors like the availability of waste and energy and/or general immiserization (due to the increased mass of work and need for different competences). More generally, in an interchain situation, a more nuanced understanding of the upgrading implemented by farming firms requires an observation of the strategies of the other actors participating in the new value chain. For biogas production, this is even more complicated given that the product derives from three industries (waste, agriculture and energy, whether bio-methane or electricity) - each of which has its own actors pursuing their own interests. Furthermore, players' strategies are not necessarily concomitant over time. Firms may increase their value-added in the short run but see this subsequently captured by other parties within their GVC. Over the long run, for instance, nothing guarantees that Ardennes farmers will be able to maintain the productivity gains they have made in the agro-industrial GVC because of their implementation of biogas production.

In the example studied here, interchain upgrading relies on the existence of a new chain whose development is being subsidised. The problem is that subsidies have only been available since the 2000s and the sums involved are due to diminish over the medium term (with electricity feed-in tariffs only being guaranteed, for instance, for a maximum of 15 years). This means that in addition to the spatial dimension, consideration must be given to temporal dynamics by incorporating the institutional context into the analysis. New objectives (i.e. the energy transition) might help subordinate actors to develop strategies enabling them to capture greater power and value-added in their GVCs. And other actors should be able to develop similar strategies, leading in turn to a certain isomorphism with existing units (Carrosio, 2013). Otherwise, the end of medium-term grant money raises questions about the strategies that livestock breeders will be able to develop in this new context, and more broadly about the possible role of interchain upgrading as biogas production expands.

All in all, the present analysis supplements approaches centred on the idea that rising biogas production is best understood by identifying territorial resources and needs (Loiseau et al, 2018). It does this by taking a new look at the subject, one that includes the strategies pursued by the actors actually associated with the trend. Following up on this, analysis of the institutional context's role and the strategies of the various actors in the agro-industrial GVC will require both quantitative and qualitative surveys comparing different geographic areas. Furthermore, and as far as we are aware, the present study is one of very few to analyse subordinate firms' upgrading strategies in the Global North. Understanding the specificities of this context would be only possible if a comparative perspective is taken, one that includes subordinate firms operating in the same sector but in the Global South.

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Appendix: Estimated profitability of a 250 kW SFBU

Expenses (annualised)		Revenues (annualised)	
Investment:		Electricity sales to EDF:	
Interest charges and depreciation:		2 million kWh:	€420,000
	€156,000		
Engine:	€36,000		
Operations:			
Diesel (3l/h):	€20,000		
Maintenance:	€15,000		
Repairs:	€10,000		
Downtime (130h/year):	€6,825		
<u>Total expenses:</u>	€243,825	<u>Total revenues:</u>	€420,000
Net pre-tax earnings:			€176,175

NB: The calculation does not include valuations of joint products, which are generally non-commercialised (heating for an industrial shed and ca. 10 homes plus the digestate used).

A 250 kW SFBU averages 8,500 hours operations annually, producing 2 million kWh sold at a subsidised price of 21 euro cents/kWh (where 60% of the input for the unit in question coming from breeding effluents). This annual estimate applies to the first seven years of a cogeneration-type SFBU run by a livestock breeder who is 100% autonomous in terms of the inputs used, with 80% coming from manure. The assumed investment is €1.4 million, including €420,000 in state subsidies. Borrowing costs are estimated at 3% APR fixed, repaid over seven years. The engine is changed every five years and costs €180,000. According to surveyed farmers' returns, the SFBU accounts for 50% of total turnover (with SFBU revenues

being integrated with operational revenues since none of the livestock breeders interviewed had separated their electricity production activity from the rest of their farming activity). Also according to the interviewees, the SFBU accounted for circa 60% of the farm's net operating profits.