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The impact of the customer order decoupling point on type and level of supply chain integration

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Literature suggests that more supply chain (SC) integration increases of SC performance. However, recent research shows that contextual factors affect the effectiveness of SC integration efforts. Specifically, the location of the customer order decoupling point (CODP) might be such a factor, but there is limited empirical evidence. This study explores the impact of the location of the CODP on SC integration. It empirically investigates upstream, internal and downstream SC integration efforts in twelve metal parts producing Dutch companies to offer a comprehensive view of the effects of the location of the CODP on SC integration. Our results show a clear relationship between SC integration and the location of the CODP. Specifically, make-to-order (MTO), assemble-to-order (ATO) and make-to-stock (MTS) companies show relatively high levels in upstream, internal and downstream SC integration, respectively. Moreover, MTO companies mainly share forecast information and engage in joint R&D with their suppliers, ATO companies focus on internal SC integration using information systems and planning, while MTS companies interact with their customers intensively to exchange forecast information. Our study adds to the insight on the application of SC integration in different situations and offers initial evidence for the effects of the location of the CODP on SC integration.

Keywords: supply chain management; customer order decoupling point; empirical study

1. Introduction

Ever since the seminal papers of Stevens (1989) and Frohlich and Westbrook (2001), the dominant paradigm of supply chain (SC) integration has been that more integration both with customers and suppliers is beneficial. This paradigm has been challenged in recent research that has shown the relevance of a contingency-based approach (Van der Vaart and Van Donk 2006; Flynn, Huo, and Zhao 2010; Wong, Boon-itt, and Wong 2011; Giménez et al., 2012). In such an approach, level and type of SC integration might depend on contingencies. Contingencies refer to different markets, different levels of uncertainty in supply and demand and/or standard or customised products: together reflected in a major contextual factor for SC integration, the customer order decoupling point (CODP). So far, research has considered the effect on the firm's planning and control upstream and downstream of the CODP (Olhager 2010). The main thrust of this study is that such effects could also be expected beyond the firm's borders and be applied to SC integration. As the CODP balances opposing market, product and process-related characteristics, we would expect that different positions of the CODP (e.g. make-to-stock [MTS] or make-to-order [MTO]) result in differences in both the use of certain integrative practices, and the level of integration both backward with suppliers or downward with customers. Earlier research (e.g. Sahin and Robinson 2005; Forslund and Jonsson 2007; Olhager and Prajogo 2012) has suggested that further research on the effect of the position of the CODP on the type and level of SC integration is necessary.

There is some related literature, specifically addressing a contextual approach to SC integration. Fisher (1997) and Ho, Au, and Newton (2002) argue for taking context into consideration, which is supported by empirical findings (Van der Vaart and Van Donk 2006; Flynn, Huo, and Zhao 2010; Wong, Boon-itt, and Wong 2011; Giménez et al., 2012). In this line of research, Van der Vaart and Van Donk (2006) and Giménez et al. (2012) also take the CODP into account, but only as part of their measure of supply complexity, without considering the single effect of the CODP. Additionally, they limit their investigation to the buyer-supplier relationship viewed from a supplier perspective. Sahin and Robinson (2005, 583) analytically explore the relationship between SC integration and the CODP using a stylised model, based on a single case applying MTO. Forslund and Jonsson (2007) suggest a difference in the use of forecasting information between MTO and MTS suppliers, but find limited evidence for an effect on performance. In a survey among Australian companies, Olhager and Prajogo (2012) explicitly consider the effect of SC integration in MTS vs. MTO companies

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and find considerable difference in the performance effects of different improvement practices in both situations. They conclude that the distinction between MTO and MTS is important for SC improvement initiatives. Surprisingly, both subsamples of companies do not show differences in the level of such practices, only in their effect on performance, leaving room for more exploratory research across all directions of SC integration. This is the gap this study seeks to explore.

Based on the above, the main aim of this study was to investigate if the location of the CODP influences the level and type of SC integration with suppliers, internally, and with buyers. As this is an explorative question, we base our findings on a multiple case study, using interviews as our data gathering approach.

The study contributes by investigating three locations of the CODP and their influence on the level of downstream, internal and upstream SC integration, considering three dimensions of SC integration, i.e. attitudes, patterns and practices of integration, following Van der Vaart and Van Donk (2008) and Vallet-Bellmunt and Rivera-Torres (2013).

The structure of this study is as follows. The next section will present the theoretical background. Then, the methodology will be described in section three. The fourth section of the study will present the main findings, followed by a discussion. The final section will provide some concluding remarks along the implications of our study, and some recommendations for possible further research.

2. Theoretical background

This section provides the theoretical foundation of this study, CODP and SC integration, and discusses the papers relating these.

2.1 Customer order decoupling point

The CODP is the point at which, on the upstream side, value added processes are based on forecasts, and on the downstream side, value added processes are based on real customer orders (see Sharman 1984; Hoekstra and Romme 1992). In other words, it is the marketing–production interface (Teimoury and Fathi 2013). The CODP, also known as the order penetration point (Olhager 2010), serves as a point of reference to decide where to implement efficiency- and flexibility-related production techniques. On the upstream side, lean- and forecasting-based mechanics can serve to make the processes as efficient as possible, and on the downstream side, agile- and order fulfilment-related mechanics can serve to make the processes as flexible as possible. Using both lean and agile like this is also labelled as leagility (Naylor, Naim, and Berry 1999).

Usually there is one dominant CODP (Olhager 2010): either MTO, assemble-to-order (ATO), or engineer-to-order (ETO), see Figure 1. In this study, ETO and MTO are seen as one type, because Olhager and Prajogo (2012, 162) argue that MTO and ETO are identical from a SC and material flow perspective. For additional discussion and decoupling points in information flow or in product structure, see Banerjee, Sarkar, and Mukhopadhyay (2012).

Olhager (2003, 2010) and Hallgren and Olhager (2006) state that strategies for manufacturing and SC planning and control differ based on the location of the CODP, in line with the above-mentioned difference between lean and agile.

2.2 SC integration

SC integration is usually defined as ‘the degree to which a manufacturer strategically collaborates with its SC partners and collaboratively manages intra- and inter-organisational processes, in order to achieve effective and efficient flows of

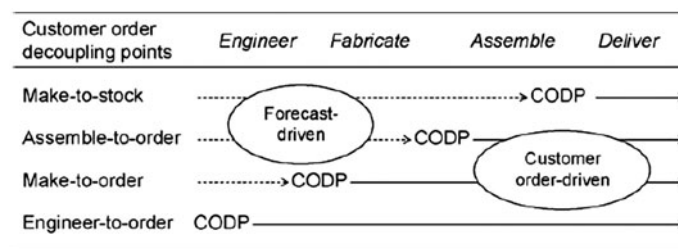


Figure 1. Different product delivery strategies relate to different order penetration points. Source: Adapted from Olhager (2010); Figure 1, 320.

products and services, information, money and decisions, to provide maximum value to the customer' (Flynn, Huo, and Zhao 2010, 58). Following the well-known paper by Frohlich and Westbrook (2001), it is generally accepted that both backward (with suppliers) and forward (with customers) integration contributes to increased performance, which is confirmed empirically (e.g. Fabbe-Costes and Jahre, 2008; Van der Vaart and Van Donk 2008; Leuschner, Rogers, and Charvet 2013). Additionally, following early conceptual papers (Stevens 1989; Harland 1996) and recent empirical work (e.g. Flynn, Huo, and Zhao 2010), also internal SC integration is important. In the early papers, internal integration was assumed to be a first step towards, or even a necessary condition for external integration. Despite its appealing logic, so far empirical evidence to support this idea is lacking (e.g. Narasimhan, Kim, and Tan 2008). Flynn, Huo, and Zhao (2010) find, from a contingency theory perspective, that internal integration serves as a condition for improved external integration it. This result shows that different types of integration need to be considered together rather than in isolation, but does not show a direct time-dependency, as the study is based on cross-sectional data. Overall, it seems that the role of internal integration in realising improved SC performance and its possible relation to both backward and forward planning is relatively ignored. While studies do relate SC integration to suppliers, buyers or both (Van der Vaart and Van Donk 2008), their mutual relationships or dependencies are hardly investigated. Frohlich and Westbrook (2001) and Childerhouse and Towill (2011) present 'arcs of integration' basically as the combination of high and low scores on forward and backward integrations. However, it is never questioned if these two are somehow connected or what possible underlying causes for these profiles are. Therefore, we consider backward, internal and forward integration and their possible relation to the location of the CODP.

Van der Vaart and Van Donk (2008) and Fabbe-Costes and Jahre (2008) argue that the current research in SC integration falls short in the rigour and consistency of its measures and in making clear what integration covers or not. Others have argued that SC integration has different dimensions (e.g. Chen and Paulraj 2004; Das, Narasimhan, and Talluri 2006). Van der Vaart and Van Donk (2008) propose to distinguish between three dimensions or categories of items of SC integration: SC practices (specific activities), SC patterns (modes of communication) and SC attitudes (relational aspects, trust). First, SC practices are defined as tangible activities or technologies that play a role in the collaboration of a focal firm with its suppliers and/or customers. Examples are the use of electronic data interchange (EDI), integrated production planning, vendor-managed inventories and delivery synchronisation. Second, SC patterns relate to the interaction and/or communication patterns between the focal firm and its suppliers and/or customers. Examples are regular visits to the supplier's facility, frequent face-to-face communication and high, corporate-level communication on important issues. Third, SC attitudes refer to the attitude of buyers and/or suppliers towards each other or towards SCM in general. Examples are a firm's expectation with respect to the future of their relationship with suppliers and/or buyers, how they consider problems that arise in the course of this relationship and whether they share the responsibility for making sure that the relationship works for both parties.

Some recent studies show that indeed these three dimensions can be distinguished (Giménez et al., 2012; Leuschner, Rogers, and Charvet 2013; Vallet-Bellmunt and Rivera-Torres 2013): 'integration has a three-dimensional structure, each dimension illustrating a different approach to the concept of integration. Attitudes can therefore be assigned to the corporate philosophy, with a relational dimension; patterns can be linked to the more strategic part and with the collaboration dimension; and practices is related to the more operative part or the interaction dimension' (Vallet-Bellmunt and Rivera-Torres 2013, 318).

2.3 Linking CODP and SC integration

There is a limited literature that investigates the relationship between CODP and SC integration. Sahin and Robinson (2005) discuss upstream SCI in a MTO environment, based on a single case and stylised models of information sharing and physical flows, and state 'tighter SC integration in MTO SCs through information sharing and physical flow coordination provides substantial opportunities for improved economic performance' (591). In contrast, they suggest that firms operating in a MTS manufacturing environment rely on forecasts, considering that most of their value adding processes are located upstream of the CODP. In addition, Forslund and Jonsson (2007) suggest that 'it could, for example, be expected that forecast exchange is more important if using MTS strategies compared to MTO' (92). However, they only find limited evidence for a difference in perceived quality of forecasting information between MTO and MTS suppliers, and performance is not affected. Finally, Olhager and Prajogo (2012) compare both types of companies and find that firms operating in a MTO environment gain significant benefits on performance upon the execution of upstream SCI efforts. In contrast, firms in a MTS manufacturing environment show no significant benefits on performance upon executing similar upstream SCI efforts, but do benefit from lean-oriented practices which do not have effect on performance in case of MTO. Surprisingly, the level of such practices is not significantly different across both types in their sample.

Together these findings suggest a relationship between level and type of SC integration initiatives and the location of the CODP, but do not give a clear answer specifically if we consider multiple dimensions of SC integration and upstream, internal and downstream SC integration together, as is our aim. Therefore, we conclude that a rather open, explorative case study design is the best way to proceed for this study as will be outlined in the next section.

3. Methodology

Given the exploratory aim of this study, we opted for a multiple case study, based upon interviews as we are interested in the what and how of the observed phenomena and have only a limited conceptualisation of the relationship between the phenomena of interest. A multiple case study enables to capture the underlying processes and relationships between different concepts (Voss, Tsikriktsis, and Frohlich 2002), while additionally multiple cases guard against observer bias and improve the generalisability of the conclusions (Voss, Tsikriktsis, and Frohlich 2002).

3.1 Sample selection

We aim for cases that might integrate with suppliers and customers. The metal part processing industry was selected as it was expected (and turned out) to have both upstream and downstream business relations, as well as companies producing MTO, ATO and MTS. From a list of 192 Dutch companies in the metal processing industry with at least 50 employees, we approached 35, based on proximity (to limit travelling) and being in business-to-business (derived from the websites). In addition, 8 companies also matching these requirements were approached through the network of one of the researchers. It was expected that a size of 50 employees was a minimum of having a certain professional management structure, while literature (e.g. Coviello and Brodie 2001) suggests that developing buyer and supplier relationship receives more attention in business-to-business contexts. In total, we approached 43 companies by phone, of which 16 expressed interest and received additional information by email. Finally, 12 companies agreed to participate. Table 1 presents the sample's characteristics. The sample offers a reasonable variety in terms of size (at least for the Dutch context), markets and type of technology employed, fitting the explorative nature of this study. Regrettably, it was not possible to assess cases upon MTO, ATO and MTS before the plant visits. That information came only available after the discussion with the interviewees. Therefore, a limitation is that the sample is somewhat biased towards MTO companies, which maybe also the more common mode in metal producing. As our sample contains all three types, it fits the exploratory nature of our study.

3.2 Interview protocol

We used semi-structured interviews as the main tool for data collection (see Appendix 1 for the interview questions). The basis of our questionnaire is the distinction between upstream, internal and downstream integration and the distinction between practices, patterns and attitudes. Most of the questions were adapted from questionnaires previously utilised in SCI research by Frohlich and Westbrook (2001), De Toni and Nassimbeni (2000), Johnston et al. (2004), Giménez and Ventura (2005), Pagell (2004), and Rosenzweig, Roth, and Dean (2003). Relatively, a larger part of the

Table 1. Sample and characteristics of companies.

Company	Revenue (*10 ⁶)	FTE	Main markets	Number of customers (C)/suppliers (S)	Share of main customer/supplier in revenue/purchasing budget	Position interviewee(s)
A	27	90	Agricultural equipment	C: 80, S: 50	C: 20% S: 10%	Logistics and quality manager
B	6	30–60	Automotive and Industrial Springs	C: 500, S: 50	C: 31% S: 35%	Owner
C	15	120	Textile industry tools	C: 1, S: 35	C: 100% S: 40%	Production manager
D	60	400	Safety & security products	C: 200, S: *	C: 3,3% S: *	Sales manager
E	14	65	General metal components	C: 22, S: 22	C: 22% S: *	Owner
F	50	43	General metal components	C: 1500, S: *	C: 10% S: *	Operational director
G	*	60	Construction/OEM industry	C: 10,000, S: *	C: 3% S: *	Sales director
H	200–250	255	Aluminium extrusion	C: 15, S: 5	C: * S: 80%	Manager logistics and sales
I	12	90	Components for OEM industry	C: 150, S: *	C: 10% S: *	Sales manager
J	8	60	Components for OEM industry	C: 200, S: *	C: 16% S: *	Owner
K	50	160	Components for SME companies	C: 7000, S: *	C: * S: *	Area director
L	60	120	Ship building, architecture, art	C: 40, S: 25	C: 25% S: 75%	Operations manager

*The interviewees were either unwilling or unable to provide this information.

underlying constructs can be associated with practices and patterns, and only a limited part with attitudes. In line with the explorative nature of this case research, the questions, of which most were originally closed questions designed for survey studies, were transformed to open questions. This adaption of the questions did not change the subject and core of the original questions. The detailed question were used as possible follow-up questions and the interviewer would typically ask for physical integration, information exchange, trust and communication patterns to keep the questions more explorative and open. In order to keep the interviews simple, we asked for the integration with the major supplier and the major buyer, and internal integration.

We measured the percentages of final products produced as MTO, ATO and MTS.

3.3 Data collection

The companies were visited once. One initial interview was used as a pilot to test both the protocol and tune the interview approach between researchers. The standardised way of data collection safeguards the validity and protects against possible reliability issues due to different interviewers (Yin 1994; Voss, Tsikriktsis, and Frohlich 2002). Interviews took place on site in May 2013 and typically lasted for one and a half hour. In order to answer the questions, the interviewees sometimes consulted with the company's information systems or colleagues. All interviews were recorded, after permission had been given. The recording, along with the field notes made during the interview/site-visit, helped the researchers to accurately summarise the relevant responses made by the interviewees. For reasons of validation and triangulation, summary reports were sent back to the interviewees along with any remaining questions and/or clarifications needed.

3.4 Data analysis and data reduction

The unit of analysis is the company, concentrating on its CODP and SC integration. In order to simplify and transform the collected data into meaningful and comparable information, the guidelines of Miles and Huberman (1984) were followed. The 'raw data' collected were inserted into an unordered meta-matrix. These data were completed based on the requested additions and corrections from the interviewees. In analysing the data, we searched for sentences or words that were related to specific practices, patterns or attitudes in each of the three areas of integration (upstream, internal and downstream). These were interpreted as unique representatives of these practices, patterns or attitudes and collected for each area and dimension of SC integration. To make integrative efforts comparable across companies and to verify our postulates, we followed an approach suggested by Miles and Huberman (1984). They state that in qualitative research, counting – of different integrative efforts in our case – is a good approach since it shows, relatively unbiased, how cases deal with integration. The next stage was indeed counting the number of integrative efforts to arrive at scores for upstream, internal and downstream SC integration and overall scores for SC integration. Finally, as overall levels of SC integration vary a lot between companies, we did calculate the relative level of each of the three areas of integration, i.e. downstream, internal or upstream integration as percentage of the total score for SC integration of that company.

To make comparison easier, we grouped the companies with respect to their dominant CODP, using the terminology of Olhager (2010), which was determined as the location of the CODP with the highest percentage of produced goods. Almost all companies had 90–100% of their production in one CODP. Only Case C is less clear with the highest percentage being 60%, which was then considered as the dominant CODP. As we aim to compare the effects of three CODP's, we concentrate on cross-case analysis to detect the overall patterns.

4. Results

Table 2 provides the integration practices, patterns and attitudes across the three areas of integration as well as the CODP's of the companies. Unfortunately, only one ATO company is present in our sample, with eight MTO companies and three MTS.

4.1 Integrative efforts

Upon observing Table 2, it is clear that some companies have a considerable amount of integration, while others have very low levels or even no integration at all. There are some interesting qualitative observations to be made with respect to what type of efforts are performed upstream, internally and downstream.

For *upstream integration*, it appears that five of the eight MTO companies frequently use shared forecasts and some type of joint research and development (R&D), including access to a drawing system (for Company A) and joint

Table 2. Upstream, internal and downstream SC integration.

CODP	Companies	SCI categories	Upstream SC integration	Internal SC integration	Downstream SC integration
MTO/ETO	A	- Practices	Customised packaging, shared product identification, frequent deliveries, 'supplier has access to drawing system of A', shared forecasts	ERP system, internal tracking & tracing	Shared product identification, shared forecast
		- Patterns	Continuous communication, face-to-face meetings	Frequent cross-functional meetings	'meets with its supplier once a month ...'
		- Attitudes	'solutions for problems are found together'	-	'The forecasts of the customers are quite reliable'
	E	- Practices	Frequent delivery, Customised packaging, 'Share information about: stock levels, productions plans, and sales forecasts'	ERP system, 'Dedicated steering groups for optimizing internal integration'	Customised packaging, VMI-system, Shared product identification, 'Share information about: stock levels, productions plans, and sales forecasts'
		- Patterns	Face-to-face meetings	-	Face-to-face meetings
		- Attitudes	Inter-organisational decision making (IODM) on R&D, production, and deliveries	-	IODM on R&D
	F	- Practices	Shared product identification, 'one way access to: stock levels, and forecasts'	Integrated IT system	Customised packaging, shared product identification, shared production plans
		- Patterns	Frequent contact, face-to-face meetings	-	'with some customers there is very frequent contact'
		- Attitudes	'amazing when suppliers are involved in the R&D process'	-	-
	G	- Practices	Inter-organisational kanban system	Integrated IT system, cross-functional projects	- ('Integration with buyers is zero')
		- Patterns	-	-	-
		- Attitudes	-	-	-
	H	- Practices	Shared product identification	ERP system, 'direct communication with all factories'	Shared product identification, 'ICT integration'
		- Patterns	Face-to-face meetings	-	'Communication with customers on a daily basis'
		- Attitudes	IODM on product delivery time, exact product quality	'There is an open door policy'	-
	I	- Practices	'Inter-organizational Kanban system', customised packaging, Shared product identification, shared forecasts	ERP system, 'A steering group which communicates with all disciplines in the company'	'Inter-organizational Kanban system', customised packaging, shared product identification
		- Patterns	-	-	-
		- Attitudes	IODM on strategic decisions	'No borders between the company's departments', 'committed and open organization'	IODM on production plans
J	- Practices	Customised packaging, shared forecasts	Integrated IT system, transparent physical flow	Customised packaging, shared forecasts	
	- Patterns	-	Numerous times a day integral checks by general manager	-	
	- Attitudes	'Interested in joint R&D in the future'	-	-	
L	- Practices	EDI, advanced delivery notifications	Integrated IT system, cross-functional project manager	Order entry through EDI	
	- Patterns	-	-	Face-to-face meetings	
	- Attitudes	-	-	-	

(Continued)

Table 2. (Continued)

CODP	Companies	SCI categories	Upstream SC integration	Internal SC integration	Downstream SC integration
ATO	B	- Practices	Special type of container, dedicated warehouse in NL, continuous forecast	ERP system, integral control of order release, 'cross functional matrix is used'	Dedicated transport
		- Patterns	-	Cross-functional training	'Communication is made on a daily basis'
		- Attitudes	'many agreements exist based on quality aspects'	'There is a high degree of cross functionality'	Discuss pricing, discuss yearly sales volumes, 'likely they will form joint-venture'
MTS	C	- Practices	Customised packaging, multiple deliveries per week	Daily meetings with departmental supervisors	Shared packaging, shared product identification, order entry through EDI, receive forecasts
		- Patterns	-	'workers are working more and more across different departments'	Face-to-face meetings, continuous communication,
		- Attitudes	'Their supplier thinks along with improvements'	'really positive about the ability of workers to perform multiple tasks'	'regular technical knowledge exchanges'
	D	- Practices	*	'Individuals are assessed on integral performance'	JIT, frequent deliveries, tracking and tracing of reverse flow, online ordering system, customer complaint system, shared forecast
		- Patterns	*	-	Face-to-face meetings
		- Attitudes	*	-	IODM on R&D, price, promotion
	K	- Practices	'goes quite far in the integration process for example the purchasing process'	Integrated IT system, 'each of those people can replace one-another entirely'	'Bins are being bought together', VMI, 'Access to ICT systems of some main buyers', shared forecast
		- Patterns	-	-	Frequent contact
		- Attitudes	'They rather feel like colleagues than typical buyer-supplier related'	-	-

*The interviewee was unable to provide this information but claimed that upstream integration was rather low.

decision-making on product quality in Company E. The companies value the joint R&D efforts a lot: 'amazing when suppliers are involved in the R&D process' (Company F) or 'interested in joint R&D in the future' (Company J). Sharing accurate forecasts with their supplier is vital because as Company A argues 'if something goes wrong with the supplier, since it is MTO, it directly affects to performance with the customer'.

For *internal integration*, almost all companies rely on ERP. Although ERP is present in most companies, less than half of the samples use their information system across the company's borders to connect up with suppliers or buyers. It is interesting that Company B (ATO) relies heavily on cross-functionality among its employees, as 'cross-functionality gives much reliability and flexibility', needed to cope with seasonal fluctuations in the product mix. Cross-functionally trained employees are flexible and reliable to meet the order winner criteria reliability and flexibility of Company B (see Table 1).

For *downstream integration*, MTS companies all use shared forecasts and mostly face-to-face meetings. Company D indicates that sharing forecasts is 'the core of their business with their biggest customer', and even communicate with 2nd tier, and even 3rd tier customers about expected sales quantities.

4.2 SC Integration and the location of the CODP

Figure 2 presents the condensed information from our research.

Figure 2 allows for a general observation related to the relative level of downstream, internal and upstream for individual companies. For most MTO companies, the downstream integration is higher than internal and upstream

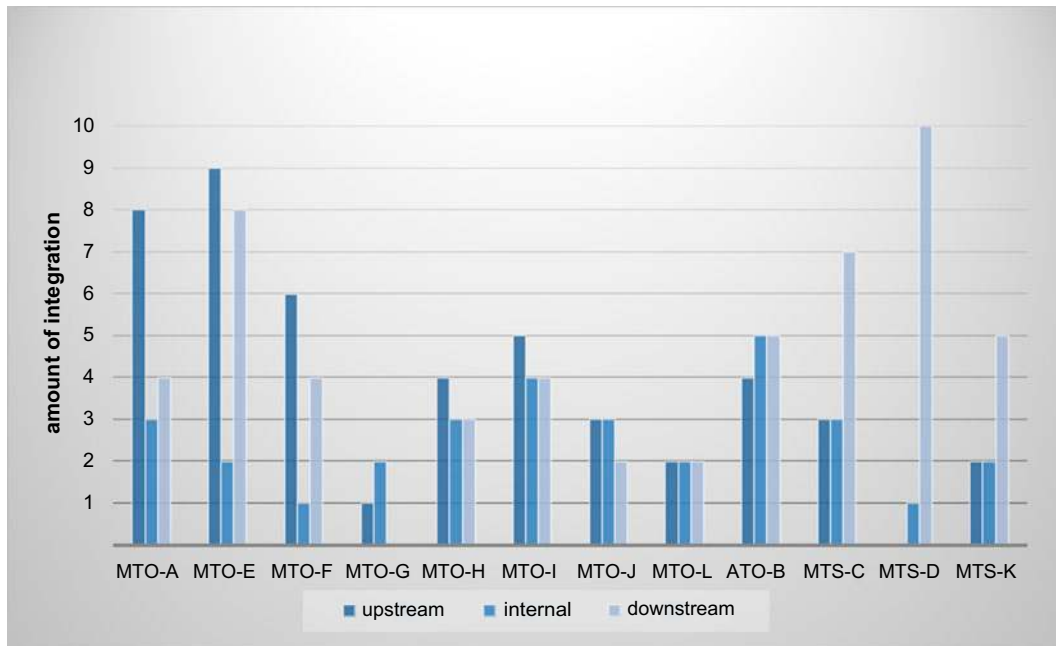


Figure 2. Levels of upstream, internal and downstream integration efforts.

integration. Similarly, comparatively Company B (ATO) has the highest internal integration, while the MTS companies have high levels of downstream integration.

Figure 3 shows the relative importance of each of the three area of integration: downstream, internal and upstream. With the clear exception of Company G, the above observations are confirmed as for MTO, ATO and MTS companies, respectively, downstream, internal and upstream integration is either the most important relative to the total amount of integration, or equally high but still the highest, for companies B, J and L.

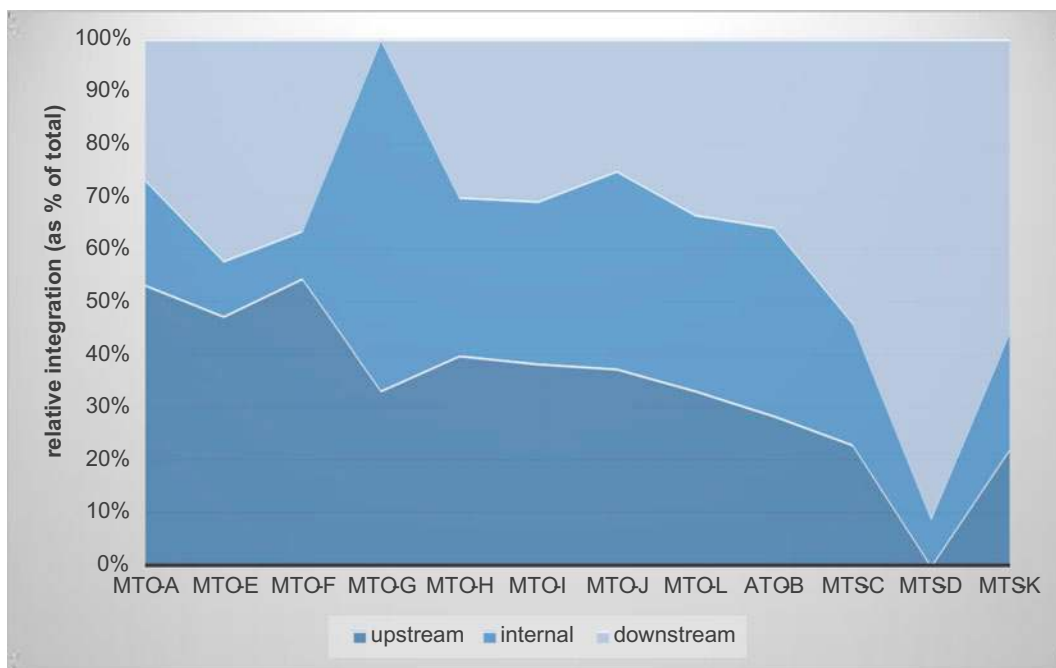


Figure 3. Relative importance of upstream, internal and downstream integration as percentage of total integration.

With respect to practices, patterns and attitudes, it is relatively hard to observe clear differences. To some extent, it seems that the number of practices is in general higher than the levels of patterns and/or attitudes. This seems a straightforward result as ultimately, the tangible initiatives to link a focal company to its buyers and/or suppliers are needed to improve performance. Further, although it is hard to quantify, it seems that specifically attitudes are higher for MTO in the upstream direction, and for MTS in the downstream direction, while these are also relatively higher for the ATO company.

5. Interpretation and discussion

Our findings offer initial evidence that different locations of the CODP can be related to a different emphasis on SC integration: for MTO downstream, for ATO internal and for MTS upstream. While not being known, it seems in line with what is the fundamental nature of the CODP. The CODP is the point where forecast-driven activities change into real customer orders. In other words, it is the point where actual requirements and planning based on forecasts are confronted; where efficiency and flexibility/agility are confronted, resulting in complexity and uncertainty. Following Childerhouse and Towill (2011), complexity and uncertainty can be mitigated by increasing the level of SC integration and that is exactly the pattern that emerges in our findings: increased levels of integration around the CODP. So, this exploratory study strongly suggests, by combining empirical findings, analysis with insights from the literature, that companies focus SC integration around the area of the location of the CODP. However, from our data, we can also conclude that some companies deviate from this general pattern. These cases will be discussed below, along with the general findings.

MTO companies J and L show their upstream integration levels to be equal to the integration levels internally/downstream, whereas for MTO Company G, the upstream integration is almost the lowest of the three. Both J and L seem to be in the comfortable position that supply of materials is relatively easy and tight integration is not needed at all, as Company J states that 'standard material which can be bought at many different suppliers', while Company G is in a similar situation given that it 'often goes "shopping" for the best price between different competing suppliers'. This is in line with the ideas of Kraljic (1983) to leverage purchasing power in case many suppliers are present. Company L on the other hand finds itself in the opposite position. Our respondent states that they 'are a relatively small customer for their supplier', which accounts for 75% of their supplies, but seems unwilling to meet the integration initiatives of Company L. In line with other SC integration research, the further analysis of these three MTO companies shows that additional to the CODP, well-known factors such as type of product (cf. Fisher 1997) or power relations (e.g. Kraljic 1983) might shape the SC integration efforts and level, as well. We find an emphasis on two ways of linking up with suppliers: forecast sharing and joint R&D. Forecast sharing has been mentioned before (e.g. Sahin and Robinson 2005), but several MTO companies assure that forecast sharing replaces inventory buffers. While supplier involvement in NPD has been found to be beneficial (e.g. Handfield et al. 1999; He et al. 2014), here we can specifically relate it to MTO companies, that rely on offering new products to satisfy their customers.

For the ATO Company B, it seems that internal integration is rather important, and across our sample, this company shows the highest level for internal integration, with intensive usage of information systems and integrated planning. However, the level of downstream and upstream integration is both at the same or almost the same level. To some extent, this seems to be in line with the character of ATO. ATO requires in fact the agility and adaptability of MTO, while at the same time, it also has characteristics equal to MTS as parts are produced to stock. Therefore, it seems logical that both downstream integration with the customer, to tune the assembly operations, as close integration with suppliers is important to acquire the raw materials. Looking at this particular company, another reason is probably the relative importance of both the largest customer and the largest supplier, and it being in the automotive sector which has relatively high SC integration (Van der Vaart and Van Donk 2008). Interestingly, this company relies on cross-functional employees to cope with mix variety and complexity in the assembly operations. Also this reflects the in-between position of ATO, as cross-functional trained employees are a compromise between general trained personnel in job shops (MTO) and specific trained personnel in mass production (MTS). Although the above observations fit in our general explanation, it is hard to conclude on the limited sample if these are normal practices for ATO companies. Therefore, further research is required as compared to MTO and MTS, as ATO seems to be relatively less investigated.

The three MTS companies seem to fully corroborate our ideas, as these three MTS companies show a high level of downstream integration, and relatively lower levels of upstream and internal integration. In line with the suggestions of Forslund and Jonsson (2007), these companies have close contacts with their customer and share forecast information, even with the second tier customer for one company. Such intensive contacts and information exchange with customers might help, to have the right level of stocks and prevent overstocking. Interestingly, the mechanisms used here for SC integration are similar to what MTO companies do with their suppliers. The intensity of the contacts seems to be

surprising, as forecast information and inventory should be enough, together with the relative high number of other integrative practices to tune activities. Probably, the amount of joint activities needs such support, while in line with Ambrose et al. (2008), intensive face-to-face contact might also be a consequence of a good supplier–buyer relationship. Moreover, as inventory of final products requires relatively high investments, companies will invest in SC integration to reduce working capital in inventories.

6. Conclusions

The main finding of this study is that the type and level of SC integration and the location of the CODP are strongly connected. MTO companies are more likely to have a relatively high level of upstream integration, ATO companies to have a relatively high level of internal integration and MTS companies to have a relatively high level of downstream integration. Further, MTO companies mainly share forecast information and R&D-related information with their suppliers. ATO intensively use integrated information systems to cope with the internal complexity of combining MTS parts manufacturing with MTO assembly. Intensive contacts and sharing forecast information with customers are the main mechanisms used in MTS, to keep safety stocks at the right level.

This study explores how the CODP shapes SC integration and adds as such to our understanding of how important the CODP is for SC integration. Rather than focusing on integration within a dyad, we incorporate upstream, internal and downstream SC integration to offer a comprehensive view of the effects of the location of the CODP on SC integration. We also provide a richer picture of different mechanisms, practices, patterns and attitudes that shape SC integration. As such, this study adds to an increasing stream of publications that provide evidence that SC integration not necessarily follows a certain path, or always needs to be high to be effective. Rather it confirms the contingent nature of SC integration (e.g. Flynn, Huo, and Zhao 2010; Danese 2011; Wong, Boon-itt, and Wong 2011; Gimenez, Van der Vaart, and Van Donk 2012). The study also expands our knowledge of CODP and its effects on how different companies might interact and tune their operations. As will be discussed below, given the exploratory nature and limited sample, it does not provide final answers.

This study also provides managers with insight on the importance of the position of the CODP and consequences for the type and level of SC integration initiatives in their SC. It also suggests what could be useful integration practices for each situation. At the same time, the findings show that other contingency factors or specific type of SC relations can be a reason to deviate from the general patterns. A final issue is that given the exploratory nature of the study, it is hard to derive clear and strong managerial recommendations.

As with all studies, the present has some limitations. Firstly, we rely on single respondents in each company which might potentially bias our findings. However, the respondents held senior managerial positions which make this issue less of a concern. Also, our interviews mainly addressed topics that are directly observable and were often illustrated with real-life examples rather than asking for opinions that could be more personally biased. Secondly, we use only information from one company, without confronting it with the information of their business partners. A third constraint is that our sample contains only one ATO company, which limits direct generalisability. However, the rich empirical data and thorough analysis that is matched with a theoretical explanation make us believe that this study contributes to our understanding of different patterns and types of integration and the underlying mechanism of SC integration for different locations of the CODP. Further research should aim for a broader sample with a better representation of all locations of the CODP. Finally, we did not include effectiveness of the integrative efforts. Although all companies show reasonable levels of performance, we can hardly say something on this. Future research could relate practices to performance, although given the firm relation between integration and performance we trust this will not result in surprises.

There are a number of avenues for further research. In general, following the findings of Olhager and Prajogo (2012), it is remarkable that so little attention has been paid to how the CODP might affect the influence of SC integration on performance. Future research should aim to incorporate this and further explore the suggested relationships from this study. Future research might also look at additional factors, as those that also showed to be relevant in this study, e.g. market-related factors. Such studies should preferably take a longitudinal design to be able to capture if and how the three types of SC integration develop over time and if their development is somehow related. E.g. Flynn, Huo, and Zhao (2010) find moderating effects for these types, as well as differences in how they influence performance, but base their study on cross-sectional data. Longitudinal research could help to better understand such relationships and the relation with the CODP, as well as how other factors influence such relationships. As indicated, we suggest investigating the themes of this study along a wider sample, which might also include other industries, to see if the same mechanisms will be detected. Finally, we find evidence that CODP is only one contextual factor that is of importance, but research into the interaction of a variety of such factors might be interesting as well.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix 1: Research protocol Customer order decoupling point

Please indicate to what extent final products are produced in any of the below ways:

-% is produced on stock (MTS)
% is assembled to order (ATO)
% is produced on order (MTO) or designed/engineered to order (ETO)

Supply chain integration measures

Topics/subtopics	Questions related to key suppliers and key buyers	Checklist
1.1. (Practices)Physical flows	How well do you think that your company is integrated with your buyer/supplier regarding the physical flows?	SC integration measures <ul style="list-style-type: none"> • <i>Containers and packaging</i> instruments of outgoing materials are adapted to the <i>precise requirements</i> of the key buyer • We share <i>product identification</i> systems. The products delivered to the key buyer can be automatically identified (bar-coding) • We deliver to our key buyer <i>frequently</i> • We receive from our key supplier <i>frequently</i>. • We <i>manage the stocks</i> of our key buyer (with programs such as Vendor Managed Inventory) • We make common use of <i>logistical equipment/containers</i> • We make common use of <i>third-party logistical services</i>
1.2. (Practices)Information exchanged	How well do you think that your company is integrated with your buyer/supplier regarding the information exchange?	<ul style="list-style-type: none"> • We receive information about <i>stock levels</i> • We receive information about the <i>production plans</i> • We receive information about <i>changes in the production plans</i> at once • We receive information about the <i>sales forecasts</i>, so we are able to plan our capacity and be prepared on time

(Continued)

(Continued)

Topics/subtopics	Questions related to key suppliers and key buyers	Checklist
1.3. (Communication)	How well do you think that your company is integrated with buyers/suppliers regarding communication?	<ul style="list-style-type: none"> • To what extent are your IT systems integrated with those of your key suppliers/buyers? • We have face-to-face communication • We communicate by phone, videoconference, chat, etc. • We communicate by email • We have a high corporate level communication on important issues • In coordinating our activities or exchanging information, formal communication channels are followed (i.e. channels that are regularised, structured modes) • In coordinating our activities or exchanging information informal communication channels are followed (i.e. casual, informal, word of mouth channels)
1.4. Buyer–supplier cooperation	How well do you think that your company is integrated with buyers/suppliers regarding decision making?	<ul style="list-style-type: none"> • We plan production together • We schedule deliveries together • We work together to improve operations and logistics processes • We work together in order to reduce costs • We work together to develop new products • We work together to synchronise operations and logistics processes
1.5. Attitudes	What is your attitude towards the relationship with the key buyer/supplier?	<ul style="list-style-type: none"> • We value a long-term relationship • We see our relationship as a long-term alliance. • We view our key buyer as an extension of our firm • We are willing to work to improve our processes in the long run • Our firm had a very collaborative relationship with the key supplier/buyer, like a real team • In most aspects of this relationship, the parties are jointly responsible for making sure that tasks are completed • Problems that arise in the course of this relationship are treated as joint rather than individual responsibilities
2.1. Internal integration	How well do you think that your company is integrated internally?	<ul style="list-style-type: none"> • How well is your internal information flow integrated? • How well is your physical flow of goods integrated? • Do you have an integrated IT system? • Do performance metrics promote rational trade-offs? • Is there any cross-functional collaboration within your company?