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Collaborative planning and its antecedents: An assessment in supply chain relationships

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Abstract

The purpose of this study is to investigate the interactive effects of individual work autonomy and interdependence on collaborative planning, building on the distinction of task and outcome interdependence. Using a questionnaire study, we assess collaborative planning and its antecedents in supply chain relationships, incorporating the forestry and timber industry. While no interactive effects hold for task interdependence, outcome interdependence only facilitates collaborative planning for individuals with low work autonomy. Individuals with high autonomy always invest in collaborative planning. This study provides a picture of supply chain reality more complete than that sketched in studies that have assessed interdependence as a one-dimensional construct and alludes to the importance, often overlooked, of work autonomy in supply chain relationships.

Keywords: collaborative planning, task interdependence, outcome interdependence, work autonomy, supply chain relationship, field study

In 2008, production at manufacturing giants Airbus and Boeing came to a halt because of coordination and planning problems with a supplier responsible for cooking galleys, seats, and toilets. Airplanes, ready for delivery, sat idle in factories because of missing components (Michaels & Lunsford, 2008). Similarly, when Motorola Inc. launched its first camera phone in 2003, demand surpassed expectations and suppliers were not able to deliver sufficient numbers of camera lenses needed to supply phones for the coming holiday season. Shortage of parts resulted in the loss of countless sales at Motorola Inc. (Upson, Ketchen, & Ireland, 2007). As these examples indicate, the functioning of supply chains essentially depends on the collaborative planning of work. Collaborative planning describes the process by which multiple individuals align their plans to jointly accomplish goals (Windischer, Grote, Mathier, Meunier, & Glardon, 2009). Indeed, collaborative planning is necessary to ensure an efficient flow of goods from the raw material stage through to the end user (Barratt & Oliveira, 2001; Handfield & Bechtel, 2002; Peterson, 2005). Furthermore, collaborative planning is expected and typically found to contribute positively to supply chain performance (Barratt, 2004; Terwiesch, Ren, Ho, & Cohen, 2005; Upson et al., 2007; Windischer et al., 2009).

Yet the processes that underpin collaborative planning and its antecedents are not well understood. Given the important consequences associated with collaborative planning, mainly in terms of coordination and performance, it is critical to assess the antecedents of collaborative planning. Antecedents generally conceived to be important to the functioning of supply chains include; joint dependence (Gulati & Sytch, 2007); joint action (Gulati & Sytch, 2007); information processing (Croson & Donohue, 2003; Gulati & Sytch, 2007); open communication (Clements, Dean, & Cohen, 2007); trust (Lejeune & Yakova, 2005; Suseno & Ratten, 2007); and common understanding (Hult, Ketchen, & Slater, 2004).

However, scholars disagree on the exact nature of the link between these antecedents and collaborative planning. It is not clear yet when these antecedents actually facilitate collaborative planning. For example; with the advent of collaborative relationships the mutual dependencies between suppliers and buyers has arguably

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increased (Clements et al., 2007; Cousins & Lawson, 2007) providing incentives for collaborative planning because of common fate thinking. While intuitively appealing, an increase in interdependencies or relationship strength might not always be beneficial to collaborative planning, and may even have detrimental side-effects. More specifically, through tightening relationships individuals may lose substantial individual decision-making freedom and control, which may undermine individuals' motivation to engage in collaborative planning.

These difficulties associated with tightly coupled relationships have not gone unnoticed in the literature (Galaskiewicz, 1985; Oliver, 1990, 1991). However, no research has yet examined how interdependencies and decision-making freedom jointly impact collaborative planning in supply chain relationships. To address this shortcoming, we revert to the organizational behavior literature where the role of interdependence in coordination has received some attention (Van der Vegt & Van de Vliert, 2005). By emphasizing the importance of behavioral theories for understanding supply chains and their functioning, we respond to recent calls for research on the behavioral underpinnings of supply chain management (Bendoly, Donohue, & Schultz, 2006; Gino & Pisano, 2008). Bendoly and Hur (2007) referring back to Powell and Johnson (1980, p. 1), for example, stated that 'if workers have *one iota of discretion* regarding the performance of productive systems, their behaviors and the determinants of these behaviors must be incorporated in the development of meaningful research models'. Clements et al. (2007, p. 52), similarly, argued that the 'complex nature of highly collaborative [buyer/seller] relationships are best explained through behavioural and specific relational theories'.

In alignment with these calls, we provide a fresh perspective on the functioning of supply chain relationships, drawing from both organizational behavior and supply chain literatures. We assess the link of task and outcome interdependence and collaborative planning, and investigate how work autonomy influences this relationship in the context of two supply chains in the forestry and timber industry. We distinguish between task and outcome interdependencies because prior research has shown both dimensions impact differently upon performance (Shaw, Duffy, & Stark, 2000; Van der Vegt, Van de Vliert, & Oosterhof, 2003). Consistent with past research and in line with structural contingency thinking (Langfred, 2005; Langfred & Moye, 2004), we assume task and outcome interdependence to foster collaborative planning for low work autonomy but to undermine collaborative planning for high work autonomy because of process losses.

This study makes a number of important contributions to the literature. First, while supply chain scholars have addressed interdependence and its implications for supply chains, this study extends prior research in distinguishing task and outcome interdependence. We submit that by distinguishing different forms of interdependence, we provide a picture of organizational reality more accurate than that presented in studies that have conceptualized interdependence in one-dimensional terms. Second, while organizational behavior scholars have been interested in interdependence for decades, this study, to the best of our knowledge, is the first to study the interactive effects of task interdependence, outcome interdependence, and individual work autonomy on collaborative planning. We suggest that by investigating these interactive effects, a better understanding of the bright and dark sides of tight coupling in supply chain relationships is possible.

Conceptual background

Collaborative planning in supply chain relationships

Christopher (1998) identified the management of relationships as being at the core of supply chain management. Min, Mentzer, and Ladd (2007, p. 509), similarly, asserted that supply chain management is 'shared in relationships between supply chain partners'. Indeed, supply chain management is not about optimizing the individual activities of functions of the supply chain, but about coordinating the relationships between these functions and aligning their different interests (Chen & Paulraj, 2004; Christopher, 1998; Larson & Halldorsson, 2004). While

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supply chain relationships consist of institutional and individual ties, it is individuals, not organizations, who interact with each other (Organ, 1971; Osborn & Hunt, 1974). In short, supply chains importantly consist of interpersonal relationships (Harland, Zheng, Johnsen, & Lamming, 2004). More specifically, it is primarily individuals holding positions at the boundaries of organizations who engage in knowledge transfer and the coordination of activities across firms (Marchington, 2005; Roper & Crone, 2003; Schultze & Orlikowski, 2004).

While short-term and long-term planning is necessary, the focus in supply chains is often on the planning of short-term tasks that span hours or weeks. Short-term collaborative planning involves (1) planning processes that take place prior to action, that is, preplanning, and (2) planning processes that happen in parallel to action, that is, in-process planning (Gevers, van Eerde, & Rutte, 2001; Weingart, 1992; Windischer et al., 2009).

Different types of collaborative processes are critical in these two planning stages. Information exchange and joint goal setting are two collaborative processes typically considered important in the preplanning stage. First, to the extent that suppliers and buyers exchange information relevant for goal accomplishment the quality of the joint plan increases (Loch & Terwiesch, 2005; Mitchell & Nault, 2007; Windischer et al., 2009). Such information exchange is important also because it helps preparing for eventualities and to initiate counteractive measures (see Artz, 1999). Second, collaborative planning affords that multiple individuals give input to the planning process and jointly establish goals (Windischer et al., 2009). Such participative goal setting is important since it increases the quality of the plan and goal commitment (Hollenbeck & Klein, 1987).

In contrast to the more deliberate processes that take place in the preplanning stage, in-process planning is relatively dynamic. In-process planning is important because individuals often need to adapt original plans in order to incorporate new information (Gevers et al., 2001; Hayes-Roth & Hayes-Roth, 1979; Mitchell & Nault, 2007). Put more succinctly, individuals need to adjust original plans *on the fly* (Marks, Mathieu, & Zaccaro, 2001). Importantly, individuals need to coordinate plan changes with others to ensure that individuals draw upon the same plan (Hayes-Roth & Hayes-Roth, 1979; Windischer et al., 2009).

Antecedents to collaborative planning: Interdependence and autonomy

The importance of interdependence for collaborative planning can hardly be overestimated. Not only is interdependence often the reason that individuals engage in collaborative planning in the first place (Clements et al., 2007; Galaskiewicz, 1985; Pfeffer & Salancik, 1978), but also, effective collaborative planning actually seems impossible if interdependencies are managed poorly (Tjosvold, 1986). More specifically, individuals need to manage both task and outcome interdependence properly in order to enable effective collaborative planning (Langfred, 2004; Van der Vegt & Van de Vliert, 2002). Van der Vegt and Van de Vliert (2005) defined task interdependence as the degree to which the design of an individual's task requires him or her to coordinate activities and to exchange goods with other individuals in order to carry out the job. Outcome interdependence, in line with De Dreu (2007), describes the extent to which the outcomes of individuals depend on the performance of other individuals.

Next to interdependence, work autonomy is important in collaborative planning. Work autonomy describes the characteristic of the work that indicates the freedom a job incumbent has in carrying out work (Day, Sibley, Scott, Tallon, & Ackroyd-Stolarz, 2009; Humphrey, Nahrgang, & Morgeson, 2007; Morgeson & Humphrey, 2006). In this sense, work autonomy indicates the extent to which the job enables the job incumbent to rule him or herself (Grote, 1997, 2004). While early work defined autonomy in one-dimensional terms as 'independence from external control' (Katz, 1965, p. 206), more recent work has treated autonomy as a multi-dimensional construct reflecting the extent to which a job allows individuals (1) to set work goals (2) to schedule work and (3) to choose the methods they use to perform (Humphrey et al., 2007; Man & Lam, 2003; Morgeson & Humphrey, 2006). It is important to note that work autonomy

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is conceptually distinct from need for autonomy, which is defined as an individual trait reflecting preference for working in an autonomous manner (Wageman, 1995). Work autonomy, instead, describes the structural opportunities the job offers for acting in an autonomous way. It is also important to note that this work focuses on individual autonomy and excludes research on collective autonomy, since collaborative planning in supply chain relationships is eventually a matter of interaction between two individuals, not two teams.

Past research, while scant, supports our argument that individual autonomy is important in collaborative planning. Gellatly and Irving (2001), for example, found individual autonomy enhanced contextual performance, which encompasses, amongst other things, working cooperatively with others, communicating effectively and keeping others informed. And Hayton and Kelley (2006, p. 412) submitted that early findings on sociotechnical systems design indicate that 'the reduction in individual autonomy leads to a breakdown in coordination' which suggests that collaborative planning may suffer under conditions of low individual autonomy.

Overall, both interdependence and individual autonomy appear to be important to collaborative planning. However, as can be seen in the following, they might outplay each other, which might negatively impact upon collaborative planning.

Task interdependence, work autonomy, and collaborative planning

Scholars have found task interdependence to enhance collaborative planning. Bachrach, Powell, Bendoly, and Richey (2006) found task interdependence increased communication and information sharing and influenced norms of cooperation. Cleavenger, Gardner, and Mhatre (2007) showed task interdependence fostered help-seeking and Ramamoorthy and Flood (2004) found task interdependence significantly increased prosocial behavior.

However, task interdependence may not always facilitate collaborative planning as task interdependence may lead to 'operational frictions' (Gulati & Sytch, 2007, p. 39) and may cause process losses under specific conditions (Steiner, 1972; Van der Vegt, Emans, & Van de Vliert, 2001). Rubin, Pruitt, and Kim (1994), favoring this argument, suggested high task interdependence to increase the likelihood of divergence of interests because highly interdependent parties have to deal with a greater number of coordination issues. Similarly, Van der Vegt et al. (2003) found task interdependence decreased helping behavior if the goals of team members were not aligned.

These inconsistent findings may indicate a moderator to mitigate the relationship between task interdependence and collaborative planning. Drawing upon past research, we suggest individual autonomy to influence the relationship between task interdependence and collaborative planning. We expect collaborative planning to benefit from task interdependence if work autonomy is low but not if it is high. This is because autonomous individuals are more likely to customize their work environment and craft their jobs (Clegg & Spencer, 2007; Langfred & Moye, 2004; Morgeson, Delaney-Klinger, & Hemingway, 2005; Morgeson & Humphrey, 2006; Wrzesniewski & Dutton, 2001). While increases in task interdependence may motivate collaborative planning, the coordination of customized work is prone to process losses, which may weaken collaborative planning (Steiner, 1972). Leana, Appelbaum, & Shevchuk (2009), in alignment with this view, argued that coordination may be more difficult if individual workers customize their job and work tasks to coincide with their individual preferences. In low autonomy conditions, in contrast, individuals have fewer possibilities to customize work; an increase in task interdependence will thus facilitate, not undermine, collaborative planning.

For example, consider the relationship between a forest owner and a paper mill; the forest owner, as common in forestry, enjoys relatively high discretion, for example, on when to harvest timber. While the paper mill depends on a relatively steady stream of timber, autonomous decisions of the forest owner (i.e., making changes to the scheduling) may harm collaborative planning efforts (e.g., costs of timber transport increase).

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Consistent with this reasoning, empirical research has shown that given high individual work autonomy, task interdependence may undermine, not facilitate, collaborative planning (Janz, Colquitt, & Noe, 1997; Liden, Wayne, & Bradway, 1997). Langfred (2005) found that teams with high task interdependence performed worse given high levels of individual autonomy than teams where members have low individual autonomy. On the contrary, teams operating under low task interdependence performed better when given high individual work autonomy. In extending this line of research and in accordance with structural contingency thinking we submit that:

> Hypothesis 1: Task interdependence and individual work autonomy will interact in such a way that the relationship between task interdependence and collaborative planning will be positive when individual autonomy is low and negative when individual autonomy is high.

Outcome interdependence, work autonomy, and collaborative planning

Unlike task interdependence, the relationship between individual autonomy and outcome interdependence and their interactive effects on collaborative planning have remained less well understood. Existing evidence suggests outcome interdependence to facilitate collaborative planning (Weldon & Weingart, 1993; Wong, Tjosvold, & Zhang, 2005). This positive influence of joint outcomes can be understood in terms of motivation; if outcomes are strongly related, individuals appear to be motivated to reciprocate and help each other to reach their goals because this might be in their own self-interest (Clements et al., 2007; Wong et al., 2005). Similarly, individuals who experience conflicts are more likely to engage in constructive problem solving if outcome interdependence is high than when it is low (Etherington & Tjosvold, 1998). Furthermore, outcome interdependence provides incentives for cooperation because it reduces ingroup–outgroup bias and favors a *we are in this together thinking* (Fan & Gruenfeld, 1998; Sethi, 2000; Shaw et al., 2000; Wageman & Baker, 1997; Wong et al., 2005).

However, there is reason to believe that outcome interdependence does not always facilitate collaborative planning. Wageman and Baker (1997) reported null effects for reward interdependence (i.e., a subdimension of outcome interdependence) and collaborative behavior. Other research – while focusing on the affective implications of outcome interdependence – even found outcome interdependence to have detrimental effects (Van der Vegt et al., 2001; Van der Vegt & Van de Vliert, 2002). The main reason for this negative impact is that given high outcome interdependence, individuals might withhold individual efforts (Wageman & Baker, 1997), a phenomenon commonly discussed in the literature as free-riding (Kidwell & Bennett, 1993).

Given these inconsistent findings, this paper suggests that the relationship between outcome interdependence and collaborative planning depends on the degree of individual work autonomy. As with task interdependence, we expect collaborative planning to benefit from outcome interdependence if work autonomy is low but not if it is high. We submit that because outcome interdependence reduces individual control over performance outcomes, individuals may experience an increase in outcome interdependence as encroachment on their individual work autonomy (Bachrach et al., 2006; Molleman, 2005). To the extent that individuals think of interdependent outcomes as threat to their individual autonomy, individuals will try to regain a sense of decision-making autonomy, for example, by withdrawing from the interdependent relationship, or, if this is not possible, by reducing relationship-specific investments (Deci & Ryan, 2000; van Prooijen, 2009). Such compensatory responses undermine collaborative planning. In low autonomy conditions, in contrast, individuals have little choice in decision-making and cannot withdraw or reduce efforts without experiencing immediate negative consequences; an increase in outcome interdependence will thus facilitate, not undermine, collaborative planning.

For example, consider the relationship between a third party logistics provider and a forest owner. While both the owner and the logistics provider may depend on each other to reach certain outcomes (e.g., high timber prices, high

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market share, etc), the forest owner may experience increases in outcome interdependence as a threat. As a result the forest owner may use his or her discretion to contact customers directly without going through the logistics provider. The higher the outcome interdependence between logistics provider and forest owner would be, the more such autonomous acts would undermine collaborative planning.

To conclude, findings suggest that outcome interdependence is likely to facilitate collaborative planning for individuals with low individual work autonomy, but not for highly autonomous individuals. These findings lead us to suggest that:

> Hypothesis 2: Outcome interdependence and individual work autonomy will interact in such a way that the relationship between outcome interdependence and collaborative planning will be positive when individual autonomy is low and negative when individual autonomy is high.

Methods

Context

The present study focused on supply chain relationships in the forestry and timber industry in Switzerland. Collaborative planning in the forestry and timber industry takes different forms in different relationships. For example; procurement managers and third party logistics providers jointly plan delivery dates; transportation contractors together with hauling operators plan the order of locations from where to pick up logged timber; forest rangers and forest owners jointly plan how and when to sell timber, and so forth. While collaborative planning takes different forms in different relationships, it typically requires individuals: (1) to exchange information; (2) to agree upon goals; and (3) to make adjustments to plans. Thus, the core mechanisms of collaborative planning remain the same across relationships.

We think the forest industry to provide a particularly intriguing possibility for studying collaborative planning for various reasons. Collaborative planning in the forestry and timber industry is critical since customers, such as paper and pulp mills, require a steady supply of timber to operate effectively and efficiently. Furthermore, short-term changes to plans (e.g., delivery plans) are difficult to realize since planning horizons stretch beyond years given that it is the growth of trees that determines supply. At the same time, plans are often limited in their reliability because of weather changes difficult to foresee. Strong snowfall but also storms and hurricanes often render plans invalid, and call for flexible and immediate rescheduling.

Sample

The analysis presented here is based on a survey of active participants from two forestry supply chains, referred to in the following as Fagus and Picea. The unit of analysis for the questionnaire survey was the individual, with each survey respondent providing data on a particular inter-organizational supply chain relationship. While supply chain members generally entertained several ties, we wanted to focus on those relationships most important to the flow of material and information across the supply chain (Handfield & Nichols, 1999). In order to determine which supply chain relationships to analyze, we conducted a process analysis yielding roughly one hundred process steps important to the fulfillment of an order. We used the number of interfaces between individuals (directly read out of the process diagrams) as an indicator of the strength of relationship and asked respondents to focus on their strongest supply chain relationship (i.e., the relationship with the highest number of interfaces). For example, because we found forest owners to have the strongest ties to forest rangers we asked them to rate their collaborative planning with forest rangers. Procurement managers, in difference, rated their collaborative planning with third party logistics providers.

The resulting sample consisted of individuals active in the Fagus and Picea supply chains from five professional groups, that is, forest owners, forest rangers, service providers, customers, and third party logistics providers. Third party logistics providers handed over 335 addresses on active supply chain members to the authors. Questionnaires were mailed directly to all members by the first author. Each questionnaire was

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prefaced by an introductory letter that outlined the objective of the study and assured confidentiality and the anonymity of respondents. In total, 107 questionnaires, which were filled in correctly, were returned representing a response rate of 31.9%. Fifty-nine supply chain members responded from Fagus, and 48 members from Picea. 99.1% of respondents were men.

Measures

Due to statistical reasons and to ease comparison with existing research findings we derived scales, where possible, from validated instruments. If necessary, the wording of items was adapted to fit the context of forestry supply chains and translated from English into German. For all the measures reported in the following, respondents were asked to indicate whether they agreed or disagreed with a series of statements on a Likert-type scale ranging from 1 (*totally disagree*) to 5 (*totally agree*).

To assess task interdependence we drew upon Campion, Medsker, and Higgs (1993) widely used three-item scale. A sample item is 'I cannot accomplish my tasks without information, material or support from (the coactor)'. This three-item scale has a Cronbach alpha of $\alpha = 0.69$.

In line with earlier research, we used Campion's subscales on goal and feedback interdependence to assess outcome interdependence (Johnson & Johnson, 1998; Van der Vegt & Van de Vliert, 2002). Sample items read 'I do very few activities in my job that are not related to the goals of my coactor' and 'Feedback about how well I am doing my job comes primarily from information about how the coactor is doing'. This six-item scale had a Cronbach alpha of $\alpha = 0.85$.

To assess individual autonomy we used the work autonomy scale by Breaugh (1985, 1998, 1999; Evans & Fischer, 1992). Sample items read 'I have control over the scheduling of my work' and 'My job allows me to emphasize some aspects of my job and play down others'. Respondents were asked to indicate their degree of individual autonomy in the respective relationship. This nine-item scale on individual autonomy had a Cronbach alpha of $\alpha = 0.94$.

Given the paucity of validated instruments, we developed a scale to measure collaborative planning. To be consistent with prior conceptual work, we chose items reflective of collaborative processes that take place in the preplanning stage, that is, information exchange and joint goal setting (Mathieu & Schulze, 2006; Mitchell & Nault, 2007), and collaborative processes important in the in-process planning stage, that is, coordination of plan changes (Hayes-Roth & Hayes-Roth, 1979; Windischer et al., 2009). On the basis of conceptual work done by Windischer et al. (2009), we developed 12 items that were subjected to a principal component factor analysis. Exploratory factor analysis instead of confirmatory factor analysis was deemed to be appropriate due to the relatively weak empirical basis (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Preconditions of exploratory factor analysis were satisfactorily tested before extracting and rotating common factors. Three principal factors with Eigenvalues greater than 1 were extracted (see Table 1). In consideration of the recommendations given by Costello and Osborne (2005), we decided to delete four items due to substantial cross-loadings. Tabachnick and Fidell (2007) defined cross-loading as an item that loads at 0.32 or higher on two or more factors. Oblique rotations did not resolve these cross-loadings. The rerun of the analysis with the eight items, found to represent collaborative planning best, resulted in the final rotated three-factor solution presented in Table 1.

Preplanning was assessed via five items that measured information exchange (items 1, 2, and 3) and joint goal setting (items 4 and 5). In-process planning was assessed via three items that tapped the extent to which the refinement and adjustment of plans is coordinated among individuals (items 6, 7, and 8). Item 8 was retained despite its cross-loading (see Table 1) given that it fit well with conceptual considerations in the literature on collaborative planning (Windischer et al., 2009). Because our primary interest in this study was in the interactive effects of autonomy and interdependence on collaborative planning as an overall construct, rather than in the determinants of the different sub-dimensions of collaborative planning, we used an aggregate measure of collaborative planning for inferential analysis.

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Table 1: Factor loadings for exploratory factor analysis of collaborative planning scale

Items	Factor 1	Factor 2	Factor 3
1. I provide (the co-actor) with timely and detailed information about upcoming work orders.	0.02	0.85	0.06
2. I inform (the co-actor) about events that are still uncertain.	0.22	0.86	0.07
3. I try to provide (the co-actor) with an insight into my own working conditions (for example on common disturbances or variances).	0.27	0.78	0.26
4. We laterally set common goals which we are committed to fulfil.	0.19	0.17	0.89
5. I commit myself to keeping set goals.	0.25	0.12	0.87
6. Before making changes to our common plan I consult with (the co-actor).	0.88	0.26	0.15
7. Before abandoning a common plan, I ensure that (the co-actor) agrees upfront with this decision.	0.91	0.20	0.16
8. If a joint plan fails, I reflect upon possible improvements on joint planning in the future.	0.75	0.03	0.45
Eigenvalue	2.36	2.22	1.85
Proportion of variance explained by eigenvector (in %)	29.5	27.7	23.2

All measures are standardized; varimax orthogonal rotation procedure is used for reported results.

Cronbach's alpha for the collaborative planning scale was 0.85.

Control variables were length of relationship and degree of interaction. To assess length of relationship (measured in years) respondents were asked to indicate the year and month of the beginning of their cooperation with the other individual. Degree of interaction was controlled for because it facilitates mutual understanding (Dhanaraj & Parkhe, 2006), which eases collaborative planning. The authors used two items to control for the degree of interaction (Parker & Axtell, 2001). Firstly, respondents indicated how often they usually had contact with the other individual on a scale from 1 (*less than once per month*) to 6 (*several times a day*). Consistent with Parker and Axtell (2001), we did not distinguish between phone, e-mail, or face-to-face contacts. Secondly, respondents were asked to indicate how much they knew about the working conditions of the other individual on a scale ranging from 1 (*no knowledge*) to 6 (*extensive knowledge*). To ensure that both items were equally weighted, scores on the two items were standardized and then averaged. Cronbach's alpha for this two-item scale was 0.62.

Analysis

We used maximum likelihood estimation to substitute the missing data in order to use all available information (Patterson et al., 2005). This technique has been shown to be superior to ad hoc missing data techniques like listwise or pairwise deletion and has been strongly recommended in the more recent literature (Enders, 2003; Schafer & Graham, 2002). The percentage of missing values across main model variables was relatively low (see Lynn et al., 2008; Newman, 2003), ranging from 4.4% (for collaborative planning), over 5.4% (outcome interdependence) and 5.5% (task interdependence), to 6% (individual autonomy).

We assessed whether any significant differences existed between supply chains regarding the means in the main constructs, that is, collaborative planning, task interdependence, outcome interdependence, and individual autonomy. Since our analysis did not yield any significant differences in means, we conducted our analysis at the individual level, irrespective of whether individuals were members of Fagus or Picea. This decision also seems warranted because both supply chains are similar in structure (e.g., groups of individuals) and function (e.g., delivery of timber).

Because data used for testing the research model was collected from one source, that is, self-respondent questionnaires, we conducted Harmon's (1967) one-factor test as recommended by Conway and Huffcutt (2003) to evaluate the possibility of common-method bias. The results of this analysis for individual autonomy, task and outcome interdependence, and collaborative planning did not identify a single factor. The first

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factor explained only 26% of the variance and more than one factor with Eigenvalues greater than 1 emerged. Although this does not eliminate common source issues conclusively, it seems that common-method variance did not significantly influence our results.

Moderated regression analysis by means of hierarchical multiple regression was used to test the interactions predicted in this study (Baron & Kenny, 1986; Frazier, Tix, & Barron, 2004). While normality of data was not assured for individual autonomy and collaborative planning (as learnt from skewness and kurtosis analysis), visual inspection of q-q plots indicated only moderate violation of normality assumptions. Because hierarchical regression analysis has been found to be relatively insensitive to nonextreme violations of normality (Cohen, West, Aiken, & Cohen, 2003), we based our data analysis on the raw data obtained. As a first step of moderation analysis, control variables were entered into the equation; the main effects, that is, task interdependence, outcome interdependence, and autonomy, were entered in step 2; the interaction effects in step 3 (Frazier et al., 2004). A significant interaction is indicated by a significant R^2 change (ΔR^2) in step 3. To explore the particular form of interaction and to test statistical significance of simple slopes, we used a computational tool for probing interaction effects provided by Preacher, Curran, and Bauer (2006). To illustrate interaction effects further, we plotted interactions by deriving separate equations for the high (one standard deviation above the sample mean) and low (one standard deviation below the sample mean) conditions of independent variables.

Results

The descriptive statistics and zero-order correlations are depicted in Table 2. Correlation analysis revealed collaborative planning to be positively associated with both task interdependence ($r = 0.42$, $p < 0.01$) and outcome interdependence ($r = 0.41$, $p < 0.01$). While no correlation existed between task interdependence and individual autonomy ($r = -0.03$, $p > 0.05$), outcome interdependence and individual autonomy were negatively and significantly related ($r = -0.23$, $p < 0.05$).

Table 3 shows the results from the moderator analysis. Moderator analysis was performed to test hypotheses 1 and 2. In order to help control for type 1 errors (Cohen et al., 2003), we followed Frazier et al. (2004), and introduced task and outcome interdependence both in a single hierarchical regression analysis.

Control variables in step 1 explained a significant portion of the variance ($\Delta R^2 = 0.238$, $p < 0.01$). In step 2, individual autonomy, task interdependence, and outcome interdependence added 14.3% of unique variance ($\Delta R^2 = 0.143$, $p < 0.01$) increasing the total amount of variance explained to 38.1%. Step 3, finally, showed that the R^2 change associated with the interaction terms was $\Delta R^2 = 0.043$ ($p < 0.05$). Since the interaction between individual autonomy and task interdependence did not reach significance (see Table 3), hypothesis 1 was not supported, as also visible from Figure 1.

Table 2: Summary of intercorrelations, means, and standard deviations for scores on the main study variables

Measure	*M*	SD	1	2	3	4	5	6
1. Work autonomy	4.20	0.91	(0.94)					
2. Task interdependence	3.08	1.19	–0.03	(0.69)				
3. Outcome interdependence	2.54	1.03	–0.23*	0.56**	(0.85)			
4. Collaborative planning	3.90	0.91	0.14	0.42**	0.41**	(0.85)		
5. Length of relationship	6.52	5.85	0.00	0.08	0.17	0.13	(n.a.)	
6. Degree of interaction	0.00	0.85	–0.01	0.31**	0.29**	0.49**	0.19*	(0.62)

Total *N* is 107. Cronbach's alpha in parantheses. Degree of interaction is standardized.
*$p < 0.05$, **$p < 0.01$.

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For outcome interdependence, however, we found the interaction with individual autonomy to be significant ($B = -0.20$, $p < 0.05$), accounting for an additional 4.3% of the variance in collaborative planning. As moderator effects are notoriously difficult to detect in field studies (McClelland & Judd, 1993) and rarely explain more than 1–3% of variance (Redman & Snape, 2005), our findings seem to be worth discussing. In total, the resulting model predicted 42.4% of the variance in collaborative planning.

Table 3: Moderated multiple regression analysis predicting collaborative planning

Predictor	B	SE B	ß	ΔR^2
Step 1				
Length of relationship	0.00	0.01	0.03	
Interaction	0.41	0.09	0.38**	0.24**
Step 2				
Task interdependence (centred)	0.12	0.07	0.15	
Outcome interdependence (centred)	0.20	0.09	0.23*	
Work autonomy (centred)	0.20	0.08	0.20*	0.14**
Step 3				
Task interdependence * work autonomy	0.05	0.08	0.07	
Outcome interdependence * work autonomy	–0.20	0.09	–0.26*	0.04*

Total *N* is 107. B indicates unstandardized regression coefficient and ß indicates standardized regression coefficient. ΔR^2 indicates change in explained variance. *$p < 0.05$, **$p < 0.01$.

Simple slope analysis (Preacher et al., 2006) revealed a positive relationship ($B = 0.38$, $p < 0.01$) between outcome interdependence and collaborative planning for individuals with low autonomy (i.e., mean level of autonomy minus one standard deviation). For individuals with high autonomy (i.e., mean level of autonomy plus one standard deviation) no significant relationship between outcome interdependence and collaborative planning was found ($B = 0.02$, $p > 0.05$). If we had not added individual autonomy as a moderator, we would have assumed that outcome interdependence had only a small relationship to collaborative planning ($B = 0.20$, $p < 0.05$). This would have obscured the fact that the relationship was much stronger for individuals with low autonomy than for individuals with high autonomy. Thus, this finding provided partial support for hypothesis 2. Furthermore, the ordinal interaction indicated individual work autonomy to somehow offset the collaborative planning decrements associated with low outcome interdependence. In other words, the high level of individual autonomy served to reduce the collaborative planning decline associated with low outcome interdependence.

Inspecting Figure 2, another important finding became visible, that is, when outcome

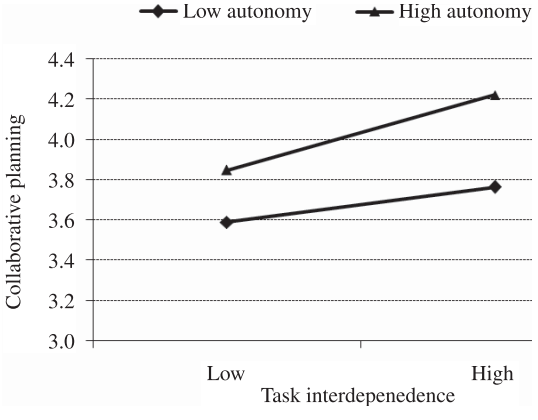

Figure 1: Interaction effect of autonomy and task interdependence

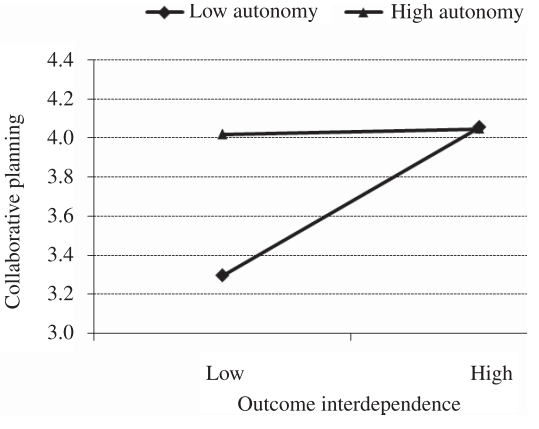

Figure 2: Interaction effect of autonomy and outcome interdependence

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interdependence was low but individual work autonomy was high, collaborative planning was enhanced.

Discussion

While collaborative planning is key to supply chain relationships, knowledge on its antecedents is sparse. Since some of the most vexing problems in supply chain relationships have their source at the individual level (Bendoly et al., 2006; Gino & Pisano, 2008), we integrated the organizational behavior and supply chain management literatures to build and test a model on collaborative planning and its antecedents in supply chains. We assessed the impact of task and outcome interdependence on collaborative planning, since interdependence often is the reason why individuals engage in collaborative planning in the first place. Because past research has indicated interdependence to outplay individual autonomy, we investigated how individual autonomy impaired the relationship between interdependence and collaborative planning. To the best of our knowledge, this study is the first to examine how task interdependence, outcome interdependence and individual autonomy jointly shape collaborative planning in supply chain relationships. In distinguishing task and outcome interdependence, we provide a picture of organizational reality more complete than that sketched in studies that have assessed interdependence as a one-dimensional construct (Dubois, Hulthén, & Pedersen, 2004; Lejeune & Yakova, 2005). In other words, our findings on the discrete effects of task and outcome interdependence on collaborative planning call into question the use of one-dimensional measures of interdependencies still common in supply chain research.

Contributions to scholarship

We first tested the interactive effects of task interdependence and individual autonomy on collaborative planning. Based on prior research (Langfred, 2005; Langfred & Moye, 2004), we expected individual work autonomy to cause process losses, because individuals in high-autonomy jobs are more likely to customize their work tasks which – to the extent that these tasks need to be coordinated – aggravates collaborative planning. We did not find any significant interactive effects to hold, however. A possible explanation for this null finding is that the actual effects of task interdependence – either positive or negative – may be less visible in forestry supply chain relationships than in other industries. Perhaps, time constraints which exacerbate the effects of task interdependence (Gittell, Weinberg, Pfefferle, & Bishop, 2008) are somewhat less stringent in the forestry industry than they are in other industries (e.g., just-in-time manufacturing environments), partly because customers hold relatively large stocks of timber (Korten & Kaul, 2008). In other words, slack may be more readily available in the forestry and timber industry, which may decrease the immediate need to respond to demands of others, thus weakening collaborative planning. While unexpected, in hindsight the non-significant findings are not implausible and may indicate a boundary condition to the relational effects typically associated with task interdependence.

Secondly, we examined how outcome interdependence and individual autonomy jointly shaped collaborative planning. In drawing upon past research, we expected outcome interdependence to facilitate collaborative planning in individuals with low work autonomy, but to decrease collaborative planning in individuals with high work autonomy. Our findings provided partial support for this assumption. A positive relationship between outcome interdependence and collaborative planning existed for individuals with low individual work autonomy. This finding corresponds with earlier research indicating outcome interdependence to provide incentives for collaborative planning due to, amongst other things, common fate thinking (Clements et al., 2007; Wageman & Baker, 1997). However, we found highly autonomous individuals always invested in collaborative planning, irrespective of their degree of outcome interdependence.

This calls into question the view that individuals high on work autonomy experience outcome interdependence as threat to their individual work autonomy (Bachrach et al., 2006; Molleman, 2005). Instead, individuals high on autonomy appear to regard outcome interdependence – while

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restricting their performance control – as necessary means to achieve coordinated performance. While tentative, this explanation is in line with the notion of higher order autonomy (Grote, 2004) which suggests individuals to use their autonomy to restrict themselves by agreeing upon rules and procedures necessary to ensure the functioning of larger organizational units.

It seems noteworthy that individuals with high work autonomy and low outcome interdependence invest substantial efforts in collaborative planning (see Figure 1). This result is perplexing, since individuals who have high work autonomy and experience little outcome interdependence appear to have little reason to engage in collaborative planning. We speculate that highly autonomous individuals invest in collaborative planning because they might feel committed to a supply chain relationship for reasons beyond the analysis of this study, such as, relationship history or anticipated future exchanges (Heide & Miner, 1992). In other words, actors might invest in specific relationships because of past experiences or expectations of the future, independent of present contingencies.

Applied implications

The absence of a link between task interdependence and collaborative planning has some ramifications for supply chain practice. Specifically, it seems important not to focus on interventions designed to address task interdependencies exclusively. Instead, supply chain members can gain much from strengthening outcome interdependence, for example, by inducing cooperative goal agreements and redesigning structures towards relationship rewards (Hertel, Konradt, & Orlikowski, 2004). However, any investment in outcome interdependence needs to be examined in light of its effects on individual autonomy. If an increase in outcome interdependence reduces individual autonomy, investments might not pay off in terms of collaborative planning. This indicates that individuals need to be careful in choosing the kind of supply chain relationship in which they engage (Oliver, 1990, 1991); vendor managed inventory programs and other large-scale joint investments, while fostering outcome interdependence, might restrict individual work autonomy. In terms of collaborative planning, supply chain members might be better off agreeing upon long-term but more flexible exchange arrangements.

Limitations and future research directions

Despite the contributions of this paper, it is important to reflect upon its limitations. While we took some methodological precautions, such as testing for common-method bias, methodological limitations remain, such as the cross-sectional nature of the study and the relatively small sample size. Thus, it would be beneficial to examine collaborative planning and its antecedents in a larger, possible international, sample of individuals. Furthermore, this study exclusively focused on supply chain relationships in a single industry; thus, it is conceivable that the relationships we found for the forestry and timber industry are context specific. Given the paucity of studies on collaborative planning in supply chain relationships, we cannot rule out this possibility, and call for further studies in related industries, as for example, other commodity industries (e.g., sand, iron, and oil). Similarly, since our study focuses on supply chain relationships within Switzerland, we believe that there is a need for future research to investigate international differences. Prior research has demonstrated how supply chain relationships and supply chain strategies differ across countries and cultures (e.g., Cannon, Doney, Mullen, & Petersen, 2010; Harland, 1996). Building on this research, we argue that there is much to be gained from replicating our findings in other countries and cultures.

Furthermore, given the paucity of validated instruments, we developed a scale to measure collaborative planning for this study. While this scale seems to be a promising instrument in assessing collaborative planning, further testing of the scale in larger samples is imperative. Confirmatory factor analysis appears necessary to cross-validate our findings (see Hurley et al., 1997). Since this study primarily focused on the antecedents of collaborative planning, there is also a chance to examine its mechanisms more thoroughly. We call for future conceptual and empirical work assessing how work conditions

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influence the different constituents of collaborative planning (i.e., information exchange, joint goal setting, and coordination of plan changes). Another possible path of inquiry might be to collect data on collaborative planning and its antecedents from both sides of the dyad (Gulati & Sytch, 2007). This is an important task for future research because it would allow gaining a better understanding of how asymmetries in task and outcome interdependence influence collaborative planning. Eventually, we encourage research studying how trust influences the combined effects of interdependence and autonomy assessed in this study. While we controlled for length of relationship, which has been argued and found to directly associate with trust (e.g., Dyer & Chu, 2000), we think it to be worthwhile to more explicitly study how trust influences the interplay of interdependence and autonomy in supply chain relationships. A question worth asking, for example, is whether individuals are more willing to accept the tightening of supply chain relationships if trust is high compared to when it is low. We leave this question for future research.

Conclusion

Collaborative planning in supply chain relationships is essential to ensure an efficient flow of goods from the raw material stage through to the end user. Since prior research on supply chain relationships has paid relatively little attention to organizational behavior, we integrated the supply chain and organizational behavior literatures. Our findings support and extend prior research on how supply chains benefit from the tight coupling of activities across firm boundaries (e.g., Jahre & Fabbe-Costes, 2005). While integration in terms of outcome interdependence indeed appears to be vital for collaborative planning, our study demonstrates that supply chains can additionally benefit from loosening – not tightening – relationships by increasing individual work autonomy.

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