WATCH THE WORKING CAPITAL OF TIER-TWO SUPPLIERS: A TRANSACTION COST APPROACH TO SUPPLY CHAIN COLLABORATION IN THE AUTOMOTIVE INDUSTRY

Xosé H. Vázquez
University of Vigo
xhvv@uvigo.es

Antonio Sartal
Universitat de Girona
antonio.sartal@udg.edu

Luis M. Lozano
PSA Peugeot Citröen
luismanuel.lozano@mpsa.com

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Abstract

Based on a theory of optimal specialisation that emphasises the need to balance production and transaction costs, this paper explains why supply chain management should be organised on a cooperative basis that goes beyond conventional wisdom on lean supply to reach upstream stages and embrace financial considerations. Our thesis is that, in spite of the liturgical discourse on supply chain cooperation, companies try to transfer their credit needs and inventory requirements to their weakest suppliers, so that what might initially seem positive from an individual financial perspective, in fact generates losses in production efficiency from the point of view of the supply chain as a whole. We test this idea using panel data over 9 years for tier-one and tier-two suppliers in the Spanish automotive components sector. The results explain the growing fragility in global supply chains because of stock-outs and upstream quality problems. We therefore call for a broader approach to cooperation in a context of more diverse components, more complex products and, above all, more difficulties for funding new projects.

Keywords:

Lean Supply, cooperation, working capital, automotive sector.

1. INTRODUCTION

With increasing globalisation and technological change, the possibility of generating a competitive advantage in operations has been transferred in many sectors from internal aspects within individual organisations to the external field of supply chains. In many sectors including aerospace, semi-conductors or automobiles (Chen et al., 2008; Owen et al., 2008), Original Equipment Manufacturers (OEMs) have built networks of firms within which cooperation has become essential for competitiveness (Dyer, 2000).

Most empirical studies have focused on the automotive sector (Lettice et al., 2010). With a history of over 100 years, it is perhaps perceived as reflecting the competitive, technological and organisational challenges that many other industries end up facing sooner or later. This sector has developed from a situation of completely vertical integration to total specialisation in the form of “contract manufacturing” (Arruñada and Vázquez, 2006). During this process, supply chain management has taken on an increasingly important role (Christopher and Towill, 2001; Lettice et al., 2010; Wu, 2014). Firstly, growing specialisation has increased both the number and the complexity of transactions, to the extent that logistics is now one of the most important components in total cost (Sachon and Albiñana, 2004; Lettice et al., 2010). Secondly, the uncertainty of a globalised world requires rapid responses in flow management because of the quantitative and qualitative changes in demand (Christopher, 2000; Agarwal et al., 2006). Thirdly, the growing customisation requirements in mature markets require greater flexibility in the supply chain in order to organise a wide range of components and technical characteristics (Prater et al. 2001; Sánchez and Perez, 2005). Most sectors are following these trends to a greater or lesser extent (Chen et al., 2008).

Such approaches have undoubtedly helped clarify how OEMs deal with supplier relations and, more generally, what we can expect to happen in other environments with similar trends.

However, most of the research to date suffers from certain limitations which this paper aims to overcome.

From a theoretical point of view, the literature has been based on descriptive approaches that aim to find regular features in large geographical areas (Yang, 1995; Vieyra, 2003; Doran et al., 2007; Pavlínek and Ženka, 2011) or functional activities (Lettice et al., 2010) and conclude by making recommendations (Aguinis, 2014). Simply discovering regularities in the data, nevertheless, does not necessarily lead to an explanation as to why certain organisational routines are considered best practices so should be recommended (Aguinis, 2014). We therefore adopt a deductive approach to develop a supplier-customer relation theory which, based on transaction cost theory and in the light of technological and organisation change, includes cooperation as an essential part of the process of production specialisation that has pushed up productivity in recent decades. Basically, our theory complements the lean supply approach to cooperation in the supply chain in a framework of greater component diversity, product complexity and financial restrictions.

In addition, the literature has three weaknesses from the empirical viewpoint which this study aims to correct. Firstly, while approaches to supply chain management emphasise the challenge of cooperation from the raw material supplier to the final distributor, empirical studies usually focus on the relations between OEMs and their tier-one suppliers (Tangpong et al., 2008). Although these are both usually the largest suppliers, this approach implicitly underestimates the importance of upstream suppliers for quality or for stock management in the value chain as a whole. We therefore focus on the relation between tier-one and tier-two suppliers.

Secondly, dynamic analyses over time are still an exception even though they make it possible to consider both unobservable heterogeneity between firms and time effects in the model. These characteristics not only make them especially useful at times of great change like today but they also avoid the problems of endogeneity that are both frequent and difficult to resolve in cross-sectional estimations. We use a 9-year data panel corresponding to 116 plants in the automotive components sector (a total of 1,044 observations).

Thirdly, most of the literature has based its analyses on management opinions and subjective external views (Lettice et al., 2010; Revilla et al., 2013; Hoegl and Wagner, 2005; Caride et al., 2006). Beyond purely cognitive issues regarding how answers are affected by the ordering or the wording of questions, respondents avoid looking bad in front of the interviewer. This means that survey participants may often feel compelled to answer when they do not actually have an opinion, misjudge their own views, report answers that are consistent with their past attitudes, or even lie consciously to comply with accepted behaviour or conventional wisdom (Bertrand and Mullainathan, 2001). This is why we use an objective variable, the difference in the working fund between tier-one and tier-two suppliers in the automotive sector, to test the degree of collaboration in the supply chain. We adopt this proxy because of the dilemma it creates. On the one hand, there is a clear incentive to transfer credit risk and capital costs to other phases of the supply chain in order to obtain positive results in the profit and loss account in the short term. On the other, this could lead to a boomerang effect by reducing financial stability in the overall supply chain, eventually resulting in a high-risk supplier base.

The following section presents the theory behind the two hypotheses we pose on the inclination of firms to cooperate, and on the effect on productivity that the existence or the absence of cooperation generates. Section three presents the data and the variables. Section four presents and discusses the results of an econometric panel data model that supports the theory. Finally, we conclude by summarising the main ideas and making some management recommendations.

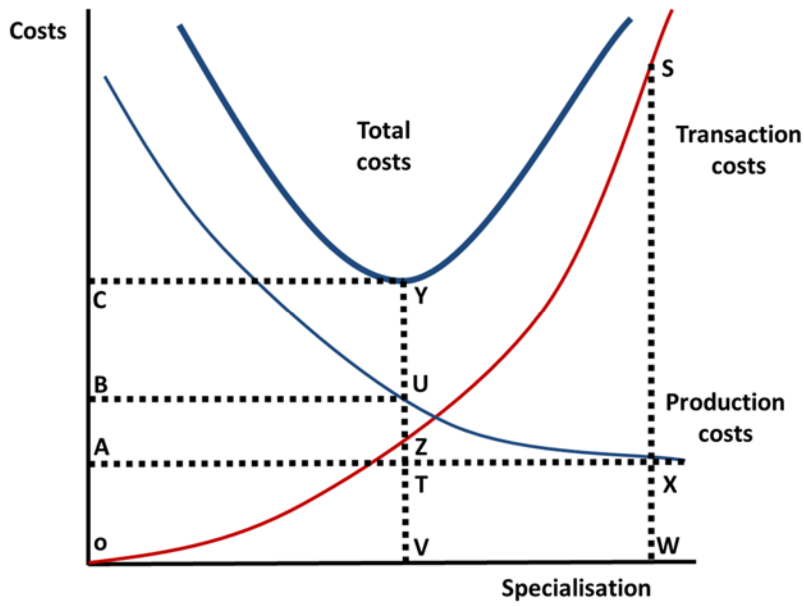
2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1. Transformation and transaction costs: pros and cons of specialization

The theoretical *leitmotiv* of this article is simple. Firms that specialise become more productive, but the more they specialise, the more transactions they have to organise with other economic agents which, obviously, is costly.

The cost of producing a good or service, therefore, can be broken down into two parts: production costs and transaction costs. Production costs fall as specialisation increases, mostly because of economies of scale and learning effects. Transaction costs, however, do the opposite; they are low while there is little specialisation (each economic agent meets his own needs) but rise as specialisation increases because of new requirements for coordination and motivation. Also, both the number and complexity of transactions will increase (Hayek, 1945), as well as information asymmetry between agents, making it difficult to make their needs compatible (Figure 1).

Figure 1. Unit production and transaction costs as a function of specialization



Let us assume that, as resources become more specialised, the cost of production drops to a certain minimum level and transaction costs rise. Under these conditions, the minimum total cost is reached at a level of specialisation that is below the minimum for production costs, as shown in Figure 1. This Figure allows comparison of the two situations, which can be described as "ideal" and "real", with transaction costs being zero in the first case, and increasing in the second as the degree of specialisation of the production resources increases.

a) **Ideal situation**. If exchanges between firms were not costly (if we could communicate all our availabilities and needs and, especially, make promises and fulfil them at zero cost), we would only have to worry about production costs. It can therefore be assumed that there is an optimal level of specialisation OW, which would give a minimum cost WX, equal to OA.

b) **Real situation**. Ideal specialisation OW is prohibitively costly in exchange terms. In order to achieve the level of specialisation OW that allows us to minimise the production cost, which would be WX, the transaction cost would have to be WS, which is so high that it alone already exceeds the total optimal cost, VY = OC.

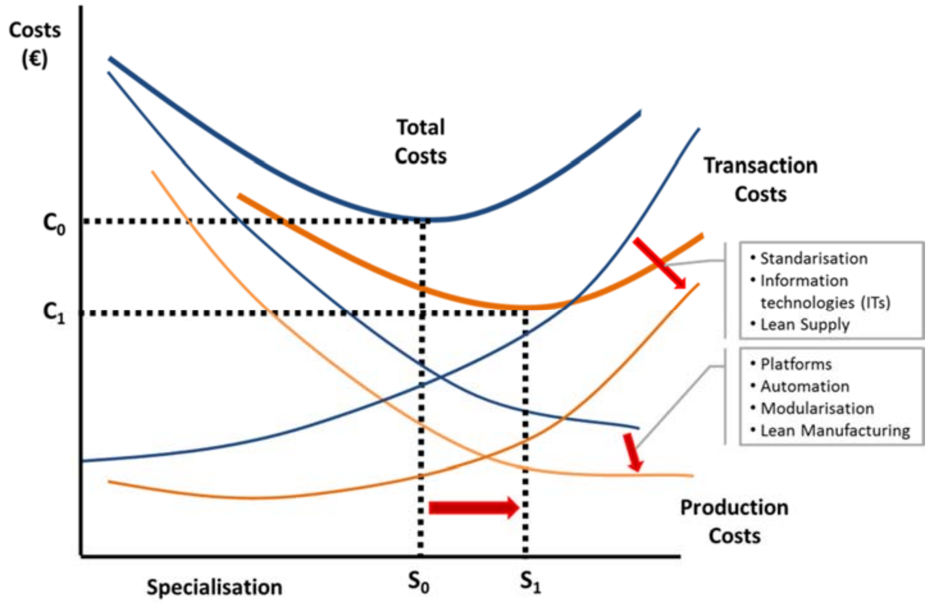
We can therefore see that the increase in total cost caused by the existence of transaction costs (AC) has two components. Firstly, the activities to coordinate and make the incentives that facilitate transactions compatible directly generate a transaction cost of VZ. Secondly, the presence of these transaction costs leads to a lower degree of specialisation and, as a result, the production cost is increased by TU (= VU - WX).

2.2. The role of cooperation in the automotive sector: from the OEM perspective to the supply chain.

Although automobile manufacturers initially produced most of their components themselves, increasing product complexity and decreasing margins led to a gradual change in strategy (Lettice et al., 2010). From the 1970s on, increasing technological requirements made it difficult for them to use a single supplier. Moreover, the surplus installed capacity in the globalised environment reduced margins to levels at which it was difficult for a single company to obtain funding for a growing number of new projects that involved greater customisation and shorter life cycles. The result was increasing specialisation in the sector and greater participation by suppliers in industrial and logistics operations (Fixson et al., 2005; Doran et al., 2007). Not only did suppliers start to design and produce different components or sub-components, but they also funded the facilities to accompany the move in worldwide demand towards emerging markets (Camuffo, 2000). Only the conception and production of bodywork and of basic mechanical parts (engine and transmission) were internalised within the manufacturer’s structure (Dannenberg and

Kleinhans, 2006). This forced firms to search for technological and organisational innovations that would allow them to combine lower production costs with the need to contain or even reduce the transaction costs resulting from this process of specialisation (Figure 2).

Figure 2. Changes induced in production and transaction cost curves by technological and organizational innovations



The use of common platforms for several models brought economies of scale and reduced the possibility of making mistakes without affecting product customisation (Sako, 2003). Similarly, modularisation[1] simplified the supply and assembly process by reducing the number of references and favouring synchronous supply (Sako, 2003). In parallel, information on the Toyota Production System (Ohno, 1988), later re-named Lean Manufacturing (Womack et al., 1990), pointed to the value of an organisation system that had been developed decades before to resolve a number of problems that initially were local (shortage of resources, small production batches, a wide range, small demand, etc.) but had become global. Finally, plant automation increased productivity while reducing investment specificity.

Similarly, standard procedures and information technology have made it possible to significantly reduce transaction costs (Frohlich and Westbrook, 2002; Sachon and Albiñana, 2004; Deveraj et

[1] The use of subsets of pre-assembled components (dashboards, doors, etc.) in final assembly.

al., 2007; Rosenzweig, 2009; Moyano et al., 2012). But it was perhaps Lean Supply, based on the *principle of cooperation*, which attracted most interest (Aláez, 1997). The aim was to find a model for a long-term committed relationship between the assembler and the suppliers that would involve sharing information, risks and benefits. In our research, however, we see varying behaviour. Although it is true that there is a firm commitment to collaborate throughout the value chain in aspects such as design, quality, lead time, etc., when this type of relation is studied from an economic viewpoint, we see that, as in other areas such as finance, these principles of collaboration and commitment are totally non-existent.

2.3. Working capital management and the supply chain: hypotheses

Working capital is the part of the working assets that have to be financed with long-term liabilities in order to avoid liquidity shortages. So, although the conventional wisdom is that inventories should be financed with supplier credit, firms generally maintain a positive working fund to ensure that any incidents arising will not prevent them from paying both any debts due and the cost of operations.

Maintaining a minimum level therefore generates certainty but also implies lower profitability. Working capital, in fact, entails that the firm has idle funds earning no profit. Companies therefore try to minimise it in one of two ways: either financially, by converting the problem into a challenge to speed up receivables collection and delay payment, or focusing on operational excellence, with inventory management to reduce the investment and using specific tools such as Just in Time and Jidoka to minimise Work in Process (Ohno, 1988), or adopting flexible production (Heijunka) to prevent overproduction (Liker, 2004; Koide and Iwata, 2007; Malhotra and Mackelprang, 2012).

Under these conditions, in the field of operational excellence, cooperative management of the supply chain has given rise to inter-organisational agreements that reduce transaction costs in order to decrease inventories and lead times (which is of interest to everyone). However, in the strictly financial field, the dilemmas faced by each individual company are significantly larger.

Although there are advantages in acting financially as a single organisation within the supply chain, the situation and financial objectives of each company mean that they all want to become "late payers" and "early collectors". This can rise transaction costs in the form of credit risk and capital costs being transferred from certain levels to others in the supply chain. For example, if payment periods are extended this may mean there is low risk for buyers, but it increases risk for suppliers, who often have limited access to sources of short-term finance and a higher capital cost. On the other hand, information asymmetries also stimulate opportunistic conducts. For instance, tier-one suppliers sign contracts with OEMs to maintain a security stock for a specific number of days; however, in the face of strikes, OEMs often suffer stock shortages quite sooner than contractually agreed, thus making the opportunistic behaviour very evident (although too late). Interestingly enough, tier-one suppliers are connected to OEMs through electronic systems that are often updated, so the information they receive has a time horizon that allows them to level production and minimize inventories. They do not follow the same policy, however, with the rather small tier-two suppliers. These firms do not receive information from OEMs; they often get the information irregularly from tier-one companies that search to optimize their own process and reduce financial costs by transferring them stock requirements. As noted above, this is a direct consequence of the increasing competitive power that tier-one suppliers are reaching compared to OEMs.

So, however much the theoretical benefits of cooperation are explained based on philosophies such as lean supply, the theoretical framework described in section 2.1 anticipates that companies will use their bargaining capacity to impose their payment terms on suppliers and transfer inventories to them. This way of using power in a supply chain can mean that the weakest companies in the chain are forced to bear the financing of their more powerful customers. Our hypothesis is therefore as follows:

- *H1: There are significant differences in the working capital of tier-one and tier-two suppliers*

Transferring the financial effort to suppliers can lead to short-term improvements in the buyer's balance sheet but at the cost of a possible boomerang effect for financial stability. Suppliers finding themselves in such a situation may be forced to delay orders for raw materials or may cut corners on service levels or quality. This in turn will lead to delivery delays and quality problems downstream for the customer, with interruptions in production, etc. It is even likely that suppliers will try to transfer their higher financial costs to the price of the goods so that, in the long term, their costs may exceed those of competitors that adopt collaborative practices.

It can therefore be assumed that, if hypothesis 1 is correct and there is a relevant difference in the working fund of tier-one and tier-two suppliers, this difference will have a negative effect on the performance of the sector as a whole and, especially, will damage the companies that have greater working capital (tier-two suppliers). We therefore pose the following hypothesis:

- *H2: The difference in working capital between tier-one and tier-two suppliers (lower level of cooperation) reduces operating efficiency for companies in the sector.*

3. DATA AND VARIABLES

Our data come from the Spanish automobile components sector. Taking the company directory produced by SERNAUTO (Spanish Association of Automotive Equipment and Component Manufacturers), which comprises 867 companies, and the SABI (*Sistema de Análisis de Balances Ibéricos*) data base, we selected companies having more than 25 employees whose financial statements were for a single plant (rather than consolidated for a group of plants). From the resulting group of companies, we eliminated those whose components were not for automobiles (but for other motor vehicles), whose main market was spare parts or for which there was too much missing data. We ended up with a strongly balanced panel covering 9 years (2001-2009), with a total of 116 companies and 1,044 observations.

Regarding the variables, we use plant efficiency, measured as operating income divided by plant employees as the dependent variable (Table 1). We chose productivity as the measure of efficiency instead of profitability for two reasons: firstly, because this measure is widely used in the literature on operations management to assess manufacturing performance (Shah and Ward, 2003; Melville et al, 2007; Heim and Peng, 2010; Saldanha et al., 2013); and, second, because our unit of analysis is production plants and not companies. Profitability is influenced by factors that are beyond the control of the plant management: supply conditions negotiated by the parent company, centralised policies of a legal or fiscal nature or market-related, etc. From this point of view it is more reliable to measure the performance of a plant in terms of productivity because changes in this variable depend on local decisions at each production unit. To avoid distortions caused by the wide variance in values for the sample, the logarithm transformation is used instead of the gross figures (Damanpour, 1992; Gupta, 1980).

Regarding the independent variables, our proxy for cooperation is the working capital differential (DifFM), which is defined for each year and for each production plant as the difference between its working capital and its sales (FM/V) on the one hand, and the average value of the of the working capital of tier-one suppliers divided by their average sales (FM_1/V_1) on the other (Equation 1).

$$\boxed{\mathrm{DifFM} = \mathrm{FM}/\mathrm{V} - \overline{\mathrm{FM}}^1/\overline{\mathrm{V}}^1}$$

(Equation 1)

where:

$$\overline{\mathrm{FM}}^1 = \frac{\sum_{i=1}^{n} \mathrm{FM_i}}{n} \qquad \overline{\mathrm{V}}^1 = \frac{\sum_{i=1}^{n} \mathrm{V_i}}{n}$$

i represents the tier-one supplier plant

For the sake of simplicity, construction of this variable assumes that the desirable value for companies is that of the average working capital of the tier-one suppliers over their average sales. We consider that in a cooperative supply chain, what tier-one suppliers generally want for themselves is what tier-two suppliers also want. So, the variable takes positive values for companies with working capital that is above the mean, and negative values for companies that use their bargaining capacity to fund themselves, charging this to their suppliers' working capital. In addition, the supplier takes 0 if the production plant mainly supplies an automobile manufacturer, and 1 if the plant supplies a tier-one supplier. From these two variables –working capital differential and supplier tier – we also create an interaction variable to determine whether, as expected, the effect of the differential on productivity is influenced by the supplier tier. We anticipate a negative effect from the differential on productivity in hypothesis 2, but we need to analyse with this interaction whether this negative effect is even greater for tier-two suppliers.

Table 1. Description of the variables and the main descriptive statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Productivity: Operating income divided by number of employees	892	230.38	186.65	8.33	1569.95
Working capital differential (*DifFM*): Difference between working capital/sales (FM/V) of a company and that of tier-one suppliers	917	82.83	342.56	-386.32	6237.23
Supply tier (N): Type of supplier. Dummy taking 0 (tier-one supplier) or 1 (tier-two supplier)	1044	0.19	0.39	0	1
Capital intensity (Cap_Int): Total assets/employees.	892	246.29	779.47	30.04	10853.37
Age: Years since creation up to 2009.	1044	23.31	16.22	2	78
Size: No. of employees in the company.	1044	273	249	25	1600
Technological intensity in the sector (sector): Dummy taking 1 (company in a medium or high technology sector) or 0 (low technology sector)	1044	0.72	0.45	0	1

Finally, four control variables are included in the model. Firstly, company size (measured by number of employees) allows us to consider the effects of scale on productivity (Banker et al., 2006). The age variable (years since the company was created) gives an indication of how this influences productivity as there is not a consensus in the literature yet. Some authors suggest a positive learning effect (Shah and Ward, 2003) but others, such as Hannan and Freeman (1984) and Baron et al. (1994), claim that there is a negative effect based on the "obsolescence process" associated with older companies. They suggest that, as time passes, older companies are unable to adapt (as fast as before) to changes in their environment so their productivity falls.

We also include a variable for capital intensity because this may affect productivity through substitution of labour (Dong et al., 2009; MacDuffie et al., 1996); this is measured here as total assets divided by number of employees, using the logarithm (as with the dependent variable) to prevent distortions because of the wide variance in values throughout the sample (Damanpour, 1992; Gupta, 1980). Finally, we also include technological intensity in the sector (OECD, 2005) to study its possible influence on productivity (Griliches, 1986; Mansfield, 1980). It has been shown that relevant scientific and technological know-how progresses at different speeds and faces different difficulties in each sector (Klevorick et al., 1995). The technological level is measured as a dummy taking 1 if the company belongs to a medium or high technology sector, and 0 if it belongs to a low technology sector. We use the Spanish National Statistics Institute classification to group sectors by the type of technology they use.

Table 2 covers the correlations between the variables. In order to determine the correlations for the continuous variables (*Productivity, DifFM, DifFM*N, Capital intensity, age and size*) we use Pearson's correlation coefficient, and to establish the correlations in the dichotomous variables (supplier tier and technological intensity in the sector), Spearman's rank-order coefficient is used. Problematic values are not obtained in terms of multicollinearity in the model. The VIF (variance inflation factor) was 1.2 and were all below 10, which is the most frequently used limit for anticipating multicollinearity problems (Kleinbaum, Kupper and Muller, 1988).

Table 2. Matrix of correlations

	Productivity	$WCDiff_{it}$	N_i	$WCDiff_{it} *N_i$	Cap_Int	Age	Size	Sector
Productivity	1							
WCDiff	-0.062*	1						
N	-0.232***	0.200***	1					
*WCDiff *N*	0.029	0.123***	0.123***	1				
Cap_Int	0.592***	0.389***	-0.125***	0.270***	1			
Age	-0.125***	-0.109***	0.062***	-0.110***	-0.124***	1		
Size	-0.147***	-0.118***	-0.207***	-0.074**	-0.196***	0.193***	1	
Sector	-0.023	-0.130***	-0.014	-0.186***	-0.130***	0.037	0.063*	1

4. ANALYSIS AND DISCUSSION OF RESULTS

4.1. Analysis of working capital in tier-one and tier-two suppliers

To test the first hypothesis which suggests that there are statistically significant differences in working capital between tier-one and tier-two suppliers, we apply a two-factor ANOVA model with measures repeated in one factor. This methodology allows us to work simultaneously with one inter-subject factor (tier) and one intra-subject factor (time). Tables 3 and 4 summarise the results obtained in a standard analysis, and Table 4 allows us to test our hypothesis. In order to makes the values comparable, the working capital of each company is considered according to its level of sales.

Table 3 shows the multivariate statistics usually used in intra-subject analysis. The four statistics all show that the time factor is not significant (Sig.=0.332 > 0.05). It can therefore be confirmed that there are no significant differences in age for the variable studied and the period analysed (2001-2009). Table 4 contains information on the inter-subject factor, that is, if the company is a tier-one or a tier-two supplier. The critical level associated with the F statistic (Sig.=0.019) allows us to reject the null hypothesis and affirm that the tier factor is significant. Therefore, whether a company belongs to one supply tier or another is significant. We can therefore confirm hypothesis 1 that there are significant differences in the working capital of tier-one and tier-two suppliers. Hence, while cooperation is an aspect that may have other markers within a value chain, when measured by the working capital differential, we find little difference between the different levels of the supply chain.

Table 3. ANOVA II repeated measures: Test on intra-subject effects

	Effect	Value	F	Hypothesis df	Error df	Sig.
Time (t)	Pillai's Trace	.126	1.167	8.000	65.000	**.332**
	Wilks' Lambda	.874	1.167	8.000	65.000	**.332**
	Hotelling's Trace	.144	1.167	8.000	65.000	**.332**
	Roy's Largest Root	.144	1.167	8.000	65.000	**.332**

Table 4. ANOVA II repeated measures: Test on inter-subject effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	2.308E+07	1	2,308E+07	134.835	.000
N_i *(Tier)*	991568.300	1	991568.300	5.792	**.019**
Error	1.233E+07	72	171187.423		

4.2. Analysis of operating efficiency by degree of cooperation.

To test the second hypothesis which suggests that a lack of cooperation in funding damages the efficiency of the whole supply chain, we estimate a panel data model as follows:

$$\text{Productivity}_{it} = \beta_1 + \beta_2 WCDiff_{it} + \beta_3 N_i + \beta_4 WCDiff_{it} * N_i + \sum_{i=5}^{8} \beta_i CONTROLVARIABLES_{it} \quad \textbf{(Equation 2)}$$

where

- $WCDiff_{it}$ represents the WC differential, a proxy for the degree of cooperation.
- N_i is the type of supplier (tier-one or tier-two)

- $WCDiff_{it} * N_i$ is the interaction between the above two variables

In line with the modified Wald test for heteroskedasticity, we can reject the null hypothesis that the errors are homoskedastic ($\chi 2 = 35417.74$, $p < 0.01$). Furthermore, the Wooldridge test (2002) points to the presence of autocorrelation ($F = 16.52$, $p < 0.01$), so in the presence of both heteroskedasticity and autocorrelation, an OLS estimation would be problematic. Although the MCO estimators would still be unbiased and consistent, they would no longer be efficient, making the standard errors not appropriate (Han and Mithas, 2013). To solve these problems we use Feasible Generalized Least Squares (Wooldridge 2002; Han and Mithas, 2013). In parallel, we carried out the necessary diagnostic tests to check the stability of results. The normality of residuals, multicollinearity and outliers were also checked (Belsley et al, 1980; Greene, 2003).

The results are given in Table 5. All the study variables are highly significant ($p < 0.01$) except for the interaction variable ($p < 0.05$). Regarding the hypothesis, we note that the working capital differential damages plant productivity; that is, the more companies move away from the desired value, represented by average tier-one working capital over sales, the worse the productivity ratio will be. This confirms hypothesis 2, that the plants showing the highest working capital differential are the ones that obtain worse efficiency ratios. It is also consistent with the additional effect of the interaction that the differential maintains with the supply tier.

We also note that tier-two suppliers have lower productivity than tier-one suppliers, probably reflecting lower levels of human and technological capital. More importantly, since we find a significant, negative interaction, the model suggests that the damaging effect of the differential is even greater in the case of tier-two suppliers. Tier-one suppliers have information advantages regarding what car manufacturers require in terms of delivery times, margins, quality specifications and tolerances, etc. These information asymmetries stimulate the opportunistic conduct of tier-one suppliers to pass on their funding needs to their suppliers' payment terms and inventory management.

Table 5. Specification of the model including all the variables

Cross-sectional time-series FGLS regression with heterokedastic and AR(1) coefficient for all panels			
Estimated covariances	= 114	Number of obs	= 892
Estimated autocorrelations	= 1	Number of groups	= 114
Estimated coefficients	= 7	Obs per group (avg):	= 7.82
		Wald chi2(6)	= 116.20
Log likelihood	= -493.863	Prob > chi2	= 0.0000

Variable	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
WCDiff $_{it}$	**-0.001**	0.000	-15.330	**0.000**	-0.001	0.0005
N_i	**-0.114**	0.033	-3.500	**0.000**	-0.178	-0.050
WCDiff $_{it}$ * N_i	**-0.0003**	0.0001	-2.370	**0.018**	-0.0005	-0.00005
Cap_Int	**0.485**	0.017	29.230	**0.000**	0.453	0.518
Age	**-0.002**	0.001	-2.160	**0.031**	-0.003	-0.0001
Size	**0.0008**	0.000	1.740	**0.082**	-0.00001	0.0001
Sector	**0.005**	0.028	0.180	**0.858**	-0.049	0.059
Const_	**2.855**	0.088	32.340	**0.000**	2.682	3.028

Accordingly, taking into account today's financial difficulties, especially those related to the renewal of revolving credit facilities, a non-collaborative perspective of supply chain management may generate even greater risks of overall instability in logistics processes. Hence, in order to bear the increased pressure on payments, upstream suppliers may be forced to delay orders for raw materials, to reduce their operating stocks below the safety threshold, or to reduce quality control in order to help generate cash. This can lead to stock-outs and non-compliances that may end up affecting the whole value chain.

Regarding the control variables, Table 7 shows the expected effects. A positive effect is observed for *size* ($p < 0.1$) and *capital intensity* ($p<0.01$) on plant productivity, while *plant age* seems to exert a negative influence ($p < 0.05$). These results can be considered, above all, to confirm the effects of economies of scale and of technological capital on productivity, while pointing to a greater trend towards entropy in older companies (Hannan and Freeman, 1984; Baron et al., 1994). *Capital intensity* has the greatest effect on plant productivity, doubtless because of on-going efforts to automate activities which, by reducing the amount of labour needed to produce the same output, generally lead to proportionally lower personnel costs in relation to assets or sales. In addition, the low significance of the *Size* variable ($p < 0.1$) in the final model is because it loses some of its statistical significance when the capital intensity variable is included in the model: in other words, in an equipment-intensive plant, high productivity can be expected, irrespective of size. Finally, we note that the *technological intensity in the sector* variable ($p > 0.1$) is not significant. The interpretation in this case is clear: whether a company belongs to a high-technology sector or not (within the automotive components manufacturing sector), this seems to have no effect on productivity. The expected effect, as in the previous case, is already included in the *capital intensity* variable.

5. CONCLUSIONS

Our results confirm that there are significant differences between the working capital of tier-one and tier-two companies. This shows that the way in which working capital is being managed in automotive sector companies is not collaborative. Individually, tier-one firms not only search to shorten collection time for their customers and to lengthen payment terms for their suppliers. They also try to charge the cost of inventory management to OEMs while actually pushing stocks to their tier-two suppliers. These practices may temporarily improve their results. However, it transfers financial costs to the link in the chain which finds it most difficult to obtain funding and which usually pays the highest interest rates. We have actually found that the more companies move away from the desired value represented by average working capital for tier-one suppliers over sales, the worse the productivity ratios will be. The overall result is that the working capital differential between tier-one and tier-two suppliers leads to lower production efficiency in plants throughout the chain, putting at risk its overall stability.

Managers should therefore avoid short-sighted attitudes and extend the conventional wisdom of lean supply, specifically regarding cooperation, to finance and even accounting. It is not just a matter of establishing cooperative relations in the management of payments and collections. It is necessary to make cost management leaner in order to align it with value chains (Maskell and Baggaley, 2003; Ward and Graves, 2004; de Arbulo-López and Fortuny-Santos, 2010). This reflection is obviously not inconsistent with the need to persevere in efforts to reduce the size of batches and intermediate stocks or to apply JIT methodologies, amongst other measures. Our research aims simply to indicate that these initiatives are not sufficient for globally maximising value creation.

In addition, suppliers at lower levels should coordinate their efforts through the organisations to which they belong so that, on the one hand, they can establish standards for payment and collection terms and, on the other, they can obtain working capital funding at more advantageous interest rates. This could at least partially mitigate the risks involved in this situation. Suppliers' associations can play an essential role by presenting such proposals to both large suppliers and manufacturers, and the administration.

It is anyway best if the chain, probably under the leadership of the OEM, can negotiate to resolve the conflicting interests that the trend towards specialisation has generated. The manufacturer, which is especially interested in the proper functioning of the chain as a whole and is perhaps the only party with the resources to achieve it, can act as third-party enforcer, which is a legal figure that has been used in a variety of contexts to prevent opportunistic conduct (Kraakman,1986). Even though they may not be the main beneficiaries of such supervision, third-party enforcers that need both global supply chains and those of the automotive sector can play a dual role (Oded, 2013): firstly as gatekeepers in that they are able to influence the requirements made of new members of the chain and, secondly, as whistle-blowers in that they can study all the information to find possible sources of conflict. The idea of a manufacturer as a third-party enforcer only implies extending the scope of the manufacturer's regulations to also cover tier-two suppliers, and extending the requirements to fields going beyond operations or the product. This strategy probably involves that OEMs re-internalize the production of particular components, since the oligopolistic position of some tier-one companies reduces their incentives to get involved in cooperative movements with OEMS that could reduce their own margins. Be as it may, our perspective ties in directly with similar trends in other sectors such as textiles in which the large companies (Inditex, Benetton, GAP, H&M…) have to find formulae for supervising their upstream suppliers from different points of view, including that of working conditions.

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