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Authors: Benn Lawson, Frits K. Pil, Matthias Holweg

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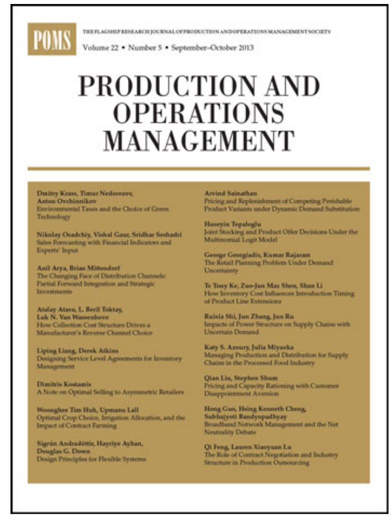

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Multi-Modal Order Fulfillment: Concept and Application

Benn Lawson

University of Cambridge

Trumpington Street

Cambridge CB2 1AG, UK

Email: b.lawson@jbs.cam.ac.uk

Tel: 44 1223 760587

Frits K. Pil (corresponding author)

University of Pittsburgh

256 Mervis Hall

Pittsburgh, PA 15238, USA

Email: fritspil@pitt.edu

Tel: 1 412 648 1612

Matthias Holweg

University of Oxford
Park End Street
Oxford, OX1 1HP, UK

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Email: Matthias.Holweg@sbs.ox.ac.uk

Tel: 44 1865 614675

Abstract

Empirical work on order fulfillment strategies suggests that building products to customer order is an important driver of organizational value. Similarly, the experimental literature indicates that customers derive value from customization. The modeling literature provides a more equivocal perspective, suggesting that a combination of build-to-forecast (BTF) and build-to-order (BTO) fulfillment modalities may lead to the best system-wide outcomes. Using an industry studies approach, we build on these theoretical perspectives to examine order fulfillment at a global automotive producer. Interviews with key decision makers and a statistical analysis of 48,534 individual vehicle sales enable the development of four propositions on the organizational and profitability implications of the firm's evolution in order fulfillment strategy. Our analyses indicate that building products to customer order is a source of higher unit profit margin. The build-to-order process also exposes fault lines and generates opportunities for operational improvement, both in the order-to-delivery system and in the broader organization. Build-to-order evolves to provide the firm with insight on customers' willingness to trade delivery lead times against their product attribute preferences. This information allows build-to-order to incorporate a demand management role, for example, by shifting custom orders to later time periods to accommodate excess demand. These changes lay the groundwork for a multi-modal order fulfillment strategy that no longer distinguishes between the order source or production modality. This strategy enhances customer responsiveness, while addressing manufacturing capacity management imperatives. Our findings open new avenues for theory building, as well as experimental, empirical and modeling research in order fulfillment.

Keywords: build-to-order; industry studies; mass customization; omnichannel; product variety

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1. Introduction

Building products to customer order enhances the link between manufacturing operations and customer needs (Alptekinoğlu and Corbett 2010, Holweg and Pil 2001, 2008, Rungtusanatham and Salvador 2008). At the same time, it presents challenges related to product design, production planning, inventory control, product allocation mix, and service levels (Cattani et al. 2010, Kaminsky and Kaya 2009, Pil and Holweg 2004). Anecdotal evidence related to several large corporations, including Dell, BMW, and Adidas, suggests that the financial benefits of building to customer order may override operational considerations (Fugate and Mentzer 2004, Piller et al. 2004, Salvador et al. 2009). In line with this, research suggests that the customization process drives value creation through enhanced product fit and customer pride in authorship (Franke et al. 2010).

The discourse on operational challenges and value creation within order-to-delivery processes often occurs in distinct research streams, drawing on different theoretical perspectives and methodological paradigms. In the real world, these imperatives collide. The automotive industry provides a rich and challenging setting in which many manufacturers offer a mix of build-to-order and build-to-forecast fulfillment strategies (Brabazon et al. 2010). Following the tradition of industry studies research (Joglekar et al. 2016), we adopt an intermediate theory approach to examine the order fulfillment practices of a global automotive producer ("OEM"). We draw on both quantitative and qualitative data collected at OEM to revisit and extend well-established theory in the order-to-delivery domain (Edmondson and McManus 2007).

We build on the optimization literature that examines hybrid build-to-order/build-to-forecast production environments, as well as on experiment-based studies that explore value creation through product customization. These literatures set the stage for an examination of OEM's implementation of a build-to-order (hereafter BTO) fulfillment process. Our qualitative work indicates that the BTO process initially implemented by the manufacturing unit exposed misalignments in OEM's organizational infrastructure and led to revised roles for other functional actors. Exploring this evolution in BTO provides a deeper understanding of the interdependencies between departmental decisions and highlights improvement opportunities unrelated to order fulfillment.

Using unit-level data from 48,534 individual vehicle sales, and their associated manufacturing, logistics and marketing costs, we assess the profitability implications of building a product to customer order, controlling for product characteristics and post-manufacturing distribution costs. Our findings suggest that BTO leads to higher profitability in most instances, compared to building products to stock. However, we also find evidence of an alternate role for BTO: giving customers an incentive to select and wait for customized orders, at times of excess product demand. While this feature allows the firm to level demand, the unit-level profitability of custom products will be lower. Our finding parallels established arguments on the role of build-to-forecast (hereafter BTF) processes in assuring customer service levels, in addition to presenting new options for addressing substantive demand fluctuations.

We build on the insights from our quantitative analysis to explore qualitatively the challenges and opportunities facing OEM. Over time, OEM blurred the distinction between BTO and BTF fulfillment by altering its processes to enable product modifications up to the very start of production, and by shifting to a multi-modal approach to meeting customer preferences, within a volume-centered manufacturing environment. Notably, the multi-modal approach does not distinguish how customer preferences are met; it is agnostic as to whether a vehicle is drawn from inventory, an inter-dealer exchange, or a real-time reconfiguration in a production pipeline. The goal is to meet customer needs in a way that optimizes responsiveness, minimizes wait times, while also ensuring correct product attributes. The manufacturing function is no longer the pivotal actor as the firm relies on a more holistic decision-making process. This evolution creates more extensive and integrated information flows across functional areas, providing the firm with insight into customer product preferences. Of equal importance is the feedback it provides on how such preferences relate to a customer's willingness to wait. This information enables the firm to make systemic improvements on a number of fronts, including production flow and capacity utilization. The findings from our qualitative and quantitative analyses allow us to introduce key propositions about new roles and opportunities for research in the order-to-delivery process. We conclude with a discussion of new insights for the development of theory related to order fulfillment, while also supporting managers, as they attempt to balance stability with responsiveness to customer needs in their manufacturing processes.

2. Order Fulfillment Modes

In a traditional mass production context, products are manufactured to stock based on either manufacturer or dealer forecasts of anticipated sales (Olhager and Ostlund 1990). BTF enables cost-efficient manufacturing processes through repetitive production and high capacity utilization (Raturi et al. 1990). Sales targets and production volumes in this forecast-driven context are determined in part by historical demand information, while inventories of finished goods absorb demand variability and uncertainty by serving as a buffer between the manufacturing process and customer needs (Bozarth and Chapman 1996). This strategy is also referred to as a "make-to-stock" approach, due to its reliance on a finished goods inventory (Cattani et al. 2010, Iravani et al. 2012).

As a contrast to BTF, we examine a mass customization process, in which the firm embeds customization within established and stable manufacturing processes (Holweg and Pil 2004, Pil and Holweg 2004, Piller et al. 2012). The unifying feature of mass customization is that customers are treated as individuals and their needs are met individually, even if this goal is accomplished through mechanisms that reach large numbers of individuals simultaneously (Davis 1987, Piller et al. 2004). There are multiple avenues for undertaking mass customization; these include build-to-order, assemble-to-order, and late-configuration approaches (Gilmore and Pine II 1997, Huang et al. 2010, McCutcheon et al. 1994). This study focuses on BTO, a variant of mass customization, in which products are produced in response to customer orders (Holweg and Pil 2001, 2004, Piller et al. 2004).[1]

The following sections integrate theory with empirical evidence derived from our case firm, OEM, a global automotive producer for the volume passenger markets. OEM offers its customers both BTO and BTF modalities. We use quantitative and qualitative data to study OEM's efforts to embed customer responsiveness in its European operations. For

[1] In the automotive sector, where our study is based, BTO has been categorized in different ways, including a "group 4/assembler" (Duray et al. 2000), "catalogue mass customization" (MacCarthy et al. 2003) and build-to-order (e.g. Gunasekaran and Ngai 2005, Holweg and Pil 2001, 2004, Piller et al. 2004).

our quantitative analyses, we integrate vehicle-specific data provided by the logistics function, OEM's European sales regions, and corporate headquarters. As described in section 4.2, the result is a comprehensive dataset of 48,534 individual vehicle sales, which allows us to assess the impact of each order fulfillment mode on unit-level profitability. For qualitative insights, we rely on interviews with senior operations executives at OEM and representatives from one of the national sales companies. These interviews were open-ended, informed by both the extant literature and the quantitative analysis results. Key topics included cost optimization challenges, the conceptualization of customer value, and the evolution of strategic thinking around BTO. We complemented these discussions with a review of board documents used by OEM to make the initial case for BTO. We situate our data in relation to the existing literature to develop four propositions around order fulfillment cost optimization, BTO and unit profitability, the shift to a multi-modal approach to order fulfillment, and the role of information systems in enabling this change. Each proposition is developed separately.

3. Order Fulfillment: A Cost Optimization Perspective

3.1. Theory

Early studies that modeled cost optimization in relation to order fulfillment started with the premise that firms adopted either a pure BTO or a pure BTF strategy (Soman et al. 2004). A substantial literature developed to examine production planning and inventory control policies in each environment (e.g. Kingsman et al. 1996, Silver et al. 1998, Stevenson et al. 2005, Vollman et al. 1997, Winands et al. 2011). What emerged from this work was a recognition that BTO and BTF could fruitfully co-exist within the same organization. Order fulfillment mode was however considered to be exogenous to the firm, and studies continued to focus on optimal planning and inventory control policies (e.g. scheduling rules under congestion), as a means of minimizing total systems cost (e.g. Carr and Duenyas 2000, Youssef et al. 2004).

Greater realism emerged with the recognition that not only can BTO and BTF co-exist, but firms can determine the relative balance between them (e.g. Arreola-Risa and DeCroix 1998, Rajagopalan 2002). In production line decisions, the strategy by which custom and standard products are produced on the same line is referred to as “spackling” (cf. Cattani et al. 2005, 2010). Empirically, evidence of such spackling strategies exists in multiple industries, including automotive (Kobayashi et al. 2014, Tomino et al. 2009), food processing (Soman et al. 2007), and messenger bags (Cattani et al. 2010). Modeling studies that allow BTO and BTF to co-exist typically rely on single stage, multi-product models based on Markov decision chains or queuing techniques; they assume stochastic customer demand (e.g. Carr and Duenyas 2000, Soman et al. 2006, Zhang et al. 2013). These studies suggest that hybrid production generally achieves lower system costs, as compared to pure BTO or BTF production. Qualitative work has similarly examined this product allocation approach. Van Donk (2001), in a series of case studies in the food processing industry, developed decision-making tools around a “customer order decoupling point,” to help firms select which products to stock, and which to produce in response to customer order. Subsequent qualitative work has refined these classifications (Kerkkänen 2007, Soman et al. 2007). For a detailed review of the literature, see Gunasekaran and Ngai (2009) and Soman et al. (2004).

While each study of hybrid order-fulfillment systems explores specific dimensions of the cost structure (e.g. inventory holding, stock out, and set-up costs), more recent work broadens the set of parameters that can be simultaneously considered. For example, Kaminsky and Kaya (2009) incorporate inventory levels, production sequencing, and lead time quotation in a hybrid BTO-BTF system, in order to minimize the costs of inventory holding, customer lead times, and late delivery penalties. Customer lead times are defined by queuing in a production process; it is queuing, rather than customer preferences, that drives quoted lead times. A further core assumption in the literature on hybrid production is that either BTO or BTF production must be assigned scheduling priority (cf. Beemsterboer et al. 2016), with the relative priority varying across studies. Iravani et al. (2012), for example, model a component supplier who treats BTF products for a major OEM customer as high priority, while low priority BTO units are used for other sales channels. In contrast, Youseff et al. (2004) assign higher priority to low-volume BTO products.

3.2. The OEM Perspective

OEM took its initial steps toward BTO in 1999, as a way of reducing the level of working capital associated with large inventories of finished goods. The initial project team was led by the manufacturing function, including members of the IT department responsible for maintaining the central production programming and scheduling systems at manufacturing sites. This team began with one overarching goal: to reduce the holding cost of finished goods, while maintaining capacity utilization. To attain this objective, it focused on enhancing the flow of logistics information, optimizing ROI, and reducing lead times. With respect to the latter, the management goal was a 14-day order-to-delivery time, rather than a specific BTO production level.

A decade after the first introduction of BTO (fiscal year 2008-2009), automotive sales were down dramatically and some of the challenges associated with OEM's BTO efforts became apparent. For example, OEM's sales organization had obtained volume assurances from the various National Sales Companies (NSCs) and sales commitments from individual dealers to ensure that its annual sales targets would be achieved. However, dealers who did not meet their sales commitments blamed BTO for the shortfall. These dealers claimed that they could have sold their full allocation, had they not lost customers, due to a lack of available production slots in the order pipeline. Successful NSCs had too few production slots, while NSCs with stagnant sales did not use their full allocation. As the head of logistics noted: *"We considered making country volume allocation rules breakable but sales did not like it and wanted to safeguard supply in the short term to avoid excuses for target failure—we managed the optimization by weekly allocations based on fill rate."*

The central planning function was responsible for mediating between the different, and often competing, demands of NSCs. Ultimately, OEM decided that independent ownership of the NSCs and their associated vehicle stocks was a fundamental roadblock to its inventory reduction goals. OEM therefore decided to take control of the NSCs. Dealers were still managed regionally, but by limiting the autonomy of the NSCs, OEM gained a direct incentive to reduce inventory post-manufacturing. A new system of centralized stockholdings through regional distribution centers was introduced. While the literature emphasizes the function of such centers in optimizing product flow (MacCarthy and Ovutmen 2015), in the case of OEM, the role played by these centers reflects an emergent rather than purposive decision.

As a next step, OEM eliminated the requirement that dealers commit to large monthly volumes of pre-specified vehicles. While dealers' volume-related sales incentives were retained (maintaining the push to sell), the pressure to shift an *individual* vehicle was removed. This allowed dealers to think more broadly about working with OEM to meet each customer's specific needs. The then head of logistics operations observed that the push to reduce finished goods inventories, both in the system and at dealers, was not supplemented by efforts to encourage dealers to embrace customization. While dealers were not committed to the sale of particular vehicles, they continued to emphasize 'shifting the metal': *"The dealers know the OEMs will get the incentives out for end-of-year landings, for half-year landings, and when LTS [long term stock] needs liquidating."*

From OEM's standpoint, these changes encouraged divisions beyond manufacturing to track in real time the allocation use of each dealer, regional business unit, and vehicle model group. However, these entities were governed by separate managerial fiefdoms with in some cases their own stand-alone IT systems. The process of fulfilling customer orders was similarly fragmented, with OEM operating three separate systems: one managing forecast orders, a second allowing dealers to place BTO orders for their customers, and a third allowing dealers to search other dealers' stock for possible matches. To overcome these organizational barriers, OEM invested heavily in the integration of IT systems across regions and functional units.

Proposition 1. Efforts to improve order-to-delivery processes can expose broader organizational barriers to operational efficiency, including misaligned incentives and inadequate IT infrastructure.

4. Order Fulfillment: A Value Creation Perspective

4.1. Theory

In the cost optimization literature, detailed above, individual customer value is not a decision variable for optimization. While some studies show that customer information can add value (e.g. De Treville et al. 2014), customer heterogeneity is generally treated as a factor to be accommodated, rather than a source of value to be maximized. Nevertheless, an extensive literature draws on experimental approaches to highlight ways in which order fulfillment can generate customer value. In examining individual purchase decisions and customer willingness to pay, this literature suggests that purchasers of bespoke products are a source of greater profitability (Franke and Piller 2004, Schreier 2006). The experimental work on customization indicates that these price premiums are substantive: €48.50 for self-designed watches versus €21.50 for comparable standard watches (Franke and Piller 2004); €7.60 for custom cell phone covers versus €3.70 for standard covers; and €10.10 for custom scarves versus €4.90 for standard scarves (Schreier 2006).

Custom products deliver higher levels of preference fit, allowing customers to express uniqueness, while also deriving greater utility, from their purchases (Franke and Schreier 2008, von Hippel 2001). In addition, customers derive affective benefits from the customization process. An example of such a benefit is the “pride of authorship” associated with the customer’s selection of product attributes (Dellaert and Stremersch 2005, Franke et al. 2010, Schreier 2006). While BTO in the automotive sector tends to focus on configuration rather than design, most vehicles are available in a million-plus potential variations; the configuration enabled by BTO is a source of value to the customer (Hildebrand et al. 2013). Opportunities for customers to configure their vehicles generally relate to aesthetic attributes, and the selection of these attributes leads to high levels of customer process enjoyment (Schnurr and Scholl-Grissemann 2015).

4.2. The OEM Perspective

We examine how the insights derived from customer value experiments relate to OEM's experience by examining the individual vehicle sales of four models sold in the European volume passenger car market during the research period. We obtained vehicle-specific order information for each vehicle model from four of OEM's European sales regions. The order information included the terms of order fulfillment (BTO or BTF), as well as the sales incentives provided to dealers to help sell specific vehicles. From OEM's corporate headquarters, we obtained internal data on each individual vehicle's contribution to net income, sales price to the dealer (dealer transaction price), and the value of any options. The OEM's logistics department provided us with vehicle-specific stock holding costs and shipping times.

The data compiled in this dataset were not available in unified format at OEM. Each automobile's unique vehicle identification number (VIN) was used to integrate the sales and incentive data with that vehicle's contribution to net income, dealer transaction price, optional equipment value, and holding and shipping data. Data matching involved 77,261 individual vehicles as the initial starting point. These vehicles represent all private customer sales across the four vehicle segments and market regions in the fiscal year 2007–8. We obtained complete data for 48,534 of these vehicles. The missing cases reflect incomplete record keeping and data entry problems, as well as matching problems across the different databases. For example, the sample excludes vehicles produced during the year but still held in inventory at the end of the period under study. No systematic differences were observed between the excluded cases and our sample in terms of cost of sales, length of stock holding, sales incentives, or vehicle option specifications within segments.

4.2.1. Measures. Our dependent measure is defined as follows.

Unit Profit Margin: Our profit metric is the OEM-determined net unit profit margin, expressed as a percentage of the vehicle's transaction price to the dealer, less the allocated share of administrative overhead and manufacturing costs. OEM's approach to the latter is not conditional on the order fulfillment mode, in part because the manufacturing process is agnostic when it comes to order type. As a result, there are no manufacturing cost differentials between similar products manufactured to order or to forecast. The net profit margin is a critical measure for OEM's manufacturing and distribution process, and was central to its evaluation of the success of the BTO initiative. As shown in Table 1, the average profitability per vehicle is 13% but the standard deviation is large (12.7%). Some vehicles garner a substantial profit, while others represent a loss.

Our independent measures are defined as follows.

Build-to-Order Fulfillment: All vehicles were designated as BTO (in which case the dealer was required to enter full customer details) or BTF. This information was recorded by OEM's sales system in each market region for every vehicle sale. The majority of observations (60%) were BTO, with the remainder BTF. In cases where a customer requested a specific vehicle that had already been produced as part of the forecast mix, the sale was coded as BTF. The order fulfillment variable was a dummy variable, set at one if the product was BTO and zero if BTF.

Inventory Holding Costs: Our measure of inventory holding costs includes two key post-manufacturing expenses incurred by the OEM: the cost of physical storage and the cost of capital. Transport costs were excluded, as OEM did not track them at the individual vehicle level. OEM uses a range of distribution centers, some owned by OEM and others owned by third parties. The company allocates a daily storage cost to its vehicles, based on the average cost across its storage network. We used this value to assign a storage cost to each vehicle, based on the length of time it spent in finished goods inventory. We used the OEM's internal cost of capital rate of 7% of manufacturing cost. We applied this cost based on the number of days between when the vehicle was completed in the assembly plant and when ownership was transferred to the dealer. All data were denoted in Euros (€), as this was the currency used internally at OEM (during the period under study: €1 = US$1.35–1.55). The average vehicle holding cost was €74 (S.D. €119), with some vehicles spending several months in inventory.

Sales Incentive Costs: For each of the vehicles in our sample, we obtained data on the vehicle-specific discounts and sales incentives provided to the dealer by OEM. These included long-term stock support. The average cost of these incentives was €845 per vehicle.

Vehicle Segment: OEM offers four different consumer vehicle segments in Europe: compact sport utility (Compact SUV); large sport utility (Large SUV); multi-purpose (MPV); and Supermini segments. The Compact SUV category accounted for the bulk of sales in our sample (48%), followed by the Supermini (30%), MPV (15%), and Large SUV (7%).

Sales Region: We used OEM's internal sales region demarcations: Central Europe (CE), which included countries like Austria and Switzerland; Western Europe (WE), which included countries like France, Belgium, and the Netherlands; the Iberian Peninsula, which included Spain and Portugal; and the United Kingdom (UK). The latter was treated as its own region by OEM. The majority of vehicles were sold in the UK (41%). A further 32% of sales occurred in Western Europe, 7% in Central Europe, and the balance (20%) in the Iberian Peninsula. We controlled for these regions using dummy variables, with the Iberian Peninsula as the default.

Product Lifecycle: The dataset included vehicle models at various stages of the product lifecycle. Some were approaching the end of their lifecycle and others were new to the marketplace at the start of the study period. Product lifecycle was measured by the number of months from the introduction of a new model. The average product had been on sale in the marketplace for about 18 months. The Compact SUV represented a new model at the start of our study period and was thus substantively newer than other products in our sample.

Option-Based Revenue: This measure captures the additional revenue generated by configurations that exceed the base vehicle specification. We followed OEM's construction of this measure. The average vehicle delivered €935 in option-based revenue.

We also included two instrumental variables (IVs) in the analysis. The IVs affect a customer's decision to select build-to-order fulfillment, but they are not related to the estimation of our outcome variable, unit profit margin. All vehicle observations, including those excluded from the analysis sample due to missing data, were used in the measurement of the IVs since they could still have influenced the BTO fulfillment decision.

Inventory Level. Our first IV measures the number of vehicles produced and available for sale within the system for each vehicle segment (i.e. BTF vehicles) at the date of customer purchase. We use the natural log of this measure. Inventory levels are expected to be relevant to the customer purchase decision because they reflect an opportunity to achieve a match between customer preferences and existing inventory holdings. Specifically, as the level of available inventory for a particular vehicle segment increases, customer preferences are more easily met from available stock. The inventory available to dealers should not affect the unit profit margin that the OEM obtains from the dealer.

BTO Wait Time. Our second IV assesses the average order-to-delivery wait time, by vehicle segment, for BTO vehicles delivered to dealerships in the seven days prior to the date of customer purchase. We use the natural log of this measure. As the expected wait time increases, customers may be less willing to select a BTO fulfillment mode. The time lag between our measurement of expected wait time (as at -1 days prior to customer purchase) and the purchase decision (on day 0) also makes this measure unlikely to have any direct effect on the output equation.

4.2.2. Findings. Table 1 provides the correlation matrix and descriptive statistics. The Supermini was the least profitable of the four models and garnered less add-on option revenue. The Compact SUV was highly profitable and had a high likelihood of being built to order. Because of the high demand, this product was, on average, less likely to receive sales incentives or to stay in inventory long. Purchasers of Large SUVs were more likely to generate additional option-based revenue. Lastly, the Mini MPV was relatively unprofitable for OEM. By region, customers in the UK were more likely to order option content than customers in other regions. Vehicle sales in Western Europe required fewer incentives, while sales in Central Europe were the most profitable. The least profitable sales occurred in the Iberian Peninsula. All sales regions exhibited a high share of BTO sales, with Western Europe having the greatest share of BTO (71%), followed by the UK (63%), Central Europe (58%), and the Iberian region (41%).

We begin our empirical investigation by constructing four linear regression models to assess the effect of BTO on profitability for each of the vehicle models produced by OEM. Table 2 (Models 1–4) presents the classic OLS estimates. We note that data on vehicle sales may be clustered by dealership, with model errors uncorrelated across, but correlated within, dealerships. Failing to adjust for this bias may lead to the default standard errors being too small, thereby overstating t-statistics for our estimators and leading to over-rejection of the true null hypotheses. We therefore use cluster-robust standard errors (Froot 1989) to adjust for the unobservables of each dealership in our sample.

To address concerns regarding potential endogeneity, we supplement the OLS models with Heckman treatment effects models, using appropriate instrumental variables (Heckman 1976, Maddala 1986). The Heckman treatment effects model improves the reliability of estimation when the potentially endogenous variable (Build-to-Order fulfillment) is binary; this helps to ensure that our estimates are not biased by unobservable variables that induce BTO choice, while at the same time enhancing unit profitability. We generate four models of Heckman treatment effects using maximum likelihood and cluster-robust standard errors adjusted by dealership. Table 2 (Models 5–8) reports the results of the Heckman treatment effects models.

Before discussing the regression estimates, we assess the relevance and validity of our two instrumental variables. The formal tests of under-identification and weak identification assume that both the endogenous and outcome variables are continuous. For the purposes of IV testing, we follow convention and also treat the binary build-to-order variable as continuous. The estimated coefficients of the 2SLS models used to evaluate our IVs are consistent with the results of our Heckman treatment effects model in Table 2. In testing for under-identification, we use the Kleibergen-Paap (2006) rk LM statistic, which produces heteroskedastic-robust results in the presence of cluster-robust standard errors. For each vehicle segment, the LM statistic is significant at $p<0.001$ (2 d.f.), suggesting the excluded instruments are correlated with our endogenous variable—build-to-order fulfillment—and are therefore "relevant." To test for weak identification of the excluded instruments with the endogenous regressor (build-to-order), we use the robust Kleibergen-Paap rk Wald F statistic. We compare this F-statistic for all models against the critical values for the Cragg-Donald F-statistics reported in Stock and Yogo (2005). Our F-statistics for each vehicle segment are all greater than the critical values for maximum bias of 10% (relative to OLS), suggesting that there is no basis to suspect our models are affected by the problem of weak instruments.

We now examine the effects of BTO order fulfillment on unit profit margin. The OLS Models (1)–(4), suggest that, for three of our vehicle segments (Large SUV, Mini MPV and Supermini), BTO order fulfillment leads to an increase in unit profit margin, after controlling for product characteristics, sales region, and post-manufacturing costs. For the Compact SUV, the results suggest a decrease in unit profit margin (β = -0.57, p = .000). As a further check of robustness, we estimated alternative models using unit revenue and unit gross margin, as dependent variables (in the former, incorporating a cost-of-goods-sold measure as an independent variable). In both sets of OLS models, with cluster-robust standard errors by dealership, the coefficient for BTO was consistent with those reported above.

With regard to the Heckman treatment models, the *P* for Compact SUV, Large SUV, and Mini MPV are not significant, suggesting that the parameter estimates for the OLS models may not be biased. Likewise, comparing the OLS results to Heckman Models (5)–(8) indicates no substantive change in the coefficients. However, in the case of the Model (8) Supermini, it appears to be important to account for the endogeneity of the BTO choice, as the model estimates a significant positive correlation (ρ = 0.193, p < .001). This result suggests that Supermini unobservables, which raise the unit profit margin, tend to coexist with unobservables that increase the likelihood of BTO fulfillment choice. For the Supermini segment, our OLS estimates may therefore reflect an under-estimation of BTO's positive effect on the unit profit margin.

Overall, our results suggest that, in line with the literature, BTO has a positive effect on unit profit margins. However, this is not the case for the Compact SUV, where BTO had a significant negative effect on unit profit margin. This result contradicts predictions in the literature on customer willingness to pay for custom products. The negative result is not the outcome of poor product-customer fit or a lack of authorship benefits, as identical customization tools and options are available for this product. In discussing this outcome with OEM, the observation was made that demand for the Compact SUV significantly exceeded supply during the time period in question.

The implications of this mismatch between product demand and supply have received little attention in the literature on hybrid production systems. Studies that model such systems generally assume that demand for a BTO unit is satisfied within the same time period (e.g. Rajagopalan 2002), or that expected demand for each product equals plant capacity (Bish et al. 2005). For studies that relax these assumptions, orders are not lost from the system, but are backlogged and available for delivery during a later period (e.g. Iravani et al. 2012). Exceptions include Carr and Duenysas (2000) and Gupta and Wang (2007), who assume sales are lost in the current period if not fulfilled. In our case context, customer orders are sometimes delayed. We learned from OEM that dealers used BTO as a way of delaying delivery on Compact SUV orders that could not be filled from inventory or current production. Indeed, some dealers placed custom orders, knowing that actual delivery would take place as much as six months later. As OEM's head of supply chain management strategy and planning noted: *"This gave senior management big concerns about customers having to wait for such a long time, but they did."*

While much of the literature discussed so far focuses on modeling monopoly firm decisions, where all customers buy from the firm (e.g. Alptekinoğlu and Corbett 2010), the fact that this customer demand lock can occur in a highly competitive industry lends credence to some previous modeling work. Indeed, we can envisage a scenario where the reduced profit associated with BTO for the Compact SUV could be modeled as a penalty cost for the delayed delivery of a custom product. We propose:

> **Proposition 2.** The effect of BTO on unit profitability is dependent on the emphasis placed on its use to fulfill customer attribute needs, in relation to its use as a demand deferral tool.

5. Integrating Cost Optimization and Value Creation in Order Fulfillment

5.1 Theory

5.1.1 Variety and Multi-Modal Order Fulfillment

Firms face a trade-off: BTO products fit customer needs precisely but are subject to order-to-delivery lead time expectations, while products held in inventory may not fully match customer preferences but are available with little delay. Early modeling work began with the premise that trade-offs are made in the factory, coalescing as a choice between producing to order or to stock. Adopting such a factory-centric perspective raises a series of questions, which the modeling literature has extensively explored. The issues we have touched on so far include the relationship between production-inventory decisions and product variety (e.g. Gaur and Honhon 2006, Van Ryzin and Mahajan 1999), and production-inventory decisions and lead time (e.g. Altendorfer and Minner 2014). This literature suggests that firms face concrete trade-offs: they can reduce available variety or increase stock holdings to meet service delivery times; alternatively, they can produce to customer order. Thus, there is either an emphasis on cost reduction, or on value creation for the customer. Ultimately, there is a need to integrate these two aims.

Recent modeling studies have focused on this integrative view in a monopoly firm setting, using models that jointly optimize product offering, pricing, and BTO/BTF decisions (Dobson and Yano 2002), and models that explore customer choice and product line diversity (Yunes et al. 2007). One underlying assumption is that all customers buy from the firm—and are relatively homogenous in their product variety and lead time preferences. For example, Alptekinoğlu and Corbett (2010) use a dynamic programming approach to model the optimal product portfolio for integrated product variety, delivery lead time, and pricing decisions. Central to the effectiveness of optimization is the firm's accurate understanding of the *customer's emphasis on a precise configuration and the extent of her willingness to wait for that configuration*. One consistent finding from this modeling work is that, when customer preferences are modeled as non-uniform, hybrid production lines are preferred.

A separate literature explores, both theoretically and through simulation, some alternative approaches to dealing with heterogeneous customer preferences. One such approach is the "open order pipeline"—a multi-modal approach for order-fulfillment, also referred to as "virtual-build-to-order" (Brabazon and MacCarthy 2006, Brabazon et al. 2010, MacCarthy 2013). Brabazon and MacCarthy (2006) compare conventional BTO/BTF fulfillment to an open pipeline system, with pipeline planning modification, while Brabazon et al. (2010) extend this work via a simulation model of an automotive virtual build-to-order fulfillment system, in which orders can be altered both in the production pipeline and through inter-dealer trading. More recently, MacCarthy and Ovutmen (2015) have developed a simulation model based on sales data from an automotive producer, assessing the impact of introducing central vehicle holdings on lead time, stock levels, and fulfillment modes. They find that central vehicle holdings can be particularly effective in reducing lead times and substituting for BTO (which makes planning and managing production easier). The results of these simulation studies suggest that multi-modality fulfillment may be beneficial to performance through improved customer fit and reduced inventory holdings. Even though the open pipeline system expands the ability to meet customer needs, it is still assumed that production volume and demand volume are in balance.

5.1.2 The Operational Value of Information

Both the experimental and modeling literatures suggest that, when the customer is involved in product selection and specification, the firm obtains useful information about underlying market demand. This information is beneficial, not just with respect to custom orders, but also for decisions regarding forecast products (Holweg and Pil 2004). Indeed, in their modeling work based on Sport Obermeyer, DeTreville et al. (2014) show that understanding precise customer need early in a product's lifecycle can provide dramatic benefits, even when a firm is primarily engaged in forecast-driven production or sourcing. The broader information value that accrues to the firm is similarly highlighted in the broader modeling literature (e.g. Milner and Kouvelis 2005).

The experimental and empirical literatures complement the modeling literature by outlining the important role of configuration tools used to attain information about customer preferences—from the vantage point of the customer. Merle et al. (2010) illustrate these customization benefits in their examination of NikeID—a simple configurator that allows customers to select various shoe attributes, in much the same way that one might select options and colors for a vehicle. They find that such configurators enable selfexpression, but also provide direct utilitarian value. Many customers lack insight into their own preferences, and the customization process can help them develop that insight (Franke and Hader 2014; Schreier 2006). As they engage with configurators and learn to articulate their own preferences, customers are also more likely to purchase a product they have designed (Franke, Keinz, and Steger 2009).

5.2 The OEM Perspective—Multi-Modal Order Fulfillment

As we have discussed previously, and consistent with the literature, OEM's initial introduction of BTO resulted from its manufacturing unit's efforts to rationalize inventory, while maintaining acceptable service levels. Integrating the NSCs was an initial step in this direction. Through greater visibility for finished goods inventories and dealer needs, OEM was able to attain modest reductions in post-manufacturing inventory holdings. Manufacturing's next step toward further opening up the order pipeline facilitated a shift towards enhanced customer responsiveness. However, as we will discuss, fully embracing customer needs requires moving beyond manufacturing-centric initiatives.

During initial efforts to further reduce its 14-day order-to-delivery lead time target, OEM modified the production planning process to allow changes to the production schedule up to six days before the start of vehicle production (a so-called "D-6" scheduling approach). The production program set parameter boundaries (Order Control Frames), which constrained the aggregate number of changes in terms of volume, mix, and vehicle specifications. Subject to these constraints, dealers were permitted to alter or add orders. If the order amendment breached any order control frame rules, then the order moved to the next available slot (without any breaches), allowing another order to be pulled forward. As the head of the BTO implementation team noted: *"[O]riginally we handled this by a heavy overnight process with the system offline when the dealers were in bed. Our expanded use of [the customer order fulfillment process] across wider Europe, including all of Russia, reduced our overnight window and forced us to do this optimization in real-time."* The new ordering system allowed dealers to see their orders in relation to their allocation, ultimately enabling them to attain higher stock velocity aligned with customer needs.

At its core, OEM's order-to-delivery process remains under the purview of central planning. Our interviewees from the central planning function consistently expressed the view that other departments were not fully on board. For example, the finance division made money through financing showroom stock. Reductions in the need for showroom stock were not received positively by that division. Similarly, marketing units in different countries felt threatened by the option of increased inventory visibility. As a senior manufacturing executive noted: "*Sales and marketing are experts at saying our market or situation is different… We have focused and still focus on ideal manufacturing and supply chain systems, but excellence can only be achieved by looking at the whole business, its effectiveness and challenging all functions."* OEM's response to such resistance has been to decentralize information and shift decision-making authority to the dealers. OEM has modeled its pipeline inventory and determined that if, in addition to opening up its manufacturing pipeline, it made all stock at dealers and distribution centers visible to all dealers, total stock would be reduced dramatically and sales of products languishing more than 90 days would fall from 6.9% to 1.5%. It has taken this approach, enabling avenues to customization that bypass the manufacturing process. This approach to customization has incentivized dealers to help customers get exactly the product they want. As OEM no longer distinguished between order types, dealers and customers could not bargain for “deals” on grounds that a vehicle was not exactly what they wanted. From the standpoint of the system overall, the same configuration might be obtained via the manufacturing scheduling system, centralized inventory, or other dealers.

> **Proposition 3**. As the voice of the customer penetrates into the order fulfillment process, manufacturing is no longer the pivot point for operational decision making. The result is a shift away from a BTO/BTF dichotomy, towards a multi-modal customer-driven order fulfillment strategy.

OEM’s shift to multi-modal order-fulfillment was accompanied by efforts to develop a greater understanding of customer desires with respect to order-to-delivery times. OEM surveyed just over 500 customers, learning that customers expected their vehicles to take a certain minimum amount of time to be “built” to order. Indeed, if order-to-delivery time was less than seven days, over half the buyers indicated they would worry that the vehicle was not of the requisite quality, while half indicated they would not wait more than 48 days. This survey offered considerable insight for OEM: Not only was there significant variability in customer expectations on lead times, but customers also differed in their willingness to trade off lead time against obtaining the precise product they desired.

OEM was thus forced to revisit a fundamental premise of the BTO initiative—that the ideal target time for customer delivery was two weeks. As a result, it decided to enable different modalities to organically yield delivery times that met customer needs. Key to this step was developing accurate representations of lead times across modalities, not just to facilitate OEM’s planning, but also to enable more effective dealer-customer interactions.

Up until this point, dealers shared the delivery date with the customer in one of two ways: either the salesperson provided a best guess based on prior experience, or dealers told customers to wait until closer to the actual delivery date, when they would have a better idea of when delivery would take place.

To more directly link its manufacturing flexibility to customer needs, OEM needed to provide accurate visibility on the previously diverse set of modalities used by dealers to source a vehicle (e.g. order amendment, central stock, and inter-dealer trading). The greatest step in this direction was the development of a single IT system that provided visibility on the different order modalities for a given specification, along with anticipated delivery times. This integrated approach eliminated guesswork on order-to-delivery time, providing the dealer with superior information to make informed decisions on compromises around product fit and customer willingness to wait. The provision of a firm delivery date meant that customers knew the anticipated delivery time of their vehicle. Handover times from dealer to customer were cut from a week to three days.

Observing the choices made by dealers across different modalities in relation to lead time proved very useful. OEM gained ongoing insight into customer expectations on lead times, allowing it to further reduce central stock when lead times could be met directly by the manufacturing process. As a next step, OEM was considering making availability visible to potential customers, allowing them to not only configure their vehicles, but also to see how their choices would affect delivery times. In this case, the dealer's ability to engage in information intermediation between the customer and OEM would be eliminated. This new philosophy was described as transitioning from a system in which lead time was based on minimal transport costs and on-time delivery to dealers, to a system that focused on the customer promise date with *"process improvement managed by quantifiable customer need and perceived performance."*

OEM's earlier approaches to revisiting order fulfillment started from the premise that customers wanted specific configurations and that BTO was the best mechanism for managing such variety. However, it became increasingly clear that customers approach the purchase decision with pre-established thoughts on both a time-line and desired product attributes; at the margin, they are willing to compromise. As the head of the BTO implementation team noted: *"[T]he reality is that we do not sell everything BTO, I wish. The customer does not come into the dealership with an end item in mind, but typically with some "must-have" features, for example, diesel rather than petrol, and some "nice-to-have" options that are contingent on price, availability and negotiation."* As part of facilitating this process, OEM has reconfigured its IT system to include anticipated wait times in each available modality, not just for exact matches to customer needs, but also for products that approximate customer preferences. This integrated information system represents an important step towards incorporating and resolving the tensions between responsiveness and manufacturing imperatives.

Proposition 4. System-wide improvement is enabled by information systems, which facilitate bi-directional information flows between customers and the firm, and allow the firm to develop insights, not just on desired product attributes, but also on the importance of those attributes in relation to customer willingness to wait.

6. Discussion

A key insight from the modeling literature is that when customer preferences are not uniform, a hybrid production strategy is preferable (e.g. Alptekinoğlu and Corbett 2010). Similarly, from a production standpoint, the literature shows that significant cost and lead time benefits are achieved when firms produce at least a subset of output to customer order (e.g. Beemsterboer et al. 2016, Kaminsky and Kaya 2009). The initial efforts at OEM mirrored this optimism; they were driven purely by efforts to reduce inventory holding costs. However, one advantage of taking an industry-studies perspective is that it can reveal operating trade-offs and opportunities that might not be immediately identified in inter-industry and broader intra-industry studies (Joglekar et al. 2016). By following the evolution of OEM's strategy, this study explores the trade-offs and opportunities that emerged as OEM moved significantly beyond its initial goals to reduce inventory-related costs. We have therefore been able to identify important considerations that may enrich the theoretical and analytical base of work in this space. As Gunasekaran and Ngai (2009: p333) have noted, "it would be helpful to modify the existing mathematical models for [hybrid BTO-BTF manufacturing systems] so that they can be representative of a real life BTO supply chain". Based on our findings, we offer some initial thoughts in this direction.

Hybrid manufacturing systems, such as the "spackling" approach to hybrid BTO-BTF production, have received significant attention (Cattani et al. 2010). However, with the shift to an open-order pipeline, the distinction between BTO and BTF in the manufacturing process is no longer a critical factor. Instead, the conversation has become more inclusive, expanding to explore how customer needs can be met through multiple modalities. In the case of OEM, the flexibility inherent in a coherent multi-modal fulfillment system allows it to harness the benefits of forecast-and-order-driven production, while exploiting any flexibility offered by the manufacturing system to alter existing orders in the pipeline. In this context, we show empirically the approach presaged by Brabazon et al. (2010) and others on multi-modal order fulfillment. The transition at OEM toward an open order pipeline brings real-life supply chains closer to those modeled in the literature. In particular, several simplifying assumptions used in the modeling literature now legitimately reflect the modus operandi at firms like OEM. For example, many modeling studies start with the premise that production costs for BTO and BTF are symmetrical, and set-up costs are negligible, if not zero (e.g. Alptekinoğlu and Corbett 2010, Altendorfer and Minner 2014, Rajagopalan 2002). Since OEM does not distinguish between BTO and BTF orders in the production process, these assumptions are valid. While they may not hold in all contexts, this does mean that findings from the modeling literature may prove to be more useful than in the past, when manufacturing systems did not take an agnostic approach to these decisions.

To optimally utilize the multi-modal approach to meeting customer demand, OEM found it essential to develop a more systematic method, which embraced customer willingness to trade off product attributes and to wait. By integrating its IT systems so that product configuration and identification could occur jointly, OEM has enabled its customers to make more informed decisions. For example, a customer may be able to get precise body style and color at the local dealer; a body style, color, and entertainment system choice via inter-dealer transfer with a five-day lead time; or a body style, color, entertainment system and other features (such as seat material and exterior trim) via a custom order to the factory with a 15-day lead time. This last model is agnostic to order type and order source. In the same way that Sport Obermeyer uses custom orders to enhance its seasonal forecast-based production (Fisher and Raman 1996), the type of information gathered by OEM about the trade-offs customers are making between product attributes and time considerations, allows for a much richer inductive approach to determining product allocations, inventory holding decisions, and customer incentive structures. In this manner, OEM followed what Franke and Piller (2003) have argued is an alternative way to think about customization—viewing it as a *solution* capability, rather than a *production* capability. This approach leads to a closer alignment between the organization's capabilities, and the needs of its customers (Holweg and Pil 2004, Salvador et al. 2009). In addition to making what customers want, it also helps customers identify what solutions would meet their needs (Franke and Hader 2014).

At the same time that OEM is aligning its order-to-delivery model to meet customer needs, it is also rethinking ways to use build-to-order production to achieve its own need for stable capacity utilization. While excess products can be stored in central storage and at dealers, when products are in high demand, the firm risks losing customers due to insufficient capacity. BTO can play a unique role in helping firms incentivize a delay in customer orders. In this way, a firm can develop a "stock" of customers willing to wait until a later date, when demand is not as excessive and capacity is available.

The symmetrical roles of BTO and BTF in addressing capacity over- and under-utilization have received little attention in the literature; these offer opportunities for analytical modeling research. Other alternatives to using stock holding to manage discontinuities in supply and demand would likewise be interesting to explore. Examples include the implementation of priority ordering rules for different customer types, and the placement of pricing premiums and discounts on production slots. These open up opportunities to incorporate insights from other contexts, including hotels, airlines and operating theatres, where inventory cannot be stockpiled and capacity availability is lost if not used. Creating a bridge between manufacturing and these contexts, and incorporating opportunities to use order-to-delivery to delay customer demand could present new opportunities for modeling and simulation to develop valued insights.

Another opportunity for further inquiry involves the role of intermediaries and other actors that place constraints on the information flow and decision processes. In some instances, the situation may be straightforward. For example, reductions in inventory at dealers may be unappealing to departments that derive part of their revenue from financing that inventory. More fundamentally, removing intermediaries from the system facilitates decision making and enhances information flow. For example, in OEM's case, the initial disintermediation of NSCs enabled inventory reduction; equally significant, it provided a more direct understanding of dealer needs. However, this enhanced understanding is predicated on information flowing from dealers to OEM. Further progress involves enhancing two-way information flow, in part through the introduction of IT systems that provide dealers and their customers with better access to information involving time/product attribute trade-offs. Such systems enable dealers and customers to make informed decisions, while providing OEM with more reliable insight into customer needs and willingness to wait. This information is critical for managing—not just inventory in isolation—but inventory in relation to the order pipeline, and incentives to induce immediate purchase or delay product delivery. Here too, there are opportunities for new efforts to model the order-to-delivery process. In particular, the modeling and simulation literature assumes implicitly that customers are not able to observe the state of the firm's queuing and inventory system. Changing this assumption will help to develop insights into ways in which firms can further optimize their order-to-delivery processes.

Our study also has implications for managers engaged with decision processes around order fulfillment. We demonstrate how BTO provides concrete customer value. Articulating this value is an important part of the transition to a responsive order fulfillment model. It helps to address objections from departments within the firm and associated supply chain actors, who may perceive or experience a reduction in their relevance and relative power. In this instance, both marketing and finance were reluctant to fully embrace BTO. From a straight manufacturing standpoint, once the pipeline is opened, the manufacturing process is fully agnostic as to order type and no longer an obstacle to the transition to BTO. Recognizing and taking advantage of the information benefit associated with specific customer orders, in addition to gaining a deeper understanding of the distribution of customer willingness to wait, can help firms attain a better balance between supply and demand over time. However, this requires both a readiness to divulge order-to-delivery information, and the requisite IT infrastructure to allow integrated downstream visibility on the time implications of all ordering options.

6.1 Limitations and Future Directions

Our findings are not without limitations. We have focused on BTO in a manufacturing context where the decoupling point rests in the manufacturing facility, the product architecture is sufficiently integral that customization is generally undertaken by the OEM, and the customer design process is limited to selecting from a series of menus centered on function and form, rather than fundamentally co-designing products for fit or comfort (Piller 2010). Each of these factors constrains the generalizability of our findings. We also note that the choice of BTO fulfillment by customers may be influenced by dealer decisions that we have not measured. For example, willingness to pay for BTO products could be influenced by dealer perceptions of risk, with some dealers placing value on not having to hold these products in inventory. While our model is adjusted for dealer unobservables via cluster-robust standard errors, the influence of individual dealer behavior cannot be ruled out.

We show that, when a product experiences excess demand, relative to the firm's production capacity, BTO provides an avenue for retaining the customer within the system. While unit profitability under BTO may decrease in this circumstance, BTO may help the OEM capture more volume over time. Unfortunately, we do not have data to assess the potential foregone sales that are recaptured in this manner. Understanding the profit trade-off in relation to potential foregone demand represents an interesting avenue for future empirical and modeling work. Empirically, as firms move to multiple modalities of order fulfillment, it would be instructive to examine the effects of improved service levels (reduced lead times) on the incremental revenue achieved. This too could generate insights that would enrich modeling work in this space.

In implementing a multi-modal order fulfillment model, a firm is forced to transition from a strong focus on meeting individual customer needs to the broader question of balancing supply and demand. Experimental work on the benefits of BTO have shown that customers derive affective benefits from engaging in the BTO process, as well as cognitive benefits from having products that more directly meet their own needs (see Gemser and Perks 2015, for a review). It would be fascinating to extend the experimental work in this area to examine how lead-time levels, and control over lead time in relation to cost, influence customer satisfaction and purchase decisions.

7. Conclusion

We examine order fulfillment in a large, global auto company. For our focal firm, BTO was part of an evolution toward a multi-modal approach to satisfying customers' preferred product configurations. These findings shift the conversation from a largely binary decision about whether or not to adopt BTO, toward the broader question of how firms can best balance overall demand and supply in conjunction with managing trade-offs in customer desired lead time and preferences for self-selected product specifications. This shift requires an understanding of the changes in power, information flows, and incentives that accompany any reconfiguration of the order-to-delivery process. We highlight the power of having information flow from customers to the factory, and equally important, from the firm's different order-to-delivery capabilities to the customer. Ultimately, the changes that accompany the introduction of a multi-modal order fulfillment approach provide the basis for performance improvements that extend beyond factory utilization or inventory mitigation, enabling a systemic approach to understanding and addressing customer needs.

Table 1 Descriptive Statistics and Correlation Table

Variable	Mean	Standard deviation	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Unit profit margin	13.01	12.73	1.00												
2. Build-to-order fulfillment	0.60		.41**	1.00											
3. Sales incentives cost	845.36	616.74	-.40**	-.24**	1.00										
4. Inventory holding cost	74.82	119.78	-.19**	-.44**	.28**	1.00									
5. Option-based revenue	935.59	759.25	.38**	.06**	.18**	.13**	1.00								
6. Supermini segment	0.30		-.65**	-.25**	.21**	.07**	-.35**	1.00							
7. Compact SUV segment	0.48		.82**	.50**	-.33**	-.29**	.24**	-.63**	1.00						
8. Large SUV segment	0.07		-.02**	-.25**	.20**	.56**	.27**	-.18**	-.26**	1.00					
9. Mini MPV segment	0.15		-.30**	-.12**	.04**	-.09**	-.07**	-.28**	-.40**	-.11**	1.00				
10. Product lifecycle	18.57	17.00	-.47**	-.25**	.08**	.05**	-.20**	.52**	-.45**	-.08**	.03**	1.00			
11. Sales region - Iberian Peninsula	0.20		-.28**	-.20**	.18**	.06**	-.26**	.33**	-.21**	-.07**	-.08**	.14**	1.00		
12. Sales region - Western Europe	0.32		.13**	.14**	-.38**	-.12**	-.13**	-.15**	.14**	.01**	-.02**	-.06**	-.35**	1.00	
13. Sales region - Central Europe	0.07		.14**	-.02**	-.08**	.02**	-.06**	-.10**	.00	.06**	.09**	-.05**	-.14**	-.18**	1.00
14. Sales region - United Kingdom	0.41		.04**	.04**	.25**	.05**	.36**	-.07**	.04**	.02**	.03**	-.03**	-.42**	-.57**	-.22**

* $p \leq .05$, ** $p \leq .01$

Table 2 Unit Profit Margin by Model Variant

	Unit Profit Margin—OLS				Unit Profit Margin – Heckman			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Compact SUV	Large SUV	Mini MPV	Supermini	Compact SUV	Large SUV	Mini MPV	Supermini
Build-to-Order Fulfillment	-0.572***	1.432***	1.184***	1.890***	-0.576***	1.303***	1.589***	3.728***
	(0.08)	(0.25)	(0.19)	(0.27)	(0.13)	(0.26)	(0.28)	(0.66)
Sales Incentives Cost	-0.006***	-0.004***	-0.010***	-0.004***	-0.006***	-0.004***	-0.010***	-0.004***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Inventory Holding Cost	-0.010***	-0.003***	-0.014***	-0.002	-0.010***	-0.004***	-0.013***	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Option-Based Revenue	0.003***	0.003***	0.004***	0.005***	0.003***	0.003***	0.004***	0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Product Lifecycle	-0.128***	0.004	-0.435***	-0.031***	-0.128***	0.011	-0.447***	-0.028**
	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)

Sales Region—WE	1.313***	-2.560***	9.522***	-3.403**	1.313***	-2.572***	9.876***	-3.848***
	(0.20)	(0.14)	(0.66)	(1.18)	(0.20)	(0.14)	(0.71)	(1.16)
Sales Region—CE	8.203***	1.004	13.155***	8.459***	8.203***	1.080	13.251***	8.267***
	(0.23)	(0.55)	(0.70)	(1.71)	(0.23)	(0.57)	(0.70)	(1.69)
Sales Region—UK	3.628***	3.417***	9.626***	-5.515***	3.628***	3.357***	9.642***	-5.903***
	(0.22)	(0.14)	(0.68)	(1.05)	(0.22)	(0.14)	(0.67)	(1.04)
Constant	23.943***	13.032***	9.855***	4.783***	23.946***	13.026***	9.521***	3.975*
	(0.21)	(0.35)	(1.09)	(1.63)	(0.23)	(0.39)	(1.14)	(1.76)
N	23,299	2,918	7,300	14,589	23,298	2,739	7,049	14,581
Adjusted R-squared	0.550	0.702	0.710	0.199				
Log-Lik					-65,639.46	-6,854.29	-23,406.76	-56,315.67
Endogeneity test, *P*					0.001	0.076	-0.066	0.193***
					(0.02)	(0.04)	(0.05)	(0.06)

Cluster-robust Std. Err., accounting for dealership, shown in parentheses

*** p<0.001, ** p<0.01, * p<0.05

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