HOW AGENCY AND STRUCTURE SHAPED VALUE STASIS
IN THE AUTOMOBILE ECOSYSTEM

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Abstract

We ask why value has not migrated in the automobile sector, despite expectations that it would follow the example of computers. We explain the factors underpinning stability in terms of value distribution in this ecosystem. Automobiles underwent vertical disintegration yet, unlike computers, the sector remained hierarchically controlled. Due to greater market scale and slower growth, plus persistence of integral product architecture, industry standards failed to emerge. Slow clockspeed, user requirement stability, and downstream access lock-in, as well as legal liability and certification, all acted as forces of stasis. We illustrate how these structural features interact with strategic agency of OEMs, intent on maintaining their central role as system integrators: retaining dominant influence over the locus of differentiability along the value chain and managing relative replaceability.

(125 words)
Over the last decade, applied strategy research has increasingly focused on co-dependent systems of complementors, through concepts such as “ecosystems” (Iansiti & Levien, 2004; Adner, 2012), “industry architectures” (Jacobides, Knudsen & Augier, 2006; Pisano & Teece, 2007), and “platforms” (Gawer & Cusumano, 2002; Cusumano, 2010). Interestingly, this has highlighted a shortcoming of our analytical arsenal. While we have had co-dependent sets of firms or segments that collaborate and compete, forming a “sector”, we have little empirical research into the distribution of value among these firms and segments. Collaborative Game Theory (Brandenburger & Stuart, 1996; MacDonald & Ryall, 2004) might provide a set of formal tools to discuss such issues, but no clear predictions, let alone empirical analysis. Other work, such as Porter’s (1980) “five forces” framework, focuses on comparative statics, as opposed to dynamics, and doesn’t focus on why some settings are less susceptible to change than anticipated. The industry-architecture view is more explicitly dynamic, but still does not predict when and how value migrates.

Yet the question is crucial – particularly when we look at the massive value migration that has taken place in sectors such as computers or mobile telecommunications. More interesting still, although such value migration is far from universal, it is often predicted. Such was the case in automobiles, with forecasts (especially during the 1990s) of value-chain reorganization and value migration from car manufacturers to mega-suppliers, emulating the similar sea change in computers. Such predictions came to naught, but with the rise of the Electric Vehicle Industry, similar speculation resurfaced (see Deloitte, 2010). Will the predictions come true this time? Probably not, but we lack adequate theory about value migration (or stasis), to explain why.

This lacuna inspired our paper. Under the rubric of studying value migration, we want to understand the conditions under which, despite expectations of change, value does not migrate. We offer an in-depth case study of the automotive industry as an example of a sector in which value has not migrated away from automakers (hereafter Original Equipment Manufacturers, or
OEMs) to other entities (e.g. suppliers), despite both efforts and expectations that this would happen. The latent comparison is with personal computers, which often serve as a canonical example of value migration. Our focus is on understanding the dynamics of the automobile sector: We want to understand what allowed forces of stasis to overcome forces for change.

The puzzle of value stasis in automobiles is real. Similar structural changes occurred in both autos and computers, fueling expectations of change including vertical disintegration (and hence an increase in vertical specialization), modularization initiatives, and technological turbulence. In both industries, suppliers tried to change the terms of engagement and capture value from OEMs by developing new capabilities. But while they succeeded in computers, they have achieved little in cars – right up to the present day. The question is why incumbent automotive OEMs were able to defend their territory more effectively. Our study explores the historical record, supplemented by recent interviews, to illustrate how strategic agency as well as structure allowed the OEMs to defend their dominant position in cars.

We expand theory on industry evolution (Nelson & Winter, 1982; Audretsch, 1995) by looking at how value shifts. We consider the evolution of the “architecture” of vertical arrangements: the “rules and roles” for the division of labor between different firms (Jacobides, Knudsen & Augier, 2006) as it relates to value migration. We look at how suppliers in the automobile sector tried to change the structure, using the computer sector as a reference point, and largely failed (even where OEMs initially supported them). This allows us to consider the combination of agency and structure that underpins stability in this sector. Our evolutionary account explains why in some sectors incumbents can help improve their plight by stacking industry forces (Porter, 1980) in their own favor, and being able to control their industry environment (Pfeffer & Salancik, 1978), resisting efforts for change. We show that agency isn’t enough, and identify the structural drivers of value stasis. We also show that industry participants vary in their understanding of the role that these structural features play, and that in this sector, several
OEMs adopted, for a time, strategically detrimental policies. Fortunately for them, these were not sufficient to unleash a value migration pattern similar to the one seen in computers.

Throughout, our inferences are based on the *causal logic* of value stasis that we uncover through our single-sector, multiple-segment design (see Mohr, 1982). On the basis of our findings, we put forth an inductive framework to explain value stasis, which we also apply to the computer sector and (in Appendix 3) to the emerging electric vehicle industry. In the discussion, we develop links to the literature, as well as implications for theory and practice.

**THEORETICAL BACKGROUND**

Understanding the foundations of profitability and value is at the core of strategy research. While the literature rarely considers either how value is distributed between segments, or how it migrates over time, it provides a framework on how to analyze it. Porter’s (1980) “five forces”, for instance, suggest that industry concentration upstream (supplier power) and downstream (buyer power) both affect the focal firm. So, for a hypothetical sector with two interrelated segments, upstream concentration reduces the profitability of the downstream segment (given supplier power); the upstream segment also has the advantage of its own market structure being oligopolistic. Likewise, the conditions of entry in different parts of a sector may predict who will capture value. This analysis, and Porter’s advice, focus on controlling the industry environment, erecting barriers to entry and improving relative concentration (as well as controlling distribution, etc). However, it doesn’t explain *under what*

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1 It must be noted, however, that Porter’s framework is based on an application of I/O ideas, rather than stylized facts. For example, Schmalensee’s (1989) landmark study finds empirical evidence that is hard to reconcile with the five forces. Subsequent research in economics has focused instead on the analysis of successive oligopolies (see Perry, 1989), and the narrower topic of double marginalization. On the modeling side of economics, Collaborative Game Theory (CGT) provides a formal framework to explain how value is created and then shared between a set of interdependent actors (Brandenburger & Stuart, 1996; MacDonald & Ryall, 2004). Yet this has not yet been linked explicitly to the empirical reality of value migration.
conditions firms are able to change the industry structure to their advantage, or at least defend their position from those who would create a favorable strategic landscape for themselves. Similarly, resource dependence theory (Pfeffer & Salancik, 1978) suggests that firms try to control their environment in order to reduce their dependencies, increasing their leeway of action and presumably their profitability. But it doesn’t offer much guidance on exactly how this happens – much less so in the context of interdependent sectors or ecosystems.

Empirical research has demonstrated the importance of value dynamics in ecosystems (Langlois & Robertson, 1995; or Bresnahan & Greenstein, 1999, for a narrative account of the computer industry). Recent strategy and technology research has argued that interdependence among firms in different parts of the value chain stabilizes over time, resulting in one or a few rival “platforms”: co-specialized “business ecosystems”, each with their own sponsors, orchestrators, and keystone members (Iansiti & Levien, 2004). This research stream has provided direct evidence of strong interdependencies between linked stages of the value-adding process (Adner, 2012). However, it offers no direct predictions on the dynamics of value migration; the focus has been at the level of a firm as opposed to a sector or entire ecosystem (Adner and Kapoor, 2010; Afuah, 2000; Kapoor, 2013).

A similar firm-level focus used to characterize research on Transaction Cost Economics (TCE), which considers how transactional arrangements come about (Williamson, 1985). With few exceptions (e.g. Langlois and Robertson, 1995), the focus was, until recently, on the way firms managed their scope and boundaries. Recently, though, research synthesizing TCE and evolutionary economics (see Jacobides & Winter, 2005, 2012) has focused on how entire

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2 This approach builds on Teece’s (1986) seminal analysis of how value capture relates to the transactional conditions in a sector. Teece and the research he inspired consider the determinants of returns from innovation, and focus on the fate of a particular firm.
sectors evolve.\(^3\) While this research hints at questions of value migration, and shows that firms do try to change their sector to benefit, it fails to offer any direct theory or evidence.

Drawing on sociology more than TCE, research on “Global Value Chains” (Gereffi & Korzeniewicz, 1994; Gereffi, Humphrey & Sturgeon, 2005; Sturgeon, Van Biesebroeck, & Gereffi, 2008) has looked at how different participants and types of firms come together to organize production, with particular attention to the conditions favoring the upgrading of supplier capabilities.\(^4\) Despite valuable insights on the relationship between OEMs and suppliers, this research doesn’t explicitly consider value migration.

Sector-wide value migration was more explicitly, if speculatively, considered by Jacobides et al’s (2006) analysis of “industry architectures”. Examining how “who does what” affects “who takes what” in a sector, they argued that firms try to shape their sector so they (and possibly their peers) can capture more value, and noted that the “rules and roles” that pertain to the division of labor affect the fortunes of both firms and segments.

Subsequent work elaborated on these processes. Pisano & Teece (2007) offered prescriptive advice for individual firms seeking to profit by changing their architecture. Drawing on qualitative evidence, Ferraro & Gurses (2009) showed how MCA, under Lew Wasserman, helped reshape the architecture of its sector, turning itself, and movie studios more broadly,

\(^3\) We should also note that studies in industry evolution have tended to overlook the question of vertical scope and how this evolves. Thus, classic analyses of technology or product life cycles (Abernathy & Utterback, 1978), stylized models of industry evolution and life cycle (Klepper, 1997), or industry demographics (Audretsch, 1995) do not consider changes in vertical scope, with very few exceptions – see Malerba et al, (1999).

\(^4\) Early studies focused on how some global value chains tend to be “buyer-driven” (Gereffi & Korzeniewicz, 1994), so buyers can extract advantage from the way they manage their suppliers – as echoed in contemporaneous research on Japanese supply systems, especially by Nishiguchi (1994). These were distinguished from “producer-driven” supply chains, where producers are able to maintain sufficient control and, presumably, margin. Later work considered the variety of supply-chain arrangements, identifying patterns of supply structure and firms’ commensurate ability to extract benefits (Sturgeon, 2002; Sturgeon et al, 2008).
into a “bottleneck” that could capture disproportionate value. Dedrick et al (2010) analyzed value distribution at the product level – iPods compared with notebook computers.

Our paper will complement existing research by exploring how, at the level of the industry ecosystem, agency and structure enabled value stasis in automobiles. Our investigation will focus on how and why incumbents are able to preserve the status quo, and why the expectation that autos would follow the computer sector (Baldwin & Clark, 1997, 2000; Fine, 1998; Fine and Whitney, 1996; Sturgeon, 2002; Bain, 1997; Just-Auto, 2001) was a misleading analogy.

**EVIDENCE AND INDUCTION: MULTI-METHOD DATA COLLECTION**

Our paper provides an inductive framework, based on archival and qualitative sources and informed by quantitative data and discussions. The empirical finding of cross-industry differences in value migration arose from analyses of COMPUSTAT data. The longitudinal analysis of expectations of dramatic restructuring and value migration in the auto industry, our primary focus, is based on multi-method evidence found in the historical record and collected in the field. The field work consisted primarily of on-site interviews at OEMs and suppliers during the exact period of the events that prompted those expectations, i.e. the late 1990s and early 2000s. Detailed examples from the field work and historical evidence are captured as vignettes in Appendix 2. Then, beginning in June 2012, to further develop and extend our analytic framework, we interviewed knowledgeable industry participants and analysts. These recent interviews were supplemental to our earlier qualitative and quantitative data collection and were not our primary data source; nonetheless, they added valuable nuance to our analysis.

We worked inductively from our observations to identify theoretical dimensions. We present the causal relations derived along with the evidence, so the reader can evaluate our inferences (Yin, 1994). But the core of the research is historical, as opposed to a qualitative snapshot that summarizes participants’ sense-making (see Walsh, 1967). We are interested in representing
both facts and the narratives through which they were presented over time, and use our involvement in studying the automobile sector (since 1984) as a source of historical evidence, triangulated with industry facts. Our “shadow comparison” with the computer sector was chosen on the basis of the auto sector’s own narrative about its anticipated trajectory. As explained in Vignette A, we draw on the computer analogy to illustrate the features of the auto sector more clearly and to consider its ongoing impact (i.e. as recently applied to the electric vehicle). The level of analysis is the entire industry/sector architecture or value chain.5

As our time period of 1979 to 2005 includes the early history of the personal computer industry, we provide some analogous examples from early automotive history (1912–37) to identify founding conditions, imprinting, and path dependencies. Our approach yields insights based on our inductive understanding of “process” as opposed to “variance”, following Mohr (1982), and is rooted in historical evidence (in the spirit of Skocpol, 1984).

The research reported here combines data from two earlier, independently conceived projects. In one project, the second author, with colleagues from the International Motor Vehicle Program (IMVP), examined whether the global automotive industry was undergoing a fundamental restructuring that would shift power from OEMs to suppliers, making explicit comparisons to the computer industry. Data were collected between 1998 to 2003 by a globally distributed team of researchers through qualitative interviews with executives, managers, and engineers at OEMs and suppliers in multiple countries. Original notes from this project capture perspectives of the time, and as such are not affected by ex post facto rationalization. Tables 1a and 1b summarize data sources from that project and the larger IMVP research program.

5 We use the term “value chain” to denote the vertical segments involved. In automobiles, our primary focus, this includes R&D, product development, and manufacturing, plus upstream supply chains and downstream channels of distribution. In computers, our secondary interest, it includes R&D, hardware and software design/development, and manufacturing, plus upstream supply chains and downstream channels of distribution.
The second pre-history project started in 2007 when the first and third authors analyzed COMPUSTAT data and identified the contrast in value migration patterns across the computer and automotive industries (described in Appendix 1). Subsequently, industry histories and qualitative evidence were reviewed to develop hypotheses about value migration.

*** Insert Tables 1a and 1b about here ***

For the current project, which started in 2011, we pooled our data and industry knowledge to begin inductive development of a framework on the underlying causes of value (non-) migration, which had been something of a surprise for automobile sector participants. We checked the emerging framework against the already-collected qualitative data plus the archival/historical sources.

In 2012 we also engaged in 20 interviews (each lasting from 45 to 120 minutes) with experienced industry practitioners and observers to supplement the combined data resources in hand. We started with open-ended questions about their observations and attributions vis-à-vis restructuring for the global auto industry, and then asked follow-up questions to understand their view of the underlying dynamics of value migration or non-migration. We closed by asking their views about the future of an auto industry dominated by electric vehicles – what did they expect the industry structure and competitive dynamics would be if that new technology became dominant? This helped reduce bias through the combination of retrospective analysis with prospective questions (Leonard-Barton, 1990; Huber and Power, 1985). In using interview data, triangulation from different sources and confirmability from diverse sources (Guba and Lincoln, 1982) was sought. Overall, we relied heavily on data and

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6 Our 20 interview subjects included two Federal Reserve Bank economists; two auto industry historians; one U.S. government auto industry analyst; one Canadian government auto industry analyst; three senior executives from OEMs; five senior executives from Tier 1 suppliers; one senior official from a supplier association; two auto industry consultants; and three financial/stock market analysts.
evidence from the historical record, which enabled us to identify a *complementary* set of causal factors (Kieser, 1994: 618). To preserve space, we provide more of the historical detail in the vignettes, using the quotes from interviews and sources in the main text – not because these were the principal pieces of evidence, but because they provide vivid illustrations.

Finally, to probe the explanatory capability of our framework, we apply the automotive industry-derived framework to explain value migration in the computer sector, both in 1978–2005 and in the current time period, when much has changed in the structure of that sector, particularly the role of Apple (see Vignette H). More important, we use our framework *prospectively* to consider our theoretically based predictions on the potential for value migration in the Electric Vehicle Industry, a hotly contested topic in the sector (Appendix 3).

**SETTING UP THE VALUE MIGRATION RESEARCH QUESTION**

*Value Migration, and Stasis, in Automobiles and Computers*

We first drew on some econometric evidence. By compiling COMPUSTAT sector-level data, ranging from 1978 to 2005 (see Appendix 1 for more details), we compared and contrasted changes in market capitalization for all vertical segments: for autos, OEMs and component manufacturers of various types, e.g., seats, brakes, air bags, audio equipment, etc.; and for computers, OEMs, software makers, microprocessor and semiconductor manufacturers, etc.

Figure 1 (upper panel) shows the market cap of OEMs in automobiles as a percentage of total market cap of the automobile sector between 1978 and 2005, juxtaposed with the same metric

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7 We leave the manifold problems of the definition of “profit” aside (see Lippman & Rumelt, 2003, for a discussion). Instead, we use an intuitive sense of profit and value based on market capitalization, which, for all its shortcomings, is a useful starting point. Market cap is the net present value of future profits (or cash flows), and corresponds to a sense of *value that is appropriated by the firms’ owners*, and as such is close to the normal sense of the word “profit” (see Jacobides, Winter & Kassberger, 2012 for a detailed explanation).
for the key auto suppliers. This sharply contrasts with the lower panel, which shows the evolution of market cap of computer OEMs compared with software publishers, microprocessor manufacturers and other suppliers, again as percentages of the sector’s total market cap. While significant value has shifted away from computer OEMs, auto OEMs as a group are still on top, despite substantial outsourcing and changing fortunes for individual OEMs, which the data (albeit not this particular graph) clearly indicate.

*** Insert Figure 1 about here ***

Expectations of (and Steps Towards) Change in Industry Structure

This stability is noteworthy given the strong expectations, during the late 1990s and early 2000s, of a new, vertically disaggregated architecture for the auto industry, organized around a more modular product architecture. Why were both external observers and industry participants convinced that value migration was not just imminent, but already under way?

Initial moves towards outsourcing were spurred on by external analysts, whose criticisms of financial performance encouraged OEMs to reduce their asset load (improving their potential ROA) by shedding activities that suppliers could perform more effectively, quickly, and cheaply. Smaller OEMs such as Chrysler and Fiat, facing constraints on their internal resources, were the first to outsource aggressively, starting in the mid-1990s. A wave of mergers and acquisitions among suppliers followed in anticipation of more widespread disaggregation, creating much larger firms known as “Tier 0.5” or “mega-suppliers”. The spinoff of the internal component divisions of GM and Ford into new mega-suppliers Delphi and Visteon in 1998 and 1999 respectively confirmed, for many, that the industry was moving towards a more horizontal structure. Modularity initiatives and technological ferment (e.g. hybrid drive trains; new safety features; “telematics”; electronic controls for most vehicle functions) reinforced these beliefs.
But the expected restructuring and value migration never came. As an economic historian told us, “The auto industry was ready to let production go at the end of the 1990s. Since then, they have pulled back from the brink. OEMs learned there was high risk of losing institutional knowledge that could lead to competitive problems.” By attending to the industry’s trajectory before, during, and after this period of raised (and, later, dashed) expectations, we are able to explain this turnabout and draw, inductively, generalizations for value migration and stasis. To this end, we now present our data.

**EXPLAINING THE DYNAMICS OF VALUE STASIS**

Our analysis starts with the discussion of agency – the intentional and conscious actions that OEM and supplier executives took in order to control their environment – before moving to the underlying structural features, and conclude by considering the role of heterogeneity, luck, path dependency, and feedback loops in shaping the outcome.

**Mechanisms of Strategic Control: Preventing Value Migration**

OEMs were able to keep their share of value, we argue here, because of the deliberate choices they made to maintain strategic control, in two ways: 1) retaining the locus of differentiability in their segment, and 2) minimizing their replaceability, or vulnerability to new entrants.

*Locus of differentiability.* Competition on differentiation depends on where differentiability takes place. Historically, OEMs in many industries have controlled differentiability through vertical integration, although new ways of maintaining this control have emerged as vertical disaggregation has become more common.

In computers, alliances of firms can differentiate through co-branding (e.g. Windows and Intel), or by promoting separate brands at the level of product components or services (e.g. the Android operating system; Samsung handset and Sprint LTE network). In the Wintel world,
consumers can differentiate by choosing from a set of configuration options that draws upon the availability of an array of interoperable components from different suppliers (although Apple offers very few such options). The mobile telephony market has shown how differentiability may shift from one part of the value chain to the next. Apple managed to become the key differentiator, changing the terms of engagement with mobile telephony providers (such as AT&T or T-Mobile) as consumers’ choice began to be primarily focused on the handset design (e.g. the iPhone) rather than the network provider. This intra-sectoral battle for the customer’s interest has characterized many recent strategies and value-capture struggles in this sector.

Automotive OEMs pursue distinctive “look and feel” at the level of nameplate (e.g. Mustang), brand (Ford), market (U.S.), and/or corporation (“world cars” such as the Ford Fiesta) as a crucial source of competitive appeal. Almost none of the supplier-provided components contained within a vehicle are known to customers; tires and car audio equipment are the primary exceptions. Even when a component is offered as a branded option (e.g. a JBL audio system), integration into vehicle design is emphasized, not “mix-and-match” opportunities. Suppliers have tried to brand their components, but such aspirations are typically rejected out of hand by OEMs. Autoliv, for instance, asked that its insignia be apparent in the seatbelts of a major OEM. The response was a resounding “no”, backed up by a clear threat to walk away from the contract. Probing further into the rationale, a first-tier supplier executive told us, “Only if the OEM isn’t so capable would it want to feature the supplier’s brand name. A firm like Geely [Chinese domestic OEM] that is starting to export to developed countries – they might want ‘Bosch Inside’.”

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8 Bose car audio systems, for example, are not offered in the aftermarket; the company’s website states that this is done “in order to ensure proper integration and appropriate in-cabin acoustic adaptation” for a specific vehicle.
Whereas at one time, OEMs were vertically integrated to keep the locus of differentiability within the firm, the process of vertical *disintegration* has now advanced to the point where many major components affecting “look and feel” are outsourced to global suppliers who serve multiple OEMs. Yet despite the potential cost advantages of sourcing a “best in class” component at industry-wide scale, OEMs consistently demand customized components that yield distinctive product characteristics. (For an example of how this pattern blocked one new business model for leasing batteries in the electric vehicle industry, see Vignette E.) Thus the locus of differentiation is quite separate from the issue of vertical integration.

Our interviews made it very clear that automotive OEMs see their role in determining differentiation as crucial. As one industry analyst noted:

> OEMs definitely believe that they need differentiability throughout the vehicle. I believe it too, but I think the OEMs overstate it. When Ford said to JCI [a large US supplier of interior systems], ‘design seats for us’, they were ready to rely on a supplier’s technical expertise rather than controlling everything themselves. But when they realized that all OEMs could end up having versions of the same seats, they reversed and demanded a customized design unique to Ford. The suppliers complain that OEMs have so much control and won’t let them inside the tent.

A financial analyst noted that a differentiation strategy creates a barrier to entry for suppliers who might be tempted to become OEMs or brand their components for consumers. “The automakers spend a huge amount to develop the product’s brand and to control access to the customer. It would not be easy for any supplier to build that up from nothing.” A U.S. government analyst noted that, “Auto OEMs make a strong linkage between controlling production and their desire to preserve brand strength on the consumer side – even though Apple shows that having a strong brand doesn’t mean you have to build the product.”

OEMs are changing their views on what is crucial for differentiation, but not their determination to control it. A supplier-association official explained that:

> OEMs will say they need to control the power train because it is like the car’s microprocessor (‘Intel Inside’) and they need to insure distinctive driveability and
brand integrity, as in BMW’s ‘ultimate driving machine’. But that is changing. Now OEMs can use the same hardware but each change the driving feel via software.

An industry analyst pointed out that “when [a GM senior executive] was recently asked, ‘How can you best differentiate?’ his answer wasn’t ‘drive train’ – instead he said ‘vehicle validation and integration is where we differentiate.’” Not only are suppliers not allowed to establish their own brand with consumers, but OEMs focus on retaining their role in customer choice.

**Irreplaceability of incumbents in the focal segment.** In contrast to the volatile supply base, there is little disruption in the OEM segment. The relative irreplaceability of actors in one part of the value chain, especially when combined with the replaceability of those in another, makes value stick – as Collaborative Game Theory would predict (Brandenburger & Stuart, 1996). The relative value of entrenched incumbents is high, while that of the more replaceable suppliers is comparatively lower, the more so with vertical disintegration and geographic dispersion. This begs the question: What makes OEM incumbency so stable?

Incumbents may be replaceable when a new firm, or group of firms, can provide products or services that satisfy exactly the same customer need, or can meet an emerging or latent need more quickly. Incumbents can make themselves irreplaceable if they have a mastery of underlying capabilities that competitors can’t match; performance that highlights weaknesses in latent competitor capabilities; or a lock on customers through proprietary distribution, service contracts, and extensive relationship-specific information. In the auto industry, OEMs have been able to make themselves irreplaceable in all of these ways. It is they, not their suppliers, who invest in branding and marketing capabilities to secure the customer relationship. While OEMs and suppliers overlap in their capabilities for production, and increasingly design, OEM capabilities have a much wider scope overall.

This remains true even after the sector’s recent vertical disintegration, which, in comparison with computers, brought less horizontal specialization and relatively little value migration from
OEMs to suppliers. OEM interdependencies with suppliers are still high, because the OEM is still ultimately responsible for product differentiation and certification, and vertical relationships have not been disrupted by changes in technology or customer demands. Their name notwithstanding, “mega-suppliers” are not powerful specialists who control designs and dictate terms to their customers, as in computers. Auto OEMs have remained squarely in control of design, pricing, system integration, and final assembly. To reinforce this point, see Vignette F, which relates how Toyota chose to re-integrate knowledge that had been readily accessible through their *keiretsu* supplier Denso, bucking the trend for disintegration.

OEMs invest heavily in R&D to develop proprietary IP.\(^9\) Despite relatively thin profit margins, the auto industry is among the most R&D-intensive, and those investments are disproportionately concentrated at OEMs. A long-time auto industry consultant noted:

> OEMs always pour massive amounts into R&D. Take airbags – why not tell an airbag supplier ‘build it and we will crash test it’? OEMs do tons of work on airbag design. Perhaps it is the regulatory and legal burden. OEMs have to do the R&D. Suppliers don’t necessarily want the responsibility. And OEMs don’t want to give suppliers any margin for innovation. Their view seems to be ‘I’m on the hook for the downside [of warranty costs and product liability]; why would I want to give you any upside?’

Most significantly, OEMs possess the system integration capabilities needed to design and build a vehicle that will appeal to customers (for more on what this requires, see Vignette G). In contrast, even where suppliers are skilled at integrating components and technologies for their own products, they rarely possess equivalent capabilities in the components and technologies with which their product will interact. When OEMs outsourced design and production (following the example of the computer industry), they often discovered that suppliers could not meet their requirements in terms of differentiation and certification, and

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\(^9\) Toyota, in 2011, was the firm with the highest level of R&D expenditure worldwide; General Motors (#9), Volkswagen (#11), and Honda (#14) were also in the top 20 (Economist.com, Oct. 30th, 2012). The auto industry is typically ranked third in overall R&D spending, after the computing/electronics and healthcare industries.
duly re-integrated those activities.\textsuperscript{10}

Finally, OEMs alone maintain the relationship with customers, particularly through the prevailing dealership business model, in which new and used vehicle sales, service, and aftermarket parts are provided primarily on an OEM-specific basis. Whether this can be called OEM “control” is debatable, since automotive dealerships are privately owned and legally protected (in the U.S. at least) from certain kinds of interference by OEMs, but there is certainly no distribution entity that threatens to replace the OEM’s role with customers.

Yet, digging a bit deeper, what enabled OEMs to \textit{win} these two strategic battles? We next turn to the structural features responsible for OEMs’ effective defense of value capture.

\textbf{The Structural Foundations of Value Stasis: Forces for Stability}

\textit{Vertical disintegration yet persistence of OEM-supplier closed hierarchical relations.} While vertical disintegration in the auto industry resembled the restructuring that caused value migration in computing, it did not have the same effect. Misinterpretation of this change is, we argue, the best example of how a computer industry analogy was misapplied to the auto industry, not only by outside observers but also by many sector participants.

Supplier-OEM relations were, for sure, different in the U.S. and in Japan. In the U.S., the pace of vertical disintegration increased dramatically during the 1990s, through both outsourcing and divestiture. By the mid-2000s, all three U.S. OEMs were at comparable levels of vertical

\textsuperscript{10} There are no examples of suppliers moving downstream to become vertically integrated automotive OEMs. According to one financial analyst, there is little incentive to do so. “Being an OEM is no fun – the competition is brutal, the margins are slim – no supplier wants to go after what they do – and no investor is eager to put money behind doing that.” Other analysts emphasize how much a supplier would have to learn. “Even the best, most capable suppliers, like Bosch and Denso, have never done stamping or designed full engines.” One supplier executive said “It costs $600–$800 million for an OEM to prove out a new platform, with all the testing and validation. We don’t have those skills and we don’t want them.” A Canadian government official addressed brand identity, saying: “It is very hard for a parts company to make a name for itself with consumers.”
integration, at around 30% of value.\textsuperscript{11} Beyond the spinoffs of Delphi and Visteon, new mega-suppliers were formed to combine capabilities and compete for larger subassemblies or “modules”, such as the Faurecia and Sommer Allibert merger in France and the Johnson Controls and Prince merger in the U.S. Yet while mega-suppliers sought to take over critical design and engineering tasks, handling more complex manufacturing and logistics tasks and overseeing the efforts of lower-tier suppliers, contracting in the sector remained hierarchical, with each OEM having a proprietary set of arrangements with each supplier, even when suppliers served multiple OEMs. And, despite the very different evolutionary path in Japan (see Vignette I), supply relationships in Japan were just as closed (if not more so), OEM-specific, and hierarchical, with no standard interface or generic market for components.\textsuperscript{12} Thus, both Japanese and U.S.-based supply arrangements are a far cry from the high separability of modules in the computer and electronics sectors through open industry standards.\textsuperscript{13} These vertical, hierarchical closed ties largely persisted despite massive vertical disintegration.

**Modularity initiatives yet persistence of integral product architecture.** Another structural feature that served to preserve the closed, hierarchical structure of supplier relations was the difficulty of modularizing the production chain. For a period beginning in the mid-1990s, 

\textsuperscript{11} Deverticalization has been going on in the U.S. auto industry since the near-100% level of vertical integration pursued by Henry Ford in the 1920s. Nonetheless, the level of vertical integration was still very high in the 1950s: estimates place GM at 75%, Ford at 66%, and Chrysler at 50% (Rubenstein, 2001).

\textsuperscript{12} Japanese automakers in the post-war period chose to procure parts externally, rather than through vertical integration, but not in spot markets or through short-term contracting (Nishiguchi, 1994; Dyer, 2000). Instead, these OEMs relied upon a small number of suppliers with whom they had long-term business relationships (often including an equity stake) – “relational” contracts governed by understandings about sharing both pain and gain, and large amounts of asset-specific knowledge on both sides. This approach allowed the close coordination of design and manufacturing tasks usually associated with vertical integration and hierarchical control, while maintaining the potential for price pressure and supplier competition associated with market transactions; it can be characterized as “quasi-vertical integration” (Takeishi, 2002; MacDuffie and Helper, 2007).

\textsuperscript{13} Luo, Baldwin, Whitney, & McGee (2012) provide direct evidence to this point, by developing network maps from Japanese sourcing data. They find that automotive OEMs tend to have relatively closed network ties, with tightly linked suppliers and hierarchical supplier relations, in contrast with the more open and vertically permeable network structures observed in electronics.
OEMs undertook significant efforts to realize computing-style modularity benefits. These included the shift of design to suppliers; lower coordination cost from predefinition of module boundaries and specifications; and faster innovation. These modularity initiatives, primarily in the U.S. and Europe, preceded deverticalization and provided the rationale for both spinoffs of parts subsidiaries and the creation of mega-suppliers.

Yet modularity of design proved difficult to achieve in the auto industry, despite both OEMs and suppliers seeking it (MacDuffie, 2013). The first automotive “modules” were subassemblies of physically proximate components that could be separated from the OEM’s final assembly line. These production-based module definitions complicated the subsequent pursuit of design modularity. One reason is that design characteristics such as NVH (“noise, vibration, and harshness”) matter greatly to consumers, yet are extremely difficult to guarantee in advance because they involve a vast number of different variables. Typically, a prototype must be built and fully tested to learn whether the design will meet all requirements, and the fine-tuning of design interactions among components requires extensive coordination throughout the design process.

Consider the instrument panel (or “cockpit”), one of the first automotive modules and still designed and produced as a distinct physical subassembly. Encapsulated within this one module are components tied to multiple functions: steering, gauges and controls, brake pedal, HVAC (heating, ventilation, air conditioning), air bag, audio system, navigation. None of these functions are contained completely within the module; each function can only be completed through interconnections across the module boundary, increasing design interdependence.

Therefore, the design of the instrument panel remains relatively integral, even though the panel is relatively modular in production (i.e. installed as a single piece, in a single step). (See Vignette B for more on this and other examples.) This difficulty in achieving the vision of a modular car was soon transformed into a strategic gain for the OEMs. Rather than bolstering
powerful suppliers and enabling them to innovate autonomously, modularity initiatives increased the prevalence of quasi-vertically-integrated and hierarchical relationships across organizational boundaries (Takeishi and Fujimoto, 2001; Takeishi, 2002; Fourcade and Midler, 2004; Fujimoto, 2007; Zirpoli and Becker, 2011; MacDuffie, 2013).

**Increased outsourcing yet no move to industry standards for components.** The constraints posed by integral product architecture also impeded the move towards more industry-level standards for components. OEMs realized, to varying degrees, that standards would ultimately challenge their dominance. Even when suppliers are able to use the same fundamental design for two customers, the interfaces often differ. They may not be substantial in terms of functionality, but these differences affect a vehicle’s distinct “look and feel” – and OEMs, mindful of the need to control differentiability, insist upon them.

While the computer industry has many standards that are “open but owned” (Borrus & Zysman, 1997), due to pressure from corporate customers for interoperability across purchases from different vendors, auto OEMs offer individual vehicle buyers an integrated proprietary package of features, with the implicit guarantee that they will work together smoothly. As an economic historian who has studied the auto industry extensively told us:

> The auto industry isn’t oriented towards standardization. OEMs won’t do it even when it is technically possible. Suppliers should be the driving force for standards because they deal with multiple OEMs. But OEMs insist on working with suppliers in ways that work against standardization; look how each OEM makes its suppliers use different CAD [Computer-Aided Design] software. 14

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14 This point was made repeatedly in our interviews. As one financial analyst put it, “While there are many components for which suppliers have specialized expertise and can offer advantages to OEMs who outsource, most OEMs enjoy sufficient internal scale economies to achieve low unit costs from making core components, such as engines and transmissions, themselves.” A long-time consultant to the industry said, “Even when OEMs outsource, they like to grant contracts for high volume per part; they say ‘economies of scale’ but this is their code for high purchasing leverage on their customized designs, allowing them to get low unit costs.” Thus custom-to-OEM components and parts, whether produced internally or outsourced, provide OEMs with a potent combination of low unit costs via scale economies plus control over design and bargaining leverage over suppliers.
This OEM stubbornness about maintaining proprietary standards can be better understood by a more granular look at efforts to change the architecture. Virtually from the start, suppliers to the nascent sector understood that industry-level standardization would help them. Starting in 1910, the Society of Automotive Engineers (SAE) sponsored an initiative to establish industry standards for numerous components. Over the next decade, SAE’s initiative made considerable progress. But while small OEMs embraced this initiative, Ford, GM, and Dodge deliberately ignored it (Langlois and Robertson, 1995). Leaders of these large OEMs were clear about the strategic benefits of their decision. While they might have been able to obtain even lower component prices for industry-standard designs, architectural change would raise various risks. First, they feared that product differentiation, and overall quality, would be eroded. Second, suppliers would gain tremendous volume by aggregating orders, which would increase their bargaining leverage. Third, smaller OEMs could stay competitive by free-riding on access to industry-standard parts from high-volume suppliers, but would struggle if each had to design its own customized components.

By avoiding industry-standardized parts, the dominant OEMs forced suppliers to organize parts and processes to conform to customer-unique specifications, crippling smaller competitors, all while enjoying ample economies of scale for their own internal product line. Largely in place by the mid-1930s, this feature has remained essentially unchanged. Automotive OEMs typically have their own specialized designs, even for apparently commodity parts such as screws. By developing proprietary component designs and having them built by different suppliers, while retaining the consummative task of final assembly (plus quality and safety certification, as discussed elsewhere), the OEMs established and progressively reinforced their central role as system integrators. This can be seen through the detailed example we provide in Vignette B, which considers why standards did not emerge for seats.
In sum, the attributes that describe the “industry architecture” – the nature and structure of the relations within the sector, and the nature of the (non-standard) links between them – favored the OEMs and created the foundations for value stasis. Yet, to dig yet deeper down to the roots of structural causes, what allowed them to do so?

_Huge scale yet slow growth, allowing low industry-level standardization._ The huge scale of the automobile sector is a force for stasis, but in our framework, the reasons lie beyond those that traditional I/O analysis would identify (e.g., Stigler, 1951). As noted above, OEMs’ production volume was typically well above the minimum efficient scale for various components, so they could maintain proprietary designs while still obtaining high manufacturing efficiency. In fact, volumes per product line within an OEM were often high enough to offer scale economies, allowing multiple component designs to be used within a single OEM. For example, in the post-war period, the two highest-volume transmissions installed in U.S. automobiles were produced at two different General Motors product divisions; GM did not converge to a single standardized design until the 1960s. When each OEM could have multiple suppliers for individual product lines (or even individual models), there was no need to pool demand and create a unified market around industry standards.\(^{15}\)

If scale economies in production don’t provide the impetus for industry-level standardization, rapid growth in market demand can certainly do so. With explosive growth, collaborative standard-setting by competing firms offers the prospect of growing the “pie” so quickly that each firm’s share could be increasingly large, enough to offset the potential downsides of

\(^{15}\) Note that our focus is _industry_ scale, as opposed to that of individual firms. At the firm level, there are surely barriers to entry from the high capital thresholds for designing and manufacturing automobiles, and these may well impede suppliers as well as other prospective new entrants from becoming OEMs. (Nevertheless, new OEMs do continue to appear in developing countries, most recently China and India.) Still, in automobile OEMs, as well as suppliers, firm scale does not seem to be directly correlated with profitability, or to be reliably associated with productivity. Firms of vastly different scale also co-exist in the sector, and high scale is often more an outcome rather than an antecedent of sales success. It is sector-level scale that shapes how vertical relations can work.
commoditization. This is exactly what happened in computing once demand shifted from large corporations to individual users at work and at home, facilitated by modularity in product architecture. Competitors embraced industry standard-setting for key components and software, with each firm aiming to influence those standards in a direction favorable to its capabilities and market position.

The automotive industry has certainly had periods of rapid growth, most notably in the U.S. soon after Henry Ford invented the mass production system that made the Model T affordable to mass-market consumers. At that time, Ford chose to pursue firm-specific economies of scale while maintaining proprietary designs and custom components, rather than agreeing to industry standards (as some suppliers requested). By and large, dominant automotive OEMs have made the same decision ever since.

Arguably, the pace of growth in automotive sales is always relatively slow, even in high-growth markets, in comparison with the growth curves seen for computers and other recent high-technology products. A vehicle is an expensive durable good – typically, the second most expensive purchase made by individual consumers after a home. Households may own multiple vehicles, but on a slow replacement cycle, often resorting to the used-car market because of the high cost of new products. When faced with a “pie” that is not expanding all that rapidly, automotive firms may be keener on preserving their strategic position than in driving change through a shift to industry standards. Furthermore, their investors may agree; the lack of equity capital to support those who challenge the status quo can help solidify value distribution. (In Appendix 3, we discuss how scale and standardization dynamics may play out for Electric Vehicles.)

*Technological turbulence, yet persistently slow clockspeed.* From the 1980s on, the auto industry offered plenty of evidence for observers expecting disruptive technological change.
The catalytic converter reduced atmospheric emissions; electronic fuel injection boosted fuel efficiency; air bags, antilock brakes, and electronic stability control offered improved safety; and alternatives to the internal combustion engine emerged, including the hybrid electric-gasoline drive train, pure electric vehicles, and clean diesel. Furthermore, the prevalence of electronic controls and the increase in “telematics” (navigation and other information services) brought a convergence with the dominant technologies of the computer and consumer electronics industries, requiring new capabilities and raising hopes for change.

However, while suppliers were certainly involved in developing these new technologies, the “rules and roles” were again dominated by OEMs. First, OEMs continued their historical pattern of massive investments in R&D, even when outsourcing design tasks; this was justified as necessary both to evaluate supplier design proposals and to integrate different technologies in the overall vehicle architecture. Second, OEM purchasing practices typically demanded that a supplier with a new and advanced design provide specifications to be circulated to competitors to allow OEMs to establish multiple sources for a given component. Third, suppliers were also expected to win contracts with low piece prices, and OEMs typically would not reimburse for R&D investments beyond what they paid in the piece price, making it difficult for suppliers to recoup their own R&D investments. Thus, all the new technological developments were eventually controlled by OEMs, who solidified their hold on the sector.

The clockspeed, or pace of technological development, is slow in the auto industry for technological and organizational, as well as strategic, reasons. With a stable dominant design at the level of the overall product – i.e. minimal architectural innovation – yet ample component innovation involving multiple technologies, integration challenges are significant; designing a vehicle is akin to solving tens of thousands of simultaneous equations. Outsourcing the design of components is also a slow process, given the purchasing practices and minimal investment in supplier R&D described above plus OEM responsibility for certification; these slow the pace
of innovation at suppliers while allowing OEMs to maintain control. OEMs are certainly interested in shortening the product life cycle, yet the penalty of overlooking these complexity challenges can be severe; witness the recent quality problems and product recalls at Toyota, attributed in part to too-short product development timelines.

When fast-clockspeed technologies intersect with automotive design, the dilemma of obsolescence prompts a cautious response from OEMs, often to the frustration of suppliers. New electronics technologies, particularly those involving new formats or interfaces, are introduced relatively slowly. As one OEM executive explained:

*We can be hurt by introducing new technologies that don’t work exactly as the consumer expects. It is not a neutral experience; the consumer is often less happy with us than if we never offered the new technology.*

The negative impact on consumer quality survey scores of introducing advanced IT features into the control panels of Mercedes-Benz and Ford vehicles is a recent case in point. The high cost of developing new features and the difficulty of integrating a new technology into a product concept and brand identity pose additional constraints upon the speed and extent of technological advance in automobiles (Midler et al, 2012), suggesting that technological development is endogenous to customer preference and industry dynamics, not vice-versa.

**Expansion to new markets yet stability in user identity and requirements.** Unlike computers, where user needs have evolved tremendously, the central purpose of an automobile has stayed the same. Take the U.S. as an example. Once the auto industry had persuaded most households to own a vehicle, subsequent sales increases have come from selling multiple vehicles to the same households (Rubenstein, 2001). This pattern has been repeated in country after country, with “motorization” occurring at a relatively predictable level of GDP, diffusing throughout a population, and then moving towards multiple-vehicle households.
The long product cycle and relatively slow technological clockspeed of automobiles is also related to the relative stability of users. Automotive product cycles were once as long as 8–12 years, and even though they are now routinely three to four years for most mass-market products, major redesigns are less frequent. Once purchased, vehicles stay in use for a long time, even if having multiple owners; the average age of U.S. vehicles still in use has risen in recent years to more than 10 years. While there is a great deal of technological change in many vehicle subsystems over time, the amount of new technology in any given model is likely to be only incrementally greater than previous models. The accelerated product cycle of many computer-based products, with its risk of rapid (perhaps perceived) obsolescence by a consumer wanting the latest features, has no comparable analogue in automobiles.

**Availability of disintermediating technologies yet stable channels of distribution.** Despite the arrival of disintermediating technologies such as the Internet, which caused many to predict the demise of the much-disliked auto dealership, the ways in which cars are bought have not changed in generations. Purchase still happens through dealerships that are dependent upon automobile manufacturers, yet not owned by them (see Vignette C). This arrangement, enshrined in laws protecting dealers from OEM interference, has, perhaps inadvertently, stabilized the industry by fixing the model for downstream access. Combined with stability in user needs, this phenomenon inhibits any challenge to existing industry arrangements, since new supply chains or distribution channels cannot easily take hold.  

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16 Contrast this with computers, where both distribution models (shifting from direct sales forces to new intermediaries, whether firms like EDS on the corporate side or wholesalers like PC World on the retail side) and final customers changed. The change in the final customers, which initially were units of large organizations, and later were individuals or purchasing managers throughout a corporate hierarchy, also came with a new set of needs. And the new set of needs led to the emergence of new value propositions and business arrangements, and with them new ways to structure the industry architecture. In computers, innovations in distribution have greatly accelerated access to new functionality, much unlike cars, which were shielded from change due to customer continuity and distribution lock-in. Of course, in autos, forces to push for change exist. In January 2013,
**Regulatory accountability, quality certification, and legal liability as a source of value.**

Automobiles are owned and controlled by individuals, yet function in the public space, where their size, weight, and operation at high speed make them dangerous (MacDuffie & Fujimoto, 2010). They generate harmful emissions and have major consequences for city and rural planning and public transport. For these reasons, they have been progressively more heavily regulated in every developed economy; this pattern repeats in each developing country as the level of “motorization” increases (driven by per-capita GDP). Besides prescription medicines, automobiles are probably the most regulated of consumer products.  

OEMs are the focus of this regulatory attention, for several reasons. As integrators, only they have full knowledge of how components interact. Particularly after an accident, it can be very difficult to attribute failure to a particular component, and hence supplier. Thus the common regulatory response is to hold OEMs responsible for vehicle performance (through pre-sale testing of designs), problems (through recalls), and legal liability (through lawsuits on behalf of individual complainants). Because the consequences of failures and accidents are so serious, regulatory oversight is extensive and often strongly enforced; users must have insurance, and vehicles must pass regular inspections.

The importance of certification makes it a logical responsibility for OEMs, obliging them to develop the technical and administrative capabilities for this task. The complexity of regulatory requirements is such that incumbent OEMs are in the best position to carry out system

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17 Contrast with computers (or consumer electronics): Whereas their products need to be safe for individual consumers, their fitness for purpose is covered by product guarantees and warranty protections. System malfunction rarely causes injury, and users can restore operation themselves in many cases. Computers and consumer electronics are mainly used in private spaces, so the consequences of malfunction are limited to the product’s owner and do not physically harm others.
integration, testing and qualification. As a Canadian government official told us, “the motor vehicle comes with a regulatory and warranty burden that no computer must bear; these obligations hinder major transformations within the industry.”

What’s more, even though as much as 75% of value added in an automobile comes from purchased parts, OEMs typically bear the liability when consumers bring legal claims for a vehicle’s malfunction. OEM contracts then specify how they can recoup warranty costs from suppliers where quality problems are attributable to their components. OEMs are typically held responsible by governments for announcing recalls and providing repair procedures for consumers, even if a supplier’s component is the cause. Furthermore, consumers associate product quality with the OEM; external quality surveys (e.g. J.D. Power; Consumer Reports) report results by OEM, brand, and model, and almost never identify suppliers.

In an interview with a senior executive of a tier-one supplier, we discussed whether the supplier of a crucial module could gain visibility and the ability to command higher margin. He argued that suppliers might not want that visibility for reasons of regulation and liability:

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18 Regulatory requirements can be a conservative force for product architecture by imposing design constraints and encouraging lock-in of certain design features through scale economies and development efficiencies, but they can also drive technological (if not architectural) change. Some recent examples of regulation-driven innovation took place at the component level: The Clean Air Act of 1973 encouraged the development of the catalytic converter and the shift from carburetors to electronic fuel injection (Lee & Veloso, 2008).

19 The auto industry in its earliest years was the setting for a definitive U.S. legal ruling on this issue. MacPherson v. Buick Motor Co., 217 N.Y. 382, 111 N.E. 1050 (1916) is a famous New York Court of Appeals opinion by Judge Benjamin N. Cardozo that removed the requirement of “privity of contract” in negligence suits. “Privity”, from common law, established that only the parties to a contract could be held accountable for negligence in its fulfillment; thus the maker of a product (component) would be liable to the end user (individual), not the intermediate manufacturer who assembled the components. Cardozo, ruling that Buick was liable for the failure of a (wooden) wheel that caused an injury, characterized the automobile as a “thing of danger”, concluding that: “If the nature of a thing is such that it is reasonably certain to place life and limb in peril when negligently made, it is then a thing of danger. Its nature gives warning of the consequence to be expected. If to the element of danger there is added knowledge that the thing will be used by persons other than the purchaser, and used without new tests, then, irrespective of contract, the manufacturer of this thing of danger is under a duty to make it carefully… If he is negligent, where danger is to be foreseen, a liability will follow.”
When Intel began to advertise ‘Intel Inside’, that boosted Intel’s profits. Would ‘Bosch Inside’ or ‘Delphi Inside’ help bring in more profit? Would consumers really notice? More likely we would look like an upstart – getting more attention from the media – more lawsuits. Right now, the OEM has to deal with product liability lawsuits. We would prefer to avoid that. If you open the door to being a rival with the OEM, you are opening the door to being asking to take full legal responsibility for product failures.

Indeed, having the responsibility for quality certification allows OEMs to fend off pressure from the component manufacturers to brand their products.20

The externalities of car safety may also limit innovative business models for vehicle sharing. A case in point is RelayRides, a new downstream service that appears at risk because of the liabilities raised by cars (New York Times, April 14, 2012; see Vignette D.)

**Articulating the framework.** Considering these forces for stasis in their entirety, we see that vertical disintegration (and hence an increase in vertical specialization) did not rock the architecture of the automotive sector, despite some experimentation with the concept of modularity. Thus the rise of “mega-suppliers” increased the prevalence of quasi-vertically integrated organizational arrangements rather than leading to powerful and autonomous supplier specialists that control designs and dictate terms to their customers, as in computers. This meant that vertical specialization happened without the loss of OEM control.

Interestingly, the fact that the architecture did not change was not the result of technological determinism. In the early history of the industry, OEMs chose differentiation and control of proprietary parts over the lower component costs and faster innovation that might have resulted

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20 Historically, automotive components have not been branded for consumers, as noted above. In the late 1970s, a Canadian government study exploring market expansion possibilities for auto suppliers found only one branded component on a typical passenger car: tires. An author of that study observed, “The supplier role has certainly changed over the past 35 years but OEMs still retain control over total vehicle cost and thus what they are willing to pay for each component. Suppliers are dependent on OEMs and can’t challenge them on branding.” A few exceptions do exist with advanced component technologies, e.g. at Brambo, which produces the trademark red-coloured brake disk for high-end sport-cars. Here, as with mass market components, the supplier designs to an OEM-proprietary specification, preventing supplier control of a branded industry standard.
from industry standards. Later, even when embarking on massive vertical disintegration and trying to move towards computer-like modularity, the structural characteristics of the OEMs’ central role as systems integrator persisted, along with hierarchically organized, quasi-vertically integrated relationships.

Furthermore, relatively slow technological clockspeed and relatively slow growth (plus strong economics of scale at the firm level) reduce the incentives for OEMs to agree to industry standards. Stability in user identity and requirements, and in distribution channels, limits the opportunities for new entrants to find a niche in which value can be appropriated from incumbents. Finally, accountability for regulation and legal liability, coupled with the importance of the quality certification role for differentiability, keeps OEMs in the system integrator role, even though they may often perceive this as a disadvantage in terms of administrative cost and complexity rather than an advantage vis-à-vis value stasis.

**Structure, Luck, and Intentionality**

Our reading of industry history, together with our discussions with industry participants, suggests that “stickiness” in product architecture is a blessing in disguise for automotive OEMs, forestalling the drastic changes seen in computers. This raises important questions. Was value stasis due to structural features of the industry? Was it the result of strategic agency? Or was it down to pure luck? Agency to control the sector did exist, as we saw. Yet the efforts to shape the sector were not equally distributed, and sometimes OEMs engaged in initiatives that, had they been successful, would have been detrimental to them (as it appeared).

While we cannot know what drove the specific efforts of OEMs (or suppliers), the historical data reveal interesting patterns. Chrysler and Fiat, the two most aggressive outsourcers and modularizers, realized the risks of excessive outsourcing and of losing strategic control when they were close to the brink, only to reverse course and partly re-integrate. GM and Ford’s
modularity initiatives after spinning off their captive parts divisions, far from fueling their recovery, were part and parcel of their further slide into financial crisis. In contrast, Toyota – the top-performing OEM over the period of our data – made few changes in its relational, quasi-vertically integrated interactions with suppliers and undertook no modularity initiatives. So while some firms were tempted to forego their strategic control (especially during the late 1990s), they had the luxury of reversing course, and, crucially, forestalling a sector-wide change.\textsuperscript{21} The lack of transformation was aided by structural features that made automotive’s environment more benign and tolerant of mistakes. And our view, informed by the historical record and our interviews, is that the stability in industry architecture, the closed hierarchical system of contracting, and the lower turbulence that kept new initiatives at bay, helped OEMs be “lucky” in being able to correct their past mistakes.

In summary, OEMs have held a central system integrator role from the early days of the auto industry to the present. Its significance has been obscured by vertical disintegration in the sector, which many have (wrongly) interpreted as increasing supplier power. Yet OEMs have made certain, through strategic choice that capitalized on technology, that they can keep themselves irreplaceable by preserving their unique capabilities and customer relationships. They maintained closed supplier networks where they retained most of the value.

Our reading of the industry evidence suggests that both structure and agency were in play.\textsuperscript{22} While our method does not allow us to see which mechanism was more important than any

\textsuperscript{21} It is interesting to speculate how the history of the computer sector would have been different, if Paul Rizzo of IBM (then SVP and responsible for outsourcing the OS and CPU to Microsoft and Intel) had kept the PC architecture closed in 1978. Arguably, IBM did recognize that it had made a strategic mistake; but, unlike cars, that sector was growing too fast and had a fiendishly quick clockspeed, no tied distribution, and faced network externalities in use, so that the computer OEMs could not recover (as the car OEMs could) from a mistake.

\textsuperscript{22} Technology, for instance, affects the role of the OEM as a guarantor; and this role eventually allows OEMs to control the technology’s subsequent evolution. Some of the factors we identify (e.g., large size of the market
other, it does uncover the pathway through which each of them shapes the final outcome. Our data suggest that the forces we identify create a dynamic feedback loop, where agency combines with structure to shape value distribution dynamics.

**DISCUSSION AND CONCLUSIONS**

Our automotive industry case study provides us with a nuanced view of industry evolution, focusing on the struggle between the forces of change and the forces of stability. Our method identifies a complementary set of causes, without being able to ascribe their relative role (Kieser, 1994: 618). We find that while there is evident agency by industry participants, industry structure appears to be sustaining the role of OEMs in the automotive sector, unlike computers. In terms of strategic struggle, we observed the fight in this sector to be over the differentiability of the final product and managing replaceability within the ecosystem. Incumbents and challengers alike aspire to keep differentiability and make their complementors more replaceable, although the extent of strategic foresight vis-à-vis these goals seems to be unevenly spread in our setting.

More important, our investigation of the frustrated efforts to change the sector showed that some structural factors impeded value migration. The misplaced analogies with the computer sector and the unrealized expectations of change may be partially explained by these harbingers of stasis not being readily observed by all industry participants. Yet such features emerge from our closer look at the structure of production and consumption, and our deeper

allowing OEMs to buy custom inputs at efficient scale, systemic interdependencies and complexity of the integration task, or lack of change of customer identity and needs) might be more exogenous than others (e.g. product differentiation strategies). Yet exogenous forces create a dynamic web with endogenous, strategic choices that firms make, shaping the sector’s evolutionary trajectory and driving value migration or stasis.
inquiry into rules and relationships in the sector. Our analysis of the interplay between strategic agency and the structural drivers of value stasis is at the core of this paper’s contribution.

Some findings are consistent with previous work. For instance, we show that standardization had been sought after by suppliers, yet rebuffed by OEMs. The insight comes not from this observation, but by probing why they were able to rebuff these efforts. We identify the relatively slower speed of technology evolution and the concomitant slow pace of growth and highlight the role of the stability in user requirements and identity, an under-appreciated factor.

Probing more deeply in the structural issues brings up questions of architecture, where our comparative design allows our automobile findings and the contributions to the literature to come in sharper focus. Consider, for instance, how computers deverticalized through the emergence of clearly defined modules, whose industry-standard designs were transacted in “textbook markets”, whereas in cars modularization efforts were OEM-specific, attainable in production, but difficult to attain in design (MacDuffie, 2013). The architecture of transactional networks (Luo et al, 2012) in autos was much more closed, and, fundamentally, it consisted of captive sets of relationships, dictated by the OEM. This suggests that the differences in “architecture” in sectors that might appear to be equally vertically disintegrated (e.g. as measured by percentage of assets produced by vertical specialists) can have a major impact on value distribution dynamics.

Our findings suggests that the large scale of the market allowed automobile OEMs to afford the luxury of captive suppliers, whereas the initially smaller scale of the market, rapid growth, and bigger economies of scale in computers led to the emergence of truly independent vertical segments. This suggests that while “the degree of specialization is limited by the scale of the market” (Smith, 1776; Stigler, 1951), a particularly large market favours captive buyer-specific ecosystems, as opposed to “textbook” standardized intermediate markets.
Another novel item we uncover is the role of legal liability and the responsibility for certification. This is often seen as a cost for the OEMs, but it is used strategically to keep potential challengers at bay by disciplining the ecosystem and forestalling structural changes. The role of liability and its connection to certification is another area where future research can expand our findings.

Finally, our paper demonstrates the way in which agency and structure, luck and foresight, interact to shape both the architecture of the sector and the value migration dynamics that emerge. While we cannot offer an opinion about the intentionality of those responsible for the strategic decisions shaping the sector, we do show that some OEMs (especially Fiat and Chrysler), wooed by the computer analogy (and cheered on by analysts) did start losing their strategic grip on their suppliers – only to reverse course soon afterwards.

Our analysis of structural features provides a dynamic extension of Porter’s (1980) thesis. We agree, at a broad level, that the threat of entry and the intensity of competition along different parts of the value chain matters, and we agree with the admonition that firms may want to manage these to their advantage (Pfeffer & Salancik, 1978). Our contribution rests on identifying the specific structural features that allow either the incumbents to defend, or the entrants to change the balance of these forces; put differently, in our explicit shift from the comparative statics to the identification of the structure that underpins the dynamics.

Our paper yields a tentative framework, issued by a combination of historical analysis and qualitative investigation, which is operational enough to be refuted or confirmed – and specific enough to yield predictions. Appendix 3 looks at the emerging Electric Vehicle Industry, to consider how our inductive framework can be used prospectively, ex ante. While we fully acknowledge the inferential limitations of our study, they are inherent to the desire to provide a broad study of the drivers of value migration. And we believe that this is an important topic
that has captured the imagination of the popular business press for a while (Gadiesh & Gilbert, 1998; Slywotzky & Morrison, 1997) yet has eluded more systematic analysis in the literature. Phenomenologically, our paper also helps move beyond the assertion of Borrus & Zysman (1997) (among others) that we are moving into a phase characterized by the universal “Wintelization” of competition, and the use of the computer setting as the template for value evolution. Epistemologically, we focus on the factors that could explain the patterns of value migration or stasis, hopefully opening up an area of research that will need to span several sectors, countries, and time periods.

In terms of theoretical contribution, we complement existing work on industry evolution of co-dependent systems of vertical segments (see Langlois & Robertson, 1995; Jacobides & Winter, 2005; 2012), by focusing on how value shifts over time; work on systemic firm interdependence (e.g. Adner & Kapoor, 2010, Adner, 2012) by looking at the perspective of the segment as opposed to the firm; and work on industry evolution and technology studies by documenting the evolution of value-capture dynamics, which have not received direct scrutiny.

Our findings also suggest that dominant design (Abernathy & Utterback, 1978) and technological trajectories more broadly (Dosi, 1982) may be endogenous to a sector’s strategic struggles: It was the OEMs’ strategic concern for dominating their sector that guided the template of technology evolution. At the same time, technological constraints provide the contours for strategic struggles. Our findings also contextualize research in the Global Value Chain tradition (Gereffi & Korzeniewicz, 1994; Gereffi, Humphrey, & Sturgeon, 2005) by explaining what drives OEM dominance, and also pointing out the role of legal accountability, proprietary and closed standards, organizational architecture, and how industry scale and clockspeed affect the power distribution.
Our analysis takes the study of emerging “submarkets” (Klepper & Thompson, 2006; Klepper & Malerba, 2010) in a new direction. Rather than only looking at industry demographics, we consider how the creation of new submarkets facilitates change in industry architecture, and possibly also in value capture. The pattern in computers, where new functionality and areas of application drive the emergence of new and overlapping submarkets (e.g. PDAs, smartphones, tablets) stands in sharp contrast with the auto industry’s pattern of adding first-time customers in countries where per capita income passes the threshold of motorization, while persuading existing customers to purchase multiple products. There is growth in both industries, but growth fuelled by new submarkets creates much more turbulence.

Our analysis also shows that there is substantial heterogeneity in terms of how different players act to keep control of their sector (or, unwittingly, to lose it). At times, automobile executives’ enthusiasm for modularity, and their desire to be seen as proactive, may have weakened OEMs’ position. We show that, once power dynamics within a sector become more evident to the industry participants, the outcome of the intra-sectoral struggle depends on some structural features. Factors such as legal liability, whose importance we stress, may be seen as a short-term impediments and inconvenient frictions, yet end up becoming useful strategic weapons.

The role of these structural features, which are not always understood *ex ante* by industry executives, may also account for the misplaced belief in the direction or magnitude of change. In this regard, managers and particularly consultants apply analogical reasoning from sectors where change has happened (such as computers). This may be because they have an interest in arguing for change, or because they semi-consciously select those analogical models that fit the conclusions they wish to reach (see Neustadt & May, 1986). Our paper shows how agency and expectations of change interact with less malleable structures to shape the outcome.
Our research design, which focuses on the in-depth, process-based understanding of the evolution of one sector (Mohr, 1982), has clear limitations: It cannot test, but can propose theory. It does so not because it claims the setting studied is more representative than others; but rather, because it helps articulate theoretically interesting phenomena or causal links (Firestone, 1993). Our historical method can articulate a complementary set of causes, not distinguish between their relative roles (Kieser, 1994). Yet there is a long and distinguished history of process-based studies, such as the Tennessee Valley Authority classic by Selznick (1949), used as the basis of theory development. In this spirit, we hope that our study will help advance future research. In a world where value migration and changes in industry architectures and ecosystems are ever more relevant, deepening our understanding of these dynamics seems long overdue.
REFERENCES


http://www.economist.com/blogs/graphicdetail/2012/10/focus-7 [14 August 2013].


TABLE 1:
DATA SOURCES FROM INTERNATIONAL MOTOR VEHICLE PROGRAM (IMVP) RESEARCH

Table 1a: Firms Involved in IMVP’s Modularity and Outsourcing Research Project, 1998-2003
(partial, alphabetical order):

**OEMs**
- BMW AG
- Chrysler Corporation
- Daimler-Benz AG
- Ford Motor Company
- General Motors
- Fiat Group Automobiles
- Honda Motor Company
- Hyundai Motor Corporation
- Kia Motors
- Mazda Motor Corporation
- Nissan Motor Corporation
- Renault Group
- Toyota Motor Company
- Volkswagen Group
- Volvo Car Company

**Suppliers**
- Borg-Warner Inc.
- Calsonic Kansei
- Delphi
- Denso
- Federal-Mogul
- Johnson Controls Inc.
- Lear
- Sumitomo Denko
- TRW
- Toyota Gosei
- Visteon

Table 1b: Phases of IMVP Research
- Understanding Lean Production (1985-90)
- The Diffusion and Evolution of Lean (1992-97)
- Understanding Persistent Integrality (2004-2007)
- Industry Crisis and Recovery (2008-2011)
- Vehicle and Mobility Innovations (2012- )
FIGURE 1: VALUE SHARE BY SEGMENT, 1978-2005, AUTOMOBILE SECTOR AND COMPUTER SECTOR COMPARISON

Automobile Sector

![Graph showing the value share by segment for the automobile sector from 1978 to 2005. The graph compares 336110: Automobile OEM.](image1.png)

Computer Sector

![Graph showing the value share by segment for the computer sector from 1978 to 2005. The graph compares 334111: Computer MFG, 334413: Semiconductors & Related Devices MFG, 511110: Software developers.](image2.png)
APPENDIX 1: BACKGROUND ON QUANTITATIVE DATA

The data on value migration/stasis for computers and automobiles over the period 1978–2005 draws on the dataset originally gathered by Baldwin, Jacobides, and Dizaji (2006), further edited for reporting anomalies per Jacobides & Tae (2012). This data consists of the market capitalization figures for the entire industry, tracking the major segments therein. To create them, we looked at the standard industry classification codes, and the sales data declared by firms for SIC/NAICS in their COMPUSTAT reports. Specifically, to identify which were the NAICS codes that were part of the sector, we started by consulting the descriptions of each code listed in NAICS manuals available from the US Census Bureau to see which obviously related to cars and computers.

We then traced the NAICS codes of leading firms in each industry such as Microsoft, IBM, Intel, General Motors, Goodyear, and Magna International, to see if we had missed some relevant codes; and we further checked if firms with “automobile”/”car” or “computer” in their business descriptions declared other NAICS codes.

Next we consulted industry experts and academics with the preliminary list of relevant NAICS codes to avoid Type 1 and Type 2 errors, and converged to a list of NAICS, and, on the basis of NAICS, a list of firms that were used for the analysis reported in Figure 1.

Specifically, we extracted the primary and secondary NAICS codes for each firm-year, market capitalization, sales, total assets, current assets, current liabilities, long-term debt, R&D spending (all in million USD) and the number of employees (in thousands) for each firm-year. All numbers are reported at firm level except for sales, which are reported at segment level (by NAICS codes). For firms that participate in more than one segment, we weighted the firm-level number by each segment’s sales amount. Following adjustment, firm-level data were aggregated up to the segment level for analysis.

Our dependent variable is the percentage of market capitalization (ratio of segment's market cap to sector's market cap),²⁴ for each segment year. We first adjusted the market capitalization of firms by sales ratio of segments in which each firm participates. We calculated each segment’s market capitalization by summing the adjusted market capitalization of all participating firms within each segment by year. We then added the market capitalization of all segments comprising a sector by year to derive the total market capitalization of the industry.

²³ NAICS was introduced in 1997 and pre-1997 data only have SIC codes. We used the NAICS-SIC correspondence tables and the descriptions of the business given by firms to ensure consistency in the data.

²⁴ Using the percentage, instead of the amount, is necessary as it highlights the relative nature of value: we are not interested in each segment’s market capitalization in absolute terms, but rather in share of value within the sector.
Dividing each segment’s market capitalization by the industry’s total market capitalization per year yielded the variable shown in Figure 1 and discussed in the text.
APPENDIX 2: EXAMPLE VIGNETTES

Vignette A: Comparing automotive and computer sectors’ value dynamics

Our analysis focuses on the automotive sector, combining historical analysis, existing notes from an extensive analysis of the sector and its OEM-supplier links, and available data sources with at-the-time field research during a period of anticipated transformative change (late 1990s to mid-2000s). These are complemented by recent (2012) interviews with industry participants and analysts, on retrospective and prospective drivers of value migration or stasis. Our shadow comparison is to the personal computer sector, for two reasons: First, the personal computer sector is the prototypical example of value migration due to the rapid shift of value from IBM (the innovator behind the PC) to the specialized suppliers controlling the operating system and primary application software (Microsoft) and the microprocessor (Intel). Second, executives at automotive OEMs and suppliers, as well as financial analysts and consultants, held the narrative of the computer industry’s (r)evolution in mind as they anticipated (and made strategic choices to further) similar disruptive changes in their own sector.

We characterize our analysis as a “shadow” comparison because we don’t, for reasons of length and focus, develop a full-fledged narrative about the computer sector that matches our in-depth analysis of the automotive sector. And our inferential basis doesn’t rest on the comparison of the two sectors; rather, it rests on the analysis of the dynamics in the automobile sector, where we further exploit international variation and the anticipated (and unrealized) changes in different points in time. Computer dynamics help put the automobile sector in sharper focus, and consider value distribution issues through the use of a latent comparison, also being made by participants in the sector.

That being said, as the “shadow comparison” between cars and computers is maintained in the paper, several similarities and differences between these sectors need to be noted: Both sectors started with a single dominant product controlled by the innovating firm (Ford’s Model T; IBM’s original PC) that put the product “on the map” and had a heavy influence on the subsequent evolution of the product architecture. Subsequent diffusion of the underlying product technologies allowed a proliferation of firms offering functionally comparable products, often for a lower price. Specialized suppliers made a bid to capture a larger share of the value as the market grew, by changing the rules of engagement and advocating standardization. (They succeeded in computers and by and large failed in automotive.) The market for the original product grew quickly, attracting bank financing and venture capital (or, in the case of cars, equity investment) and resulting in many new firms.

During the period of both sectors’ early rapid growth, competition among alternate design approaches gave way to a sector-level dominant design that was technically feasible to produce at scale. Significant advantage went to the firms best able to execute the dominant design successfully, in terms of controlling product/brand differentiation and making themselves
irreplaceable. Yet, as our analysis points out, the impact of the dominant design on each sector differed dramatically because the product architecture of personal computers was open, with industry standards for modules that were highly separable, and the product architecture for automobiles was closed, with firm-specific specifications for components that were highly interdependent and hence more integral and less modular. Thus rapid growth in computers favored the horizontally oriented firms making key components and/or controlling crucial technical parameters. In contrast, rapid growth in automobiles favored those vertically integrated automakers that could coordinate the full set of manufacturing, sourcing, and logistics issues while retaining control over suppliers via the specification of firm-specific components.

It would be tempting, but inaccurate, to portray computers and cars as sectors with a simple “life-cycle” evolution, starting in the end of the 19th century for cars and late 20th century for computers. In cars, there has been substantial industry change and expectation of structural transformation, particularly from the late 1990s to mid-2000s, focused quite explicitly on trying out the computer industry’s strategic approaches in pursuit of faster innovation and lower development costs. In the computer sector, the “textbook” case of the “open” structure, the dominant Wintel approach has given way to new ways of organizing the sector, with value staying with firms that can most successfully integrate the entire system of hardware, software, and complementors (at the moment, Apple is the exemplar of this approach). Ironically, computers (or computer-like devices) are becoming more like cars, in terms of both structure and value migration patterns, rather than vice versa.

Our quantitative data analysis captures the share of value held by different types of firms (OEMs vs. suppliers) for the same period of time – 1978 to 2005. For the computer industry, this period captures the sector’s “birth”, adolescence, and first phase of maturity. For the automotive industry, this is a period of relative maturity in developed countries. To provide a better “apples to apples” comparison, we also provide some examples from the early history of the automotive sector whenever we want to compare the two sectors at the same developmental stage. For example, 1912 to 1937 covers the first 25+ years of the automotive sector, while 1979 to 2005 covers the first 25+ years of the computer sector. It should be stressed that even in the early years of the computer sector, value did migrate from the dominant player (and the OEM segment) to other parts of the value chain, whereas in the car sector this did not happen – and nor did it happen in the more recent period of turbulence and expectation of structural change. More to the point, our research design is predicated not on the exact comparability between the two sectors (and the thorny question of how sectoral dynamics can be compared in time), but rather on the lack of value migration in automobiles, despite the expectations to the contrary.
Vignette B: Car seats, unibody architecture, tires, and constraints on modularity

The aim in outsourcing modules (such as the instrument panel example given in the text) was to stimulate modularization processes that would allow the reduction of interdependencies. Instead, new interdependencies often sprang up, creating additional complexity that was difficult to model fully, even with computer-aided design tools. Other examples include components often identified as “modular” such as seats and tires.

Seats were the first automotive “module” – although they didn’t initially take this name. At one time, they were built in OEM assembly plants. Beginning in the 1980s, they were gradually outsourced to suppliers such as Johnson Controls and Lear, who could design, manufacture, and deliver them for one-step installation. In this regard, seats were modular for production. However, seats were not produced with “standard” interfaces that would span different car models, brands, or OEM customers. For example, during interviews at the seat suppliers mentioned above, we learned that every OEM had different design specifications for their seats, and wanted firewalls between the supplier teams working on designs for each customer. This made it difficult for suppliers to realize any gains from creating a stable set of potentially reusable designs.

Nevertheless, suppliers told us that they had made progress towards specifying a small number of seat frame designs that could meet the need of most customers, and on to which customized shapes, upholstery, and features could be added. But even as low-level modularization processes advanced, the relationship between buyers and suppliers did not; unlike in computers, industry standards that could become the “thin edge of the wedge” did not emerge. And this was not for want of trying from the supplier side – or lack of expectation from industry analysts. As a 1997 Bain and Company report on “the dawn of the mega-supplier” predicted, “the new giant suppliers will quickly move to designing vehicle systems that can be ‘standardized’ within and across OEMs – in other words, used in multiple models of an OEM and eventually by multiple OEMs.”

Why didn’t it happen? A key impediment to persuading OEMs to adopt seat designs based on common frame types was the increased regulation around crash safety. The tracks by which a seat was attached to the car’s floor pan (and hence to the underbody) had to be precisely designed to take into account the specific body architecture for structural integrity and crash resistance. For one supplier engineer, this proved that full modularity in seats would always be out of reach. “The mounting system is proprietary, and it will stay that way. The floor pan is different in every vehicle, so you need to manage the energy and the loads differently. Even as we do more design, [the OEM] still wants to control it. Anything on the vehicle the final customer can see, the OEM wants that kept proprietary.” At one time, attaching seats to floor pans had been one of the most straightforward stages of customizing the product for a
customer; now it was one of the most complex and time-consuming, requiring data exchange at earlier stages of the product development process, when key body decisions were made.

The rise of “unibody” architecture is another example. Initial automotive architecture, even before the Model T, involved building up a metal body separately from the chassis (engine, transmission, suspension, wheels) and then “dropping” the body onto the chassis late in the assembly process. This “body-on-frame” approach was relatively modular; body and chassis could be designed and manufactured separately and only integrated late in the production sequence.

Beginning with experimentation at Lancia in Italy in the 1920s, and at Budd in the U.S. in the 1930s, in an effort to improve ride smoothness and safety, design shifted to “unibody” construction, where a single-piece metal body is built up from large panels and chassis components are bolted onto the underbody later. This less modular design was adopted widely by the 1960s because of its effectiveness in eliminating the noise inherent in the body-on-chassis approach (Rubenstein, 2001) as well providing more scope for structural features that improved crash protection.

More recently, the Ford Explorer-Firestone tire recall crisis of 2000–01 demonstrates that even a component as seemingly modular and decoupled as a tire must be designed precisely, and interactively, to anticipate systemic interactions with a specific vehicle’s design, shape, and steering and braking systems. Government regulators documented a high number of deaths from rollover accidents from Explorers outfitted with a particular Firestone tire. In the subsequent disputes between Ford and Firestone, it became clear that the specific tire model was less associated with accidents on other vehicles and that Explorers were less inclined to roll over with different tires; it was precisely these systemic interactions that caused the high incidence rate. In the bitter disputes between the companies that followed the tire recall, Ford and Firestone completely severed their relationship, one that dated back to the friendship between Henry Ford and Harvey Firestone in the first decade of the 20th century.

Over a decade later, there is still no agreement about exactly what managerial choices helped create the conditions for this particular dangerous combination of vehicle and tire. Yet since then, many changes have been made to address this safety issue (Ernst, 2011). Starting with 2007 models, many new vehicles were equipped with tire pressure monitoring systems; these monitors warn drivers when tire pressures drop below an acceptable threshold.

While integrality and systemic interactions may have prevented modularization, they have not prevented disintegration. Technology may affect the architecture, but does not fully determine the division of labor, which depends on the strategic and organizational choices of firms in the sector. OEMs still source components outside, albeit in a hierarchical fashion, and the complex contractual issues (which, according to TCE, would have pushed the sector to downright integration) are addressed with a combination of relational and legal tools. For instance, in the
aftermath of an expensive recall and brand-damaging publicity, both parties have the incentive to fix problems via technical improvements, such as the tire monitoring system mentioned above.

Meanwhile, OEMs keep trying to overcome the disadvantage (from their point of view) of being held ultimately accountable for vehicle safety failures – by building more and more conditions into supplier contracts. For example, in June 2013, GM announced new terms in its contracts requiring suppliers to reimburse GM in the event of a component failure, not only during the term of the contract but for the entire life of the vehicle. This responsibility would hold even when the supplier had accurately constructed the component to GM specifications (Sedgwick, 2013). In the control struggle between OEMs and suppliers, the primary power to dictate terms still lies with the OEMs, and the difficulty in modularizing is an element that gives them greater architectural, and thus strategic control, despite the thorny contractual issues.

Vignette C: The direct-selling model in autos

While U.S. OEMs briefly experimented with direct sales models early in the industry’s history, they found it difficult to set up new dealerships quickly enough; even more difficult was incentivizing employed salespeople to be as motivated to make sales as an independent dealer whose own capital was tied up in the vehicle inventory stock (Bury, 1974). Once the model of dealers as small independent businesses was established, laws steadily accreted protecting those dealers, ostensibly from exploitation by big OEMs but also as a reflection of the political strength of auto dealers and their use of that power to buttress their position in the value chain.

These laws helped lock in the prevailing distribution system and made it resistant to change, even when the Internet offered new purchasing alternatives for most other consumer goods. For example, buying a new automobile over the Internet is still illegal under state franchise laws, which stipulate that a dealer must be involved in all such transactions. Indeed, the mighty OEMs have found themselves quite powerless to make major changes in the distribution model.

However, even in countries where franchise laws are not as strong, the dealership model is prevalent. It appears that an OEM-affiliated dealership is a logical source of bundled services beyond new car sales, including the sale of “pre-owned” (used) vehicles (often after a OEM certification of quality), repairs, and sales of aftermarket parts. Indeed, competition among dealerships is intense enough that no dealer makes as much from new car sales as they do from these other services, for which direct price comparisons are more difficult and customers are tied to a specific dealer for reasons of prior transactions, brand-specific repair or parts needs, geographic convenience, etc. While there are many participants in the auto industry ecosystem for customers who already own their vehicle (auto parts, independent repair shops, specialized
providers of mufflers/silencers, tires, paintwork, and bodywork), these supplement rather than
displace OEM-linked dealerships.

Vignette D: RelayRides users penalized by insurers

RelayRides is a personal car-sharing program. As a RelayRides member, an MIT computer
science student offered her hybrid vehicle for rent to other members; her reasons were that she
didn’t use her car much, wanted to minimize environmental impact by giving her car more
utilization rather than having other people buy their own cars, and, as a dog-owner, was willing
to have dog-lovers use her car (difficult to find in a rental car or traditional car-share).

Then a driver of her car had a collision with another car. He was killed, and the four people in
the other car were seriously injured. RelayRides has $1 million in insurance per accident, and
the vehicle owner had $300K in coverage from her company, but total claims are likely to be
greater than that, leaving the car owner potentially liable for the remainder. Certain insurance
companies are already saying they will drop people who sign up their cars with RelayRides. So
automobiles are likely to face restrictions on an innovative business model that appears to work
in other realms (e.g. Couchsurfing) where there is also insurability risk for the owner, but not
the same public risk.

Vignette E: Industry standardization foiled again; the “A Better Place” venture

The initial business model for battery-leasing firm A Better Place was predicated on having
industry-standard car batteries that would enable universal swap-out stations (i.e. replacing a
depleted battery with one fully charged) at something resembling current gasoline service
stations. Yet with battery technology still in flux and an ever-wider range of electric-vehicle
products on sale, each with different battery requirements, the prospect of battery
standardization continues to recede. As we discuss in greater detail in the paper, automobile
OEMs have resisted standardization, and there has been no real progress in this direction – not
because it would have been technologically difficult, but rather because the existing actors in
the industry architecture have not found this to be to their advantage. This has forced A Better
Place to revamp its model and focus entirely on small, contained experiments, e.g. in Denmark,
Israel, and Hawaii, in collaboration with governments that can insist upon a standard vehicle-
battery configuration for pilot testing.

Vignette F: Toyota establishes a new vertically integrated electronics subsidiary

In the mid-1990s, Toyota established a fully integrated electronics subsidiary, despite (and in
addition to) its very close quasi-integrated relationship with Denso, a global leader in
automotive electronic technology (Ahmadjian & Lincoln, 2001). While speculation at the time
raised the possibility that Toyota was unhappy with Denso’s performance, subsequent
developments suggest that Toyota chose integration for three reasons: 1) Toyota wanted to be sure its electronic capabilities were strong enough to evaluate new electronic technologies offered by Denso and other suppliers; 2) Toyota sought to develop its own software for the Prius hybrid drive train, particularly for switching smoothly between internal combustion engine and battery power; and 3) Toyota wanted to patent and otherwise protect the intellectual property associated with electronic innovations.

As a side effect, this move may also have limited Denso’s ability to become ever more essential to Toyota in this crucial domain, and ultimately turn the electronics sector into a “bottleneck” that could appropriate more value. However, a Japanese supplier executive whom we interviewed maintained that this was the least important of the three reasons. Understanding the costs of electronics was by far the highest priority, he said; after that, the Prius IP was a strong concern. “Toyota could see that electronics was becoming a bigger and bigger black box; they didn’t want this. It is Toyota’s culture to want to know all about every aspect of a vehicle’s technology – and they found they couldn’t do this with electronics.” This, and other instances, suggest that OEMs (especially the more successful ones) try to maintain sufficient knowledge to perform the system integration role competently, in addition to maintaining hierarchical control.

**Vignette G: Integration requirements and capabilities, automotive vs. computers**

The integration challenge in automobiles is considerable, given the large number of distinct parts/components (4,000–5,000), the large number of key parts (100) and technical subsystems (12–15), and the large number of suppliers whose efforts must be coordinated (300–500), plus staggering product variety (for some OEMs, customers can choose from up to a million potential variants, based on body style, color, engine/transmission combination, and optional features). Thus system-integration capabilities have become a key competitive differentiator in terms of automobile quality and price, while the dominant design has remained stable.

A supplier executive emphasized this distinction in an interview, saying “In the computer, besides the CPU, there are not so many vital organs. In the automobile, there are many vital organs – the heart, the liver, the kidney – and the OEM still controls the engine, which is the heart. To evaluate and integrate all the vital organs – only the OEM can do that.”

Furthermore, technological change over time has been primarily evolutionary and at a component (rather than system) level, enabling OEMs to avoid crises of disruptive technical change. For many years, OEMs primarily pursued incremental changes in features and body styling based on the lock-in of higher-level design concepts. Component innovations, which often occurred in response to new regulation, maintained the role of the OEM as an integrator. Examples include the catalytic convertor and electronic fuel injection replacing the carburetor-based combustion system, and the implementation of safety equipment such as seatbelts and airbags. The same happened on those rare occasions of architectural innovation, as in the
steady substitution of electronic software-based controls for physical controls in steering, braking, and suspension systems. The OEMs updated their electronics skills, retaining the system integrator role because each of these control systems still interacted with physical, electromechanical components elsewhere in the automobile.

In contrast, the personal computer has seen rapid evolution of its dominant design at both the component and the systems level, within a product architecture that is modular and open. Once the basic Wintel specifications were established at industry level (under the guidance of Microsoft and Intel), including bus design and interface standards, component makers could innovate relatively independently of each other. Advances in the complexity, processing power, and speed of microprocessors, consistent with Moore’s law, and sharp reductions in the cost of memory and storage, rapidly opened new opportunities for technical advance. These extremely rapid yet predictable hardware improvements, combined with the well-defined Wintel industry standard, were of particular importance in supporting increasingly complex software (both operating systems and applications) while improving overall operating performance. Furthermore, final consumers (including individuals) were increasingly able to do the system-integration job themselves. All this meant that OEMs had a contestable position along the computing value chain.

Coordination challenges for computers are also minimized, relative to automobiles, by a much lower level of complexity, with a PC consisting of up to 50 components, with 8–10 key parts and three or four key technical subsystems. While the number of suppliers can be large for commodified parts, a relatively small number of suppliers dominate key components due to a combination of scale and design advantages (see Jacobides & Tae, 2012).

Vignette H: Testing the framework in the context of computers

Let us consider how our framework can explain competitive dynamics in the computer sector of the 1980s and 1990s (illustrated through our COMPUSTAT data as discussed above), as well as accounting for Apple’s strategies, and success, in the last few years. In Appendix 3, we use the same framework to analyze the emerging electric vehicle sector, which provides a prospective analysis of our framework in a setting where things are still fluid.

Consider, first, the massive value migration that happened between computer OEMs and software makers and microprocessors. IBM’s decision to open and unbundle its PC, motivated by the gains of a rapidly growing ecosystem, led to a modularized structure with widely used standards (see Baldwin & Clark, 2000). While this might have spurred growth in IBM PC-compatible complements, it was a mistake in sector-shaping terms. IBM realized this way too late when it tried to re-integrate and reassert control with Personal System/2, but by then the proverbial cat was out of the bag. Players such as Microsoft and Intel were able to structure the sector to their advantage, helped by the underlying drivers as well as their conscious strategies. Differentiability was pushed explicitly to microprocessors (through the “Intel Inside”
campaign) and to software (through software design and compatibility choices, as well as link to downstream corporate users), and IP was managed in a way that strengthened the emerging new giants. This was facilitated by complementary entry, with a plethora of new players coming in and finding ready sources of funding and capital, and by the changing needs of the customers and new types of products, services, and delivery.

The more recent episode of Apple’s resurgence also fits our framework. Based on the same beneficial underlying drivers, Apple opted for a very different strategy from IBM, yet leveraged the same relationships – so far, remarkably efficiently. Apple understood the role of differentiability, but ensured that this would happen at the level of the overall system, in terms of the integration of hardware and software. Its efforts to “upgrade” the role of the device producer were the result of conscious choice. We also see that Apple has been ruthless in managing its vertical alliances: keeping all IP, maintaining secrecy, and even balkanizing its own supply base so as to forestall entry that might harm its prospects in the value migration game. Consider, e.g., a recent analyst report on Apple (Moel et al, 2012). They note:

> Our interviews with a number of Apple’s suppliers suggest that Apple ‘atomizes’ its supply chain to an unprecedented degree, breaking up component processing steps across multiple vendors. This aids in preserving product secrecy – since even the suppliers themselves often do not know how Apple will ultimately use a component – and gives Apple inordinate control over the manufacturing process, as if Apple were vertically integrated and owned the factors of production.

Apple has made itself, as a system integrator, much more irreplaceable than other system integrators are, and this partly accounts for the vastly different margins that it commands (Dedrick et al, 2010). And while Apple does not have the legal responsibility vis-à-vis society that has been the automobile manufacturers’ unexpected ally, it has made itself both the quality controller of its ecosystem and its ruthless manager, while managing its technologies and complements to that aim.

**Vignette I: History, evolution, and current status of Japanese approach to supplier relations, in comparison with U.S. approach**

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25 In this regard, Apple parallels dramatic changes in the bicycle industry, once considered the context with the most modularity and interchangeability of components, with the highest product performance believed to arise from the ideal mix of components from different suppliers. Shimano, in a strategic move of tremendous power, redefined the product architecture through a new integral design linking index gear shifting with derailleur operation in a proprietary system requiring installation of the entire system (and even special training for installers). Within five years (1985–90), the market share for Shimano’s system reached 55% in road bikes and 80% in mountain bikes – and all other competitors were forced to develop their own integrated systems (see Fixson & Park, 2008).
Nagaoka, Takeishi, & Noro (2008) examine the Japanese approach of quasi-vertical integration, first historically and then during recent changes. They find that the extent of pure vertical integration in Japan has never exceeded 20–25%, and by the 1980s was under 15%. From 1984–2005, a subset of the period we examine, the percentage of quasi-vertical integration (defined by customers holding an equity ownership stake in the supplier, extensive information sharing during design, and suppliers operating their own production facilities) was high and stable at Toyota (over 60%), increasing at Honda and other Japanese OEMs (from roughly 40% to 50%), and only decreasing at Nissan (from 55% to 35%, due to the alliance with Renault and Carlos Ghosn’s decision to break all equity ties with suppliers). The OEM’s system integrator role has remained strong throughout the post-war history of the Japanese industry, despite minimal vertical integration; even after the extensive deverticalization in the U.S. from 1999 on, vertical integration in the U.S. remains more than double the level in Japan.

Another perspective on the same issue is to look at how OEM-supplier contracts are established. As Clark and Fujimoto (1991) point out, contracts can be organized in three ways: supplier proprietary (supplier designs and manufactures the part and sells it through a catalog); OEM detail-controlled (all design specifications are pre-determined by the OEM, the supplier has no design role and only manufactures the part), or “black box” (the OEM provides performance requirements and basic parameters of size, weight, etc. and the supplier provides the rest of the design). Note that all of these involve a hierarchical contracting structure.

U.S. and Japanese companies do differ in how contracts are set up. In data from the late 1980s, Clark and Fujimoto find marked differences between U.S. and Japanese companies in how subcontracts are organized, with 62% of all procurement cost handled in “black box” mode in Japan vs. 16% in the U.S. and 81% of procurement cost handled in OEM detail-controlled in the U.S. vs. 30% in Japan; European firms were in between, with 54% detail-controlled parts and 39% “black box”.

Despite these differences, the auto industry norm in both the U.S. and Japan is hierarchical and proprietary relationships between OEMs and suppliers, both historically and at the present time. In many ways, the Japanese example of quasi-vertically integrated relationships with suppliers that are tightly controlled by OEMs may have served as a template for U.S. and European OEMs when they began working more closely with suppliers on design and while the new mega-suppliers emerged from divestiture and acquisition.