Industrial and Corporate Change, 2020, Vol. 29, No. 5, 1075–1099
doi: 10.1093/icc/dtaa043
Original article

OXFORD

Innovation, governance, and capabilities: implications for competition policy

A Tribute to Nobel Laureate Oliver Williamson by his Colleague and Mentee David J. Teece

David J. Teece

*Institute for Business Innovation, University of California, Berkeley, CA 94720, and Berkeley Research Group, USA. e-mail: teece@haas.berkeley.edu

Managing Editor's Note

Oliver Williamson (1932–2020) was on the editorial board of ***ICC*** since its founding in 1992[1]. He was willing to lend his good name to the journal, and ***ICC*** published four articles authored by him over his lifetime. We also published a special issue honoring the 25th anniversary of his book *Markets & Hierarchies* as *ICC* issue 4:1 (1995) which was later published as *Firms, Markets, and Hierarchies: The Transactional Cost Economics Perspective* (New York: Oxford University Press, 1998), edited by Glenn R. Carroll and David J. Teece. In addition, *ICC* published a *Special Issue in Honor of Oliver E. Williamson* as its issue 13:6 (2006). Oliver Williamson was David Teece's colleague, early mentor, and good friend. In this essay he engages with the Williamsonian tradition in a forward-looking manner with a focus on the tech sector and competition policy. *Industrial and Corporate Change* has always been focused on the role of innovation and change, so it is appropriate here to explore how Williamson's transactions cost framework can deal with the issues that are the key focus of this journal.

Abstract

Oliver Williamson's contributions to many subfields of economics are salutary. However, he was recognized by the Nobel Laureate Committee primarily for his work on the boundaries (scale and scope) of the firm. This tribute endeavors to marry Williamson's transaction cost economics with a capabilities framework to obtain new insights into how the scope and scale of technology companies influence their competitive performance in today's digital economy. The role of big data and learning are highlighted. Strong implications for competition policy, and for management, emerge from the fusion of the two frameworks. Such fusion yields a more granular view of management and policy issues but requires the policy analyst to understand not just industrial economics but also the technology management literature which also has useful insights for competition policy and regulatory professionals.

1. Introduction

Oliver Williamson was a multi-disciplinary scholar whose work impacted many areas of economics, political science, sociology, and the law. He was responsible for reviving the subject of Institutional Economics. The Nobel Prize Committee of the Royal Swedish Academy could very well have recognized him for his work on antitrust and regulation or the study of institutions, but instead chose to recognize him "for his analysis of economic performance, especially the boundaries of the firm." The explication of firm boundaries, and, indirectly, firm size, lies at the center of his work, and it's his thinking on (vertical) integration that I focus on in this paper.

In his Nobel Laureate address (Williamson, 2010), Oliver proclaimed that transaction cost economics (TCE) is concerned with complex contracts—not with the exchange "of nuts for berries on the edge of the forest" (Coase, 1992)—but instead with complex business organization. His break with orthodoxy was that he did not accept the logic of zero transaction cost, which was hitherto a standard economic assumption. Rather, he pursued the implications of the more realistic assumption that transactions or governance costs associated with organizing economic activity are positive. By doing so, he found that institutions, regulations, and complex organizational structures (particularly firms) were very often necessary to make markets work well. He endorsed Harold Demsetz's view that the "vision of neoclassical economics is to understand how the price system coordinates the use of resources, not the inner workings of firms" (1983, p. 377) and went on to help replace neoclassical views of the firm with a transaction cost perspective that has been very influential.

The best tribute I can think of providing for a scholar—particularly one who has already received so many accolades[2]—is to continue to press his research agenda forward as if he were still with us goading us on. Indeed, in his Nobel Laureate address Williamson predicted that:

> Research in transaction cost economics faces an interesting, challenging future (Williamson, 2010, p. 687).

This future is the focus of this article. That task is made easier than otherwise because, like Ronald Coase before him, Oliver Williamson chose to work on fundamental questions; and those fundamental questions are still very much alive—they will likely be with us forever, although the context in which they manifest themselves will constantly evolve.

I now endeavor to employ his framework, as he would wish, to illuminate one of the pressing issues of our time, namely, the role of Big Tech firms in our economy, illustrated by the FAANG companies (Facebook, Apple, Amazon, Netflix, and Google) along with their Chinese counterparts. In particular, I sketch the construction of a framework that uses Williamson's insights in concert with a capabilities approach to inform big questions such as: How should we understand the nature of the competitive advantages of "Big Tech" firms? Is their business conduct/behavior consistent with the TCE-capabilities logic? Are they "too big"? When should they be allowed to make acquisitions? Should they be made to divest any of those they made in the past?

In order to begin this article, I must first introduce elements of today's complex and dynamic systems-oriented digital economy. While Oliver Williamson's focus was more the industrial economy, he was quite clear that:

> the introduction of innovation plainly complicates the earlier described assignments of transactions to markets or hierarchies based on examining their asset specificity qualities (Williamson, 1985, p. 143).

Although a tantalizing statement, he didn't give much guidance on how this should be done, except to say that:

> innovation poses special challenges. Transaction cost economics can speak to some of these but it does not have a well-rounded explanation. You can interpret some of these functions in terms of the need to act rapidly in real time in high velocity environments. . .where timeliness is of the essence, one has to suspend equilibrium-type views of organizations (Williamson, 2007, p. 376).

He also notes that:

> I entirely agree that transactions cost economics stands to benefit from more fully dynamic constructions. But whereas saying dynamics is easy, doing dynamics is hard (1999, p. 1101).

1 Williamson was also co-founder of the *Journal of Law, Economics & Organization*.

2 See for instance De Figueiredo, 2010; Hermalin, 2010; Shapiro, 2010; Spiller, 2010; Tadelis, 2010; Teece, 2010 where there are many papers from Williamson's U.C. Berkeley Haas School colleagues honoring him.

The world of high tech and the (digital) innovation economy is one of high velocity laced with deep uncertainty(Teece and Leih, 2016; Teece *et al.*, 2016). TCE recognizes how that amplifies contractual problems by compounding issues arising from what Williamson calls "contractual incompleteness." The link between uncertainty, which is pervasive in high tech, and contractual incompleteness is crucial to the Williamson paradigm, and was featured heavily in *Markets & Hierarchies* (1975). I explore the nature of competition in the digital economy here because, as Williamson noted, "The action, often, is in the details" (Williamson, 2007, p. 374).

2. The digital economy and big data

In the early industrial economy studied by business historian Alfred Chandler and others, large enterprises emerged because of the revolutions in communications and transportation, and the efficiencies of vertical, horizontal, and lateral integration.[3] The rise of big business is well explained by a combination of TCE and organizational capability considerations. However, the digital economy differs significantly from the industrial economy and warrants reconsidering our theories.

2.1 Early days—algorithms and electronic devices (e.g. PC's, mobile phones, tablets) as assets

Over the past 15 years, the digital age has seen innovation in the form of algorithms and portable electronic devices (e.g. Google's search algorithms, Apple's mobile devices). Commercialization of these inventions required the development of new business models (what Williamson would call "organizational innovation"). These business models involved the development of ecosystems (in the case of the iPhone) and often utilized multi-sided markets with zero pricing on one side coupled with advertising to capture value. Network externalities (see Shapiro and Varian, 1998) of various kinds were developed and harvested. Scale mattered too.

The digital upstarts competed in different ways from the industrial age companies that came before. Network effects, switching costs, multi-sided markets, and ecosystem centrality were new or more prominent, marking the beginning of a break with industrial-age economics. The algorithm or the device platform was the asset (or resource), and it was continuously improved and leveraged. Now, however, the rules of the information economy have changed yet again, and standard approaches need to be further revised.[4]

2.2 Post-2020 customer data and learning are now more prominent

Deeper revisions are now needed to standard frameworks. Today network effects are not the principal advantage of incumbent tech firms. The growth of Amazon, Google, Netflix, Facebook, and even Apple is now powered primarily by the generation of customer data as a byproduct of engagement with the platforms (including transactions/purchases). Real time data on customers' activities, locations, and behaviors provide important clues as to their aspirations and needs. The application of AI to data enables rapid learning about customer demand. The accumulation, maintenance, and analysis of this data are now a key capability of big tech firms—not one that is on the balance sheet, but one that is nevertheless incredibly valuable for driving engagement with customers. The existence of such data resources and the tools for rapid learning has important implications for firm and industry boundaries.[5]

Williamson did not deal directly with the innovation economy or data issues. Learning is not central in TCE, although arguably it is in the background of what he called "the fundamental transformation" (of a competitive relationship into unilateral, bilateral, multilateral "dependence"). He admitted that TCE "makes only limited contact with the subject of learning" (Williamson, 1999, p. 1101; 2002, p. 190).

If Williamson had focused on data and learning, he would likely ask whether proprietary data resources should be leased or sold or use-restricted to the firm itself. His advice might be that such assets could not readily be bought

3 For a review of one of Chandler's leading treatise (see Teece 1993, pp. 199–225).

4 Teece (2012a) summarizes some of these issues.

5 Hayek (1945) was frequently referenced by Williamson. Hayek argued that no central authority could command the information needed to organize a rational economy. However, AI enthusiasts are of the belief that this may be possible soon. There is no doubt that AI could allow more analysis and control from a hypothetical command center, but this is unlikely to be enough to equal the benefits of a decentralized pricing system. Some "idealists" like Ray Kurzweil may believe otherwise. AI does, however, enable greater control inside the enterprise.

and sold, as contractual complexities and associated transaction costs are rife.[6] The key questions would be (i) whether these data assets are transaction-specific and (ii) whether the cost of acquiring and using them was higher or lower inside the firm versus outside. This latter point may have opened the door to consideration of the role of learning. He might also ask whether strategic behavior would be likely with partner enterprises, and whether contractual incompleteness could cause problems. His focus would be on whether contracts amongst a number of fragmented firms specializing in various activities would be as effective as an integrated (internal) approach. In this manner, his framework is well disposed to answer tough questions about Big Tech and antitrust.

Oliver was also always adamant that any proposed theory of the firm must be able to scale up from "toy model" status—the penchant of contemporary academic economists—to approximate the phenomenon of interest. He would constantly ask "what is going on here?" to force his students to come to grips first with reality, and only then with theory. Applying this criterion, we can go through the thought experiment of having a constellation of small firms scaling up through joint venture or alliances to achieve what the FAANG firms referenced earlier can each do as integrated enterprises. This type of thinking was natural and organic to TCE reasoning. The next section explores how to think about the boundaries of the firm in a way that can inform competition policy with respect to mergers and acquisitions and related corporate behaviors and divestiture.

To Williamson, the "big locomotive"[7] that determines firm boundary issues was always asset specificity (non-redeployable investments made to support the transaction). If a business relationship needed one or more parties to invest in idiosyncratic (transaction-specific) assets, a "fundamental transformation" in the relationship was likely and would be concerning.[8] If such investments are present, as they are in data-driven "big tech" firms, internalization is preferred, and tech firms will grow as opportunities to leverage their proprietary data are identified.[9] He always put the contractual issues first and foremost. However, as he recognized, there are other considerations too, many of which cannot be squeezed into a contractual framework. I now will consider how transaction cost and capabilities considerations must coexist in a theory of the boundaries of the firm—something he acknowledged as necessary, but did not pursue.

3. The capabilities approach

TCE predicts that, other things equal, common ownership (vertical or lateral integration) will be desirable when there is the need to invest in idiosyncratic (transaction-specific) assets, there is deep uncertainty, and transactions are likely to occur frequently. Williamson agreed with Holmström and Roberts (1998, p. 91) that "the theory of the firm has become too narrowly focused on the hold-up problem" and "the role of asset specificity" (2002, p. 189). Other relevant considerations could include firmlevel capabilities.

Although not mentioned in his Nobel Laureate address, Williamson, perhaps reluctantly,[10] saw the capabilities/competences framework and transaction cost economics as both "rival and complementary. . .more the latter than the former" (1996, p. 1106). He noted the possibility that "transactions cost economics informs the generic decision to make or buy while competence brings in particulars" (1999, p. 1097).

One can observe that Williamson was concerned with firms versus markets, not firms competing with other firms, which is of course the subject of the field of strategic management where the competences/capabilities perspective is incredibly relevant and has received considerable attention (see Williamson, 1999). He was clear that the firm size puzzle should be posed as Frank Knight (1921) and Ronald Coase (1937) had recommended: Why can't a large firm do everything that a collection of small firms could do and more? This would naturally take him towards a

6 That said, there are data brokers for certain data sets.

7 See slides delivered with Williamson's Nobel Laureate address (Williamson, 2010).

8 Williamson's much cited "fundamental transformation" of bargaining positions is the process according to which required transaction specific investments reduce the field of available alternative suppliers/buyers from the large number of qualified parties that likely existed in our *ex ante* bargaining situation to a likely small number (because of learning and associated idiosyncratic investment) in the *ex post* bidding circumstance.

9 Unlike Penrose (1959) and a few others who have worked on the theory of the firm, Williamson did not explicitly focus on the growth of firms.

10 Oliver remarked that with respect to the competencies/capabilities framework that "[a]s with early uses of transaction costs, there are too many degrees of freedom and too much *ex post* rationalization" (Williamson, 2007, p. 375).

capabilities framework under which one would need to ask: (i) whether relevant capabilities (present and future) ought lie inside or outside the firm, (ii) where does the customer data reside, and who owns it, and (iii) how can decisions be made by humans and by machines to use that data in real time to learn about customer needs and desires. Accordingly, the boundaries of the firm must also be set with reference to capabilities, learning, and rapid recombination and redeployment, not just with reference to TCE contractual issues.

If one accepts the above propositions, then some exploration of capabilities concepts is required. Oliver agreed, but believed that "all good theories of the firm and market organization be examined with respect to the four precepts of pragmatic methodology. First, keep it simple; second, get it right; third, make it plausible; fourth, make predictions and engage in empirical testing" (Williamson, 2007, p. 374). As a first step, the rest of this section attempts to lay out the capabilities framework. I accept Williamson's challenge to bring in the particulars and engage in empirical testing. All antitrust/competition policy issues require focusing on particulars, and hence on competences/capabilities. There is considerable literature on competences/capabilities which I will not attempt to review here. Good summaries include Helfat *et al.* (2007) and Teece (2007, 2014, 2016, 2017). As with TCE, the competence/capabilities perspectives both "takes exception with orthodoxy, both use bounded rationality constructions, and both maintain that organization matters (Williamson, 1999, p. 1098)."

3.1 Firm-level competences/capabilities

The essence of the business enterprise lies in its capabilities, and according to one noted industrial organization economists "the proximate cause [of differences in the wealth of nations] lies for the most part in the capabilities of firms (Sutton, 2012, p. 8)." Notwithstanding, economic models most often treat firms as homogeneous, leading economists today to think about boundary decisions with reference only to transaction costs, or to some theory of monopoly leverage. Agency theory considerations animate choices with respect to financial structure. A richer view of business organization is contained in the work of organization theorists and strategic management scholars. The capabilities perspective is now well represented in the fields of strategic management and technology management, but the economics profession has not yet been impacted. Capabilities can be categorized as "ordinary" or "dynamic."[11]

When weak, ordinary capabilities may permit sufficiency. When strong, they allow excellence in the performance of a delineated task. A firm's ordinary capabilities enable the production and sale of a defined, but static, set of products and services. Nevertheless, the presence of ordinary capabilities says nothing about whether the current product and production schedule is right (or even profitable). The nature of competences and their underlying processes, is such that they are not meant to change—until they have to.

Change processes are key elements of higher-level competences called *dynamic capabilities*. Dynamic capabilities determine whether the enterprise is currently making the right products and addressing the right market segments(s). Dynamic capabilities are also forward looking, helping to decide whether the enterprise's future plans are aligned with changing consumer needs and with technological and competitive opportunities (Teece *et al.*, 1997). Put pithily, ordinary capabilities are about doing things right; dynamic capabilities are about doing the right things.

Strong dynamic capabilities reflect an enterprise's excellence at orchestrating its resources, competences, and other assets. They allow the organization, especially its top management, to develop conjectures about the evolution of markets and technology, validate them, and realign assets and competences to meet new requirements. Dynamic capabilities are also used to assess when and how the enterprise is to ally with other enterprises and to engage in the co-creation of business ecosystems.

The capabilities approach explains firm-level heterogeneity and individual firm performance. Neoclassical economics and standard microeconomics usually assume homogeneity. The focus is on the firm's position in product markets (as measured by market share) when the real action that defines competition lies upstream, embedded in the firms' capabilities.

In conventional analysis, a firm's market share is viewed as an inverse measure of competitive vulnerability. Big firms with high shares are seen as protected. This is often not the case. Smaller firms may have more market security than big firms. Market share is not an automatic measure of invulnerability. Just the opposite is often the case in the digital economy. A large market share can derive from chance, network effects, or other factors that are not dependent on the firm's innate capabilities. Andy Grove, Intel's former CEO, once claimed, quite correctly, that all Intel's

11 This section draws in part on Teece (2014).

relatively high market share provides is a seat at the table for the next round of innovation. In short, incumbency often conveys no special benefits in regimes of rapid technological change.

In fact, large incumbents are often more vulnerable because they are often reluctant to implement innovations that would compete with their existing products—innovations that are readily adopted by rival and new entrants (Christensen, 1997). Therefore, there is no substitute for assessing competitive strength at the capabilities level. Analyzing product market shares and treating them as a measure of competitive vulnerability are not only meaningless; it is often quite misleading. Look as Tesla's tiny market share in automobiles and high market capitalization. Traditional antitrust market share would have Toyota with less market vulnerability, but the capital markets think otherwise.

In summary, microeconomic analysis employs static analytics and is more oriented to an ordinary capabilities perspective and ignores dynamic capabilities. Schumpeter was (implicitly) focused on dynamic capabilities and dynamic (high-powered) competition. Standard industrial organization economics is implicitly about static optimization and hence about ordinary capabilities and ordinary (low-powered) competition. Inasmuch as it informs competition policy, it has led to innovation being downplayed as a competitive mechanism.[12] Even worse, it has led to policies that favor static competition and cripple dynamic capabilities.

3.2 Technological capabilities and firm boundaries

As noted in the previous section, TCE requires that the boundaries of the firm must be set not only with reference to contractual issues but also with reference to the technological capabilities of the organization, seen through a contractual lens (Teece 1980, 1981). Williamson (1975) was clear that technological non-separabilities were not sufficient to determine firm-level boundaries. He discussed why "thermal economies" alone were not sufficient to explain the integration of iron and steel manufacturing. He always asked, "Why couldn't these economies be captured by contract?" Over time Williamson came to see the problem of economic organization not so much as markets or hierarchies, but markets and hierarchies (Williamson, 2002, p. 175). He was critical of the property rights approach because of its assumption of "common knowledge of payoffs" (Kreps and Wilson, 1982) and costless bargaining.

The field of strategic management teaches that the competitive advantage of individual firms, especially in high-tech arenas, stems from having the right capabilities (and using them astutely) and setting the right boundaries (governance). Technological capability involves elements of both ordinary and dynamic capabilities. The measure of a firm's capabilities relates not only to the stock of knowledge (technological resources) that a firm possesses and uses to achieve best practice (part of ordinary capabilities), but also to the firm's capacity to anticipate, develop, coordinate, and combine existing technologies and invent new ones—a key aspect of dynamic capabilities. Put differently, the way technology/data and other resources are used in adapting to shifting user needs matters a great deal. As Bell and Pavitt (1995, p. 78) note "the technological capabilities needed to generate and manage technical change include skills, knowledge, and experience that often (but not always) differ substantially from those needed to operate existing technical systems." These skills and capabilities are likely to be firm-specific. Judge Learned Hand in the 1945 *Alcoa* decision[13] recognized the concept of firm-specific capabilities and noted that the law must not punish success achieved by superior "skill, foresight, and industry." Judge Hand was toying with a dynamic capabilities perspective long before frameworks existed in the strategic management literature, let alone the antitrust literature.

However, technological assets will not support competitive advantage unless they are deployed astutely. The firm needs a viable commercialization strategy to build competitive advantage. Kodak, for example, had an early lead in digital imaging technologies, but failed in its commercialization in part for fear of undermining its highly profitable emulsion film sales. In short, the firm also needs continuous improvement and a robust commercialization strategy if it is to have a good shot at succeeding in the market. Success is not just about a few big bold moves, it also requires continuous (but rapid) learning involving invention, imitation, modification, acquisition (if there are missing technological elements) and strategic alliances. In short, strong capabilities are necessary for two reasons: (i) to achieve or exceed "best practices" (in quality and functionality) with respect to existing product (e.g. through informed

12 Some competition agency employees and many antitrust scholars may disagree; however, their inability/unwillingness to look much beyond the standard industrial organization literature speaks otherwise, as does what they write and the recommendations they make.

13 *US v. Alcoa* 148 F.2d 416 (2d Cir. 1945).

adoption and modification of existing technologies), and (ii) to develop new products and services that meet and where possible anticipate customer/user needs. The first requires strong operations management (ordinary capabilities); the second requires entrepreneurial management, which in turn requires the ability to "sense" new markets and technological trends, understand them, and then "seize" the moment (i.e. strong dynamic capabilities; see Teece, 2007, pp. 1319–1350; and Teece, 2016).

Technological capabilities are by no means the only capabilities required. The firm must be able to effectively govern the ecosystem of actors on which it relies for outsourced activities. Governance and contracting are thus closely related. Some firms (e.g. Apple) may choose to outsource some parts of their value chain while others (e.g. Samsung) keep different parts in-house or in wholly owned subsidiaries where they can rely on the rule of law to protect their technology from misappropriation (i.e. theft). Getting the make/buy balance right requires an understanding not just of what needs to be done, but also of what external capabilities might be available to do it at a competitive price and of what level of in-house supervision will be needed to make the arrangement succeed. The what, where, and how of outsourcing are critical management questions with strong public policy implications, and the answers hinge on capabilities as well as on contracting costs.

Achieving the right mix of make-or-buy involves not just good management (see Chesbrough and Teece, 1996); it also requires good corporate governance as board members need to be supportive of bold moves. Given the way boards are constructed today, with board members possibly facing distraction from myriads of regulatory compliance issues, the availability of good strategic governance cannot be assumed even in advanced economics. The governance challenge here is that "sins of commission" tend to be more visible and laced with liability for board members than "sins of omission." Having the enterprise do less (in terms of bold strategic moves) rather than more will seem more comfortable to many board members.

3.3 The (apparent) paradox of tighter integration and amplified outsourcing

A key feature of the capabilities view is that it recognizes that successful firms have resources that are "strategic" or core and therefore non-contractible, that is, they need to be brought under common ownership and control. All but the largest tech firms tightly integrate around a strategic core and outsource much of the rest.

The core can change over time. Some things, such as data processing and storage, are obviously "less core" than they were in the past—as evidenced by the shift to third-party cloud services.[14] Over the last decade, on account of changes in the distribution of key capabilities in the ecosystem, there has been a fundamental shift in the computer hardware and software industry towards network-delivered services. Prior to 2010, for small to very large companies, software systems were often designed in-house and deployed by buying racks of servers, putting the necessary software on them, and running them in appropriately sized data centers.

Now the key capability is not designing and provisioning the basic elements of the software—that has become quite ordinary. What's more critical now is the dynamic capability needed to orchestrate the system.[15] In this scenario, outsourcing those basic elements is completely consistent with creating and maintaining an asset orchestration capability. The elements of the software systems are often a combination of open-source libraries and widely available computing and storage capacity deployed by renting access to applications, platforms, or infrastructure running in the cloud, operated by the largest horizontal providers—in the West, most notably Amazon, Google, IBM, and Microsoft. This was made possible by the ubiquity of high-speed network connections and massive, scalable architectures. Under these circumstances, the need to vertically integrate into digital infrastructure has been reduced. Contractual arrangements with external providers are quite satisfactory.

The incentive to outsource the elements is reinforced by the growing cost reductions and quality improvements obtainable through outsourcing. On the other side of the market, Amazon and Google have realized that they can provide of the same type of infrastructure that they operate in support of their own proprietary businesses. At the very least it gives them scale advantage, allowing them to amortize the fixed costs of data infrastructure across a

14 Similarly, one may observe different choices within the same firm. For example, Netflix outsources cloud computing support to Amazon but has vertically integrated into content production.

15 It is worth noting that TCE is ill-suited to the study of ecosystem or supply chain orchestration because its unit of analysis is the dyad. TCE is, *stricto sensu*, interested in the trees, but not the forest.

broader base and leverage higher volumes. At its best, it's also a major new profit source—Amazon Web Services (AWS) has significantly higher margins than Amazon's core retail business.

Providing infrastructure services to others works when the transaction costs are acceptable. This in turn requires the function being sold to be well-understood and standardized, the interconnections necessary to utilize the cloud service are of tractable complexity, and the cloud service is advantaged because of scale. Scale advantage can come from either physical scale (i.e. bigger data centers have lower variable costs) or from learning effects (i.e. better solutions can be provided because their development cost is spread over a large customer base). In the early days, cloud services were quite basic—compute capacity, storage space, etc.—with well understood and simple interfaces. With maturation, the reach and complexity of the services offered is increasing—now, for example, the whole complex problem of managing user login credentials can be outsourced to a specialist provider who can do a better job because they are managing hundreds of thousands of users, and therefore can better protect against spam and spoof. This is as predicted by the Williamson TCE framework; contractual relationships can completely and stably govern the relationship between suppliers and consumers of non-transaction specific services. Much of what is needed to provide infrastructure services is quite generic—and has very limited transaction-specific (i.e. idiosyncratic) elements.

3.4 The advantage of data ownership

It is becoming increasingly clear, however, that a critical source of firm-specific competitive advantage for digital enterprises (especially those that face the consumer) comes from owning and exploiting key "data lakes" that record customer behaviors and preferences (and the relevant environmental factors that drive those choices) and that help train the AI systems that support the capabilities necessary to deliver value to customers and other users. These data lakes are typically very complex, integrating multiple different sources and types of data. And the source of these data is increasingly the connected devices such as phones and automobiles that are either owned by customers or are in some way observing their behaviors.

Google is an iconic example of a firm that, through the ecosystem of devices on which its applications run, is able to collect, manage, and exploit customer behavioral data systematically. To achieve its end, Google adopts an approach that delivers a unified experience across multiple device classes and multiple services. Google's approach is more than simple integration: it believes each of its services benefits from its other services. Similarly, the customer is the same regardless of whether the customer is accessing services through a phone, tablet, or media device. Although a key attribute of Apple's positioning is that it tightly integrates all of its hardware and software products, each of Apple's device-class businesses benefits from its other device classes. The customer is the same regardless of whether the customer is accessing services through the iPhone, the iPad, or the Apple TV. Apple's media services benefit if they are paid for with the Apple Card. It makes use of customer data too, but perhaps not to the extent Google does.

The challenge of building the right capabilities for behavioral customer data orchestration is much more than a technical challenge. There are two significant economic challenges as well: the joint output challenge and the knowledge asset challenge.

The first challenge, the joint output problem, arises because the data comes from many different sources and is used in many different ways. It is often not possible *ex ante* to know which sources and which uses will be valuable. The core issue here is some version of the classic joint product problem. When an enterprise produces a product involving fixed, or near-fixed, proportions (or what Leontief called "production processes"), it sometimes produces ancillary products/services that may be valuable, useless, or even of negative value. The value of those ancillary products may change unpredictably. Thus, when early Australian sheepherders raised sheep for wool, mutton was a byproduct. The mutton was of no value at first; but, with the invention of refrigeration in the 1880s, it became valuable. Similarly, refining crude oil also produces petroleum coke, with low—but not zero—value since it can be further processed for use as an industrial fuel. Sometimes the "byproduct" can end up being the main product! Netflix, for example, recorded customer data as an inevitable byproduct of managing its DVD rental business. That customer data formed the basis of its prediction algorithm that became its core competitive advantage. Likewise, Amazon initially developed, in the 2000 timeframe, cloud computing as an ancillary software support function for itself and third-party merchants (e.g. Target, Marks and Spencer). To more fully utilize the excess capacity it created to meet peak demand, it began providing services to others, and AWS is now a very profitable business. This example is very Penrosean, as Edith Penrose had built a theory of firm growth around excess resources. Amazon realized it was quite

good at running infrastructure services like computer storage and at running reliable, scalable, and cost-effective databases (see Miller, 2016).

The second challenge is the knowledge asset problem. The same data on customer behavior can in certain circumstances be reused, and so is a non-depreciating asset.[16] This means that while one knows that an asset might be valuable, ascertaining its potential value (and whether it is worthwhile collecting and processing) is difficult because one may not know (*ex ante*) how many times a piece of information can be reused. This means that another judgment call is required with respect to how much money should be invested in collecting the data.

Google is an excellent example of a firm that was a successful early mover in understanding the value of collecting customer data from search and then linking it to advertising.[17] When Google was launched 20 years ago its key asset was its structured understanding of content on the Web; if one searched for something, there was a good chance Google could find it. At first, the customer data from this search activity were only weakly connected to the advertising industry. Google became a sub-contractor to Yahoo in 2000, the same year it launched its AdWords service (Hu, 2002). In the beginning Google made modest profits.

Now, because of its ability to connect the data[18] assembled from customer search with the needs of a vast number of firms in many industries, Google has a very profitable business model. It has a finely detailed picture of online consumer activity, assembled from all of the tracker cookies it puts on all of its advertisers' web sites, its knowledge of individual search history, and all of the data that Android phones send back. Google knows where device users are located, and what is located geographically proximate to the user. Google knows what Web sites a user just visited. Google reads Gmail emails. Google knows a lot, and leverages this data with advertisers, encouraging advertisers to refine the way they present themselves, clarifying what they want and then making the match. This structure means that when users search, they can get results that are much more likely to be useful. And the ads they give users are much more likely to be relevant and clicked on. As a result, the profit margins of Google have risen as the company has become one of the largest in the USA.[19]

What is also true is that new product (and service) development and delivery involves coordination complexities and risks (negative spillovers) around software development and data mining. Data security is essential for this all to work well. It's also a technical challenge. Capabilities (both ordinary and dynamic) matter too. Few firms can do this well. Creating and orchestrating digital capabilities to yield value to ultimate users involve achieving the convergence of expectations within the ecosystem, requiring ecosystem management of a kind the price system cannot achieve by itself.[20]

4. Capability considerations, Williamson's contracting framework, and firm boundaries: some illustrations

As noted earlier, and as Williamson recognized, the capabilities framework can be used in conjunction with TCE, and vice versa, to get a better understanding of Big Tech management and policy issues. The capabilities approach requires that one bring in the particulars. This article advances the proposition that one framework without the other isn't viable when it comes to managerial decisions or competition policy enforcement actions. The two approaches are complements but not necessarily cospecialized to each other.

16 Some of these issues were explained in Teece (1980, pp. 223–247).

17 Google is also an excellent example of vertical and lateral integration. Much of Google's ad revenue has long involved traffic acquisition costs (TACs; i.e. Google pays a revenue share to Google network members that run a Google search product on their websites or devices. In 2011, TACS represented 51% of Google's Adsense advertising fees. Google has therefore spent the past decade trying to decrease payments of the revenue share, end Adsense relationships, and integrate verticals served by Google network members.

18 In the dynamic capabilities approach, this is called "asset orchestration" and is part of "seizing" (Teece, 2007).

19 Google is an interesting organization, because it builds its own software and owns its own storage and even designs its own chips. Whether these last moves are really necessary is an issue to be probed.

20 Facebook is discovering this currently (July 2020). For several years, it has dismissed concerns over how its algorithms, designed to maximize user engagement, spread hate speech and misinformation. It now faces a (time-limited) boycott by major advertisers, with hundreds more considering such a move (Bond, 2020).

In order to explore these issues further I now look at some historically informed—and quasi-hypothetical—illustrations that demonstrate the application of TCE and capabilities concepts with implications for management and policy. The four illustrations involve compelling questions of common ownership.

4.1 Illustration 1

Suppose Google owns an advertising company (Adco) and realizes that selling advertisements will be more profitable if it can link it to a mobile mapping application (Mapco). Can these two entities be run well together absent integration that is, can economies of scope be achieved without expanding the scope of the enterprise? This is the fundamental question addressed in Teece (1980, 1982); but it is rarely framed in this very Williamsonian manner by competition economists. However, it is clearly a fundamental question when assessing Big Tech and antitrust.

Because we know that there are significant scale economies associated with each business (billions of dollars has been spent to develop and maintain Google Maps and Google Earth), the business environment is likely to be populated by only a few providers, creating what Williamson (1975) called a "small numbers" situation. Were Google's Adco to partner with an independent Mapco, this would enable Mapco to scale and become a potential competitor that is, Mapco (not Google) would capture the benefits of scale in mapping. Even if there initially were two or three independent mapping companies, after a Williamsonian "fundamental transformation" had taken place (1985), there would be a scale-dominant Mapco with the potential to "hold up" Google. The result is contractual instability stemming in part from the fundamental transformation and in part from what Williamson would call unavoidable "contractual incompleteness." The number of Mapcos will diminish rapidly as the apps evolve, and Google would be disadvantaged from a bargaining perspective. Very early on, in Markets and Hierarchies (1975), Williamson stressed that the fundamental causes of contractual incompleteness are bounded rationality (one cannot specify every contingency because of cognitive or "neurophysiological" limits of human decision makers) and uncertainty (the number of possible contingencies is infinite because of unknown unknowns). Integration (i.e. common ownership) is therefore called for to escape potential hold-up and related problems.

Pursuing the Mapco/Adco hypothetical further, it is important to note that frequent product upgrades on both sides would amplify contractual complexities/difficulties if Adco and Mapco were separate. Applications (maps and others) move over time onto different platforms, with different properties and different requirements. These have ranged from desktop PCs, to laptops, to mobile, to vehicles. Each transition requires coordination/reengineering of the application and of the interfaces and data alignment between the parties. In other words, they require (dynamic) orchestration capabilities that are costly to build and maintain above and beyond any transaction costs considerations.

Perhaps it is helpful to think of Mapco as analogous to a billboard. When users look at and search in maps there is the opportunity to place advertising so that Mapco and Adco need to work together to ensure that eyeballs get fully saturated for revenue optimization. Decisions with respect to placement, handoff and the like require joint optimization and frequent recalibration, which is hard to effectuate both technically and contractually. Mapco knows where the user is looking, whereas Adco knows a lot about the user. Furthermore, new data, whose ownership must be negotiated, is generated by the user's subsequent behavior (click on an ad, look elsewhere, etc.). The better the data can be coordinated, the greater the revenue generation.

The firm boundary issues I discuss here were addressed in a more subdued way in my early career as I endeavored to apply TCE to technology sharing issues. "Economics of Scope and the Scope of the Enterprise" (1980) and "Towards an Economic Theory of the Multiproduct Firm" (1982) combined insights from Oliver Williamson, Edith Penrose, and Richard Nelson to look at the contractual issues associated with sharing technology via contractual arrangements (vs. lateral integration) in the market for knowhow and for intellectual property rights. These papers identified issues that would often lead a firm with technology assets to consider common ownership as the best way to organize. The TCE analysis conducted back then was already referencing assets/resource/capability concepts and led to the conclusion that (lateral) integration was indicated in when knowhow assets were at issue.[21] All the more so now with the complicated and changeable interfaces which are encountered in the tech world (see Baldwin and

21 Knowhow and data are similar in terms of their organization remifications. Although knowhow has codified and uncodified dimensions, and data is clearly codifiable, understanding it and using it has tacit dimensions.

Clark, 2000). Not surprisingly, the FAANG firms have evolved many but not all aspects of their business in tightly integrated ways (particularly in design and development) because of such issues.

4.2 Illustration 2

Another Williamsonian question is whether Google should have had a contractual relationship or, instead, an ownership relationship, with YouTube. Google's business model is to provide search for free and generate revenue from ads associated with users seeking search results. According to Williamson, the downside of ownership is that the incentives of YouTube employees would supposedly be blunted by their absorption inside Google.

Williamson's TCE requires us to ask about the nature of the required contract if the two businesses were to remain separate but seek to capture benefits contractually. Are there transaction-specific assets at risk—either at YouTube or at Google—if the two companies enter into a long-term contract? The TCE approach requires one to ask whether either party needs to make large, specific (non-redeployable) investments to support the delivery of the service and avoid the risk of a "fundamental transformation." From a TCE perspective, it is not immediately clear that this would be the case. YouTube could commit to store and index its video content in a way that makes it searchable by Google's technology. TCE analysis might therefore argue for separate entities doing business via contractual relationships. However, deeper examination within a forward-looking (i.e. dynamic) TCE framework surfaces challenges: technologies for indexing video content are rapidly evolving—video content is increasingly categorized by directly reviewing the content using deep learning systems, rather than simply relying on its text-based metadata. Those systems require large and specific investments, and high-speed access to all aspects of the video content. A capabilities perspective reinforces that insight: knowing the consumer and how to index content is part of Google's core strength. It wants to capture the results of search activity on YouTube's platform; and contracting for the information would be complicated. Moreover, Google has a strategic interest in owning a video platform that could eventually equal its word-based search engine in importance. Opportunity recognition skills associated with dynamic capabilities favored Google's purchase of YouTube whereas TCE logic alone might not have been sufficient (see Appendix).

4.3 Illustration 3

The Apple iPhone is the most iconic device/system of the last 20 years, and it provides multiple insights into how TCE and the capabilities concepts can be combined. Steve Jobs, in launching the iPhone, said the following:

> Well, today we are introducing three revolutionary products. . .The first one is a widescreen iPod with touch controls. The second is a revolutionary mobile phone. The third is a breakthrough internet communications device. . . . these are not three separate devices. This is one device. And we are calling it the iPhone (Mingis and Kossovsky, 2007).

In addition, the application processor, the key microchip providing the iPhone's computer-like functionality, was designed and made by Samsung to Apple's specifications using the processor architecture of Advanced Reduced Instruction Set Computing Machine (ARM), a UK company. By the time of the iPhone 4, Apple moved to its own "A-Series" ARM-based processor, exercising a capability in which it had begun to invest 2 years earlier. The A-Series architecture is now central to not just the iPhone but the iPad and Apple's watch platforms.[22] Although Samsung continued to manufacture A-Series chips for several years, it was no longer in charge of the design, which was particularly important from a dynamic capabilities perspective as Samsung had become Apple's main rival in the smartphone market.[23]

22 In June 2020, Apple announced it would also transition its Mac computers from Intel processors to ARM-based Apple processors.

23 It is interesting to compare this transfer of the chip design in-house to Apple's continued reliance on external manufacturing services from providers such as Foxconn. Williamson would again turn to transaction cost and contractual complexity for insight. The contract with Foxconn and others is likely relatively well defined, stable, and quasi competitive. However, Foxconn and other Apple contract manufacturers have strong manufacturing capabilities that would be hard to replicate. As Liang (2016, p. 149) notes Foxconn's unique capabilities—especially its flexibility to respond to specific requirements and adjust scale and specification quickly, is very appealing to Apple. He notes that the Foxconn–Apple partnership goes well beyond a conventional relationship between supplier and buyer. TCE considerations appear to be swamped by capabilities considerations. Considerable transaction specific investment probably exists now on both

The iPhone itself was a display of design integration capabilities. It could conceivably have been three devices designed and made by one company; or three devices by three separate companies; or one device by three companies contractually bound together; or one company creating just one integrated product.

In the spirit of Williamson, let's consider how the development of the iPhone would have gone if Apple had contracted with three independent companies to design three separate "modules" (phone, music player, mobile web device) that had to somehow come together on one device, reflecting the three revolutionary "products" Jobs had teased his audience with. First, one cannot assure that modularization is viable without sacrificing performance and compromising design. Google, in fact, experimented with a modular phone design ("Project Ara") as a low-cost device, but abandoned it after several years of development work.[24] Outsourcing to alliance partners, similar to how Boeing develops and manufactures airplanes,[25] would add still more cost and complexity to smartphone development. Contractual arrangements (with lawyers in the middle of things) would have added to the managerial and organizational trauma.

One strategic dimension that would have suffered is time-to-market. Steve Jobs had set a hard shipping deadline of June 20, 2007. Even inside one integrated firm, it was far from smooth sailing, with one account characterizing the disagreements that took place as a "dog fight" (see Vogelstein, 2013). If it was a dog fight within Apple, I suspect it would have been something worse if it were three separate companies trying to collaborate by contract, and the iPhone might well not have appeared on schedule. Williamson observed that the firm has "its own dispute settlement machinery" (see Vogelstein, 2013), and Steve Jobs ensured that Apple's machinery worked quickly—faster than the courts or threat of court action could likely achieve. Without Steve Jobs using his executive authority, the launch deadline would likely have been missed. Jobs' instinctive preference for integrating core capabilities under one roof was consistent with Williamson's predilection in favor of (vertical) integration.[26] But note that the successful iPhone launch relied on capabilities as much, or more than, the minimization of transaction costs. However, without a senior executive guiding the process,[27] the integrated approach might have been less successful than a best-in-class alliance among separate entities in the computing, telecom, and entertainment industries.

Sometimes Apple has gone for an in-house (i.e. integrated) approach too quickly. With the release of iOS 6 for the iPhone and the iPad in 2012, Apple introduced its own version of Maps, competing with Google Maps. The initial Apple Maps release was broadly viewed as a fiasco, leading to an apology by Apple; there were flaws in the maps and turn-by-turn navigation was inaccurate. Apple completely rebuilt the entire service, and it is now the most used navigator app on iOS. Digital maps benefit from customer usage and customer data, which Apple initially lacked (see Cornell University Network Course blog for ECON 2040). Indeed, the initial investment in suboptimal mapping service may have been a necessary step to generating the data needed to support what is now the leading service (Capron and Mitchell, 2012).

The complementarity of capabilities and contracting framework for explaining the scope of the enterprise can be seen by taking a closer look at Apple's experience with the application processor in the first iPhone model. Apple lacked the ability to design a processor in the time available. Intel was not that eager for the business,[28] so Apple turned to Samsung. However, because Apple doesn't have a chip design capability it was disadvantaged in not even being able to specify its needs well. As Apple manager John Randolph remarked:

sides. Because of the complex and continually changing interface between mobile hardware and software, a contract with a specialist chip provider would involve even greater dependence. However, its relatively easier for Apple to overcome this dependence through vertical integration. This is discussed in Section 5.

24 Issues with the modular concept include the loss of volumetric efficiency as the physical frame holding the device would increase the size and weight of the phone—all negative attributes to the user.

25 The wings, fuselage, and engines are all somewhat modular and many subsystems are outsourced.

26 As a Bloomberg report noted: "Steve Jobs long believed Apple should own the technologies inside its products rather than rely on mashups of companies from other chip makers, including Samsung, Intel, and Imagination."

27 The entrepreneurial capabilities of managers are an important element of a firm's dynamic capabilities (Teece, 2012b, pp. 1395–1401).

28 Intel CEO Paul Otellini reportedly did not believe that the iPhone would sell enough volume to justify a low chip price; so Intel offered a very high price and failed to win the business.

> Not having their own chip design experts in-house made for very poor communication with Samsung, which is why the H1 processor in the iPhone wasn't quite what they wanted, although it was exactly what they asked for. In other words, mostly Apple's fault, not Samsung's (Dilger, 2015).

Randolph's quote highlights another contractual issue not always called out by Williamson, namely, that firms may not even know how to specify their needs if they don't have an in-house capability. In the same vein, it is Apple's in-house hardware design and supply-chain management capabilities that allow it to completely specify and outsource the final manufacturing steps to Foxconn and the other firms that assemble its products. This is consistent with Williamson's Haas School of Business colleague David Mowery's early work (Mowery, 1983), as well as with research on concurrent sourcing (Parmigiani and Mitchell, 2009), which showed that in-house R&D and outsourcing are complements, not substitutes. This (complementary) aspect of integration and contracting—which is fundamentally a knowledge/capability issue—is absent from transactions cost economics.

It would not make sense for Apple's contracting choices to all be made with reference to contractual issues alone. Capabilities are key, as are strategic priorities of a different kind from what Williamson touted that is, anticipated contractual dilemmas and hold-up concerns. Apple sells premium products and competes by providing the best user experience. That requires everything to work together well, and a high quality user experience is easier to ensure the more the core elements are both technically and organizationally integrated.

4.4 Illustration 4

In 2012, the FTC in the USA investigated the Facebook-Instagram merger and didn't recommend further action. In 2014, it also cleared Facebook's acquisition of WhatsApp. Facebook maintained separate branding for both acquisitions until 2019. Interoperability wasn't at first possible. Data autonomy has likewise been abandoned.

The acquisition of Instagram by Facebook—which should probably not have been approved by the antitrust agencies—shows the shortcoming of current antitrust frameworks, which do not take capabilities and their likely evolution into account. There were no obvious integration benefits such as those discussed in Illustrations 1–3; and there was a failure to recognize that Facebook was, through acquisition, eliminating a competitor that was highly likely to compete vigorously with it, creating needed competition in the digital advertising market.

The most familiar way for enforcement agencies to assess the competitive impact of these mergers would have been to employ the potential competition doctrine. The potential competition doctrine grew out of the 1950 amendment to Section 7 of the Clayton Act (Glick and Ruetschlin, 2019). However, there were two problems with its use: (i) the doctrine has never had much substance and analytical muscle to it (ii) it had been effectively neutered by various court decisions and (Chicago School) economic analyses which had (rightly) indicated that the concept was vague. This, in turn, made the concept ripe for mischief. Its frequent use and uncertain meaning would make enforcement actions capricious, given the state of the art.

That said, there is need for a workable potential competition framework as Glick and Ruetschlin (2019) note:

> Facebook and Big Tech companies maintain their market dominance by harnessing the network effects that reinforce user value in the consumer-facing market and advertiser benefits in digital advertising markets. Innovative start-up firms provide competitive pressure in these markets. . .the acquisition of startup companies may benefit the dominant firm by reducing the disciplining competitive pressure of potential entrants. . .by preventing future entry and expansion of such firms that could undermine the incumbent's dominance (pp. 12–13).

Gluck and Ruetschlin ignore big data issues which, as discussed earlier, may now be more significant than network effects. They argue that the "anticompetitive effects" approach which would favor consideration of potential competition was weakened through various Supreme Court decisions including *U.S. v. El Paso Natural Gas* and *U.S. v. Penn-Olin Chemical Co*. In the latter, the court noted quite correctly that potential competition "is not susceptible of a ready and precise answer." The 1968 and 1982 merger guidelines addressed potential competition but did not lay out clear criteria for applying it. The 1976 *U.S. v. Marine Bancorporation* further gutted what was, at the time, an unworkable concept. The case law thereafter did not let a potential competition claim succeed absent the presence of a concentrated market and the absence of other potential entrants and evidence of the procompetition effects of independent entry. It seemed apparent that neither economists nor the courts had the expertise to determine the likely future market evolution and new entry with and without the merger at issue.

Table 1. Mapping of market characteristics to organizational forms

Characteristic	Organizational form to enhance value and minimize hazards	
	Internal (in-house)	External (contractual)
1. Hold-up and "lock in" exposure	Unlikely	Likely
2. Easy access to strategic/critical complements	Likely for large diversified corporations with relevant complements	Less likely
3. Technological Leadership	Likely	Likely
5. Scale advantages	Less Likely	Likely
6. Ease of integration	Likely	Unlikely
7. Learning from others	Less Likely	Likely
8. Competitors learning from you	Less Likely	Likely
9. Loss of trade secrets	Less Likely	Likely
10. Flexibility	Sometimes	Sometimes

The acquisition of Instagram by Facebook exposed weaknesses in the traditional approach. The transaction no doubt looked innocent through a static non-strategic framework. Since the services provided were free, what could possibly be the consumer welfare harm?

Of course, the Facebook business model was always to monetize in the advertising market. Before the acquisition, Instagram was succeeding in encouraging defections from the Facebook platform. Instagram wasn't just a potential competitor, it was a competitor. The online advertising market hitherto had Google and Facebook as major players and might well have had a third—Instagram.

The analytical challenge is to determine, *ex ante*, if Instagram is a likely—let alone the most likely—competitive challenger to Facebook! Perhaps the clue should have been in Instagram's capabilities, manifested in an impressive user growth rate and strong venture capital backing. It hadn't entered the digital advertising market at the time of the acquisition, but it was surely clear that their business model would require it to do so sooner or later. What's needed, and what didn't exist then, and what is still absent today, is the ability of analysts to assess the capabilities of potential entrants. The capabilities framework and TCE could have helped out. It would have caused one to look at Instagram's capabilities and where they could be deployed and the likely revenue model that would have been adopted.

Both Facebook and Instagram provide social media services for free, but they both competed for advertising dollars. Looked at through a traditional industrial economics lens, where capabilities don't matter much at all, the merger presented no obvious consumer harm because both services were free to use so long as users were willing to give up their data to the network. Facebook's advertising business was relatively new, especially on mobile phones. Instagram didn't seem to have a viable business model at all. Facebook said there were plenty of other apps like Instagram, including Path, Flickr, and Pixable. Regulators believed that Instagram wasn't uniquely placed to compete against Facebook either as a provider of advertising space or as a potential social network.

Regulators in both Europe and the USA were not forward-looking and did not see that Facebook and Instagram were girding up to be competitors. Instagram already had users and associated positive network externalities to build upon. The UK regulators saw Instagram as "complementary to social networks." Facebook knew otherwise. Once a network takes off, there are few reasons to start *de novo*; buying it is better, if you can. As long as there was a rapidly growing installed base of users on Instagram, Facebook knew it faced a future competitor. The regulators did not see that Instagram was poised for a possible "winner take all" or "winner take most" outcome that would also allow it to provide serious competition for Facebook.

Instead of being fixated on short-term consumer prices, which is perhaps how the Obama FTC was thrown off the scent, they should have looked forward and focused on capabilities. Instagram had strong capabilities in a new form of social media interaction, where Facebook had weak capabilities. Instagram was native to mobile, Facebook was not. Instagram also had younger user demographics, an area where Facebook was starting to lose. In sum, Instagram would have been strong competition where Facebook was weak.

The FTC and competition authorities in Europe have tended to focus on consumer pricing and little else—and their lack of both a capabilities framework and a forward-looking focus—would tend to lead them astray.[29] Both companies were competing for the time and attention of users, not for a nonexistent current market share. The UK competition office went so far as to say that the two companies were not competitors at all, because both services were free! They failed to see that each would be competing for advertising dollars. The merger has allowed Facebook to raise prices to advertisers and also, perhaps, to invade the privacy of their users without fear that they will readily find an alternative.

Competition law with respect to potential competition has proven unworkable and will remain so until industrial organization economists and competition policy professionals begin to understand business firms from a capabilities and a TCE perspective. Brodley (1983) made an effort to do so and referenced capabilities noting the importance of examining "production and marketing information and other capabilities" to redeploy resources from one market to another. His language is quite "Penrosean," and Penrose was an incipient capabilities scholar. Modern mainstream antitrust economists have clearly mastered many complex ideas. For instance, Baker (2019) endeavors to update antitrust but puts forward a view of modern economics which is very light on the study of innovation and non-existent in the recognition of firm-level capabilities and their importance. Moreover, his framework is impaired on account of the fact that he ignores the impact of innovation on competition, focusing almost entirely on the undeniable important impact of competition or innovation. The Chicago presumption that potential competition is an unworkable proposition will not be undone until scholars and competition policy professionals begin to master TCE, concepts relating to organization capabilities, and the extensive literature outside of economics in innovation studies.

5. Integration (make-buy) decisions and dynamic capabilities

In the tech world, the make-or-buy decision is decidedly not static, and an important consideration for make/buy choices is whether in-house (integration) allows for quicker responses than contractual arrangements allow. Throughout his work, Williamson stressed the benefits of managerial fiat, including the ability of managers to direct resources with alacrity. He proclaimed as follows: "I take the defining characteristics of [firm] governance structure to be incentive intensity, administrative control, and the contract law regime" (Williamson, 2007, p. 375). He stressed, in the Carnegie School tradition of March and Simon, the adaptive properties of organizations, perhaps underemphasizing at times the fact that large organizations can become ossified and rigid.[30] He did worry about maladaptation.

Williamson tends to frame the make-buy decision in rather static terms—although not entirely so. In a 2007 interview, for example, he noted (as he has elsewhere) that there is a dynamic, adaptive aspect to the business enterprise:

> I see the firm as a mode of contracting that uses unified ownership and an authority relation to promote coordinated adaptation, which includes real time adaptation to disturbances, real time development of convergent expectations, has weaker and longer term career incentives, and has its own dispute settlement mechanisms (Williamson, 2007, p. 376).

Dynamic capabilities concerns are also implicated when choosing organizational forms. If there is either a wooden contractual structure for managers to orchestrate or a wooden internal bureaucracy to overcome, dynamic capabilities will be compromised. Flexible governance, including board-level governance, facilitates dynamic capabilities. Unfortunately, we do not get much insight into these issues from Williamson, although he did recognize their importance as the quotations earlier in this section indicate. His focus, however, was not on high-tech Silicon Valley

29 Both the US DOJ and the FTC claim they have the credentials to understand innovation; but this bold confidence is misplaced. It is extremely rare for economists at the competition agencies on either side of the Atlantic to cite literature in technology management, and it's hard to accept that they know the phenomenon when there is no evidence that they read, let along understand, the considerable literature on innovation. Oliver Williamson was far more eclectic and he did read (and contribute to) literature beyond industrial organization. As noted earlier, his constant refrain was to figure out "what is going on here." One didn't reach for the theory first. One first figured the phenomenon out, and then one would be free to apply existing theory or construct new theory. The reverse order would likely lead one astray. It's time for staff at competition agencies to develop an appreciation for literature beyond the largely technology benefit filed of industrial organization.

30 Rigidities and decision biases were mentioned in Williamson (1975) but later de-emphasized.

companies and the requirements of highly dynamic markets. Perhaps that shielded him from issues that are now of great importance.

When developing new products, there are myriad transactions that need to be completed, and make/buy choices to entertain. In the digital realm, key concerns typically include (i) the complexity of organizational and product interfaces, (ii) the volatility of the interfaces, (iii) the strategic and systems importance of the activity, and (iv) the nature and evolution of required capabilities.[31] Contractual issues that arise include contract specification and flexibility. Related questions to ask include: Are there (i) small numbers problems? Are there (ii) lock-in problems? Are there (iii) fundamental transformation concerns? Is there (iv) easy access to (external) complements? Is (v) learning from partners likely? Are there (vi) opportunities better addressed through integration and control?

Capability issues include (i) whether there are other advantages/disadvantages relating to control advantages; (ii) whether access to skills and external technology is a "strategic" issue (i.e. will it become a bottleneck); (iii) whether easy access to (internal) complements is possible; and (iv) whether learning and scale advantages/disadvantages exist. Table 1 maps these concerns as to how they vary with the internalization (integration) decision.

Contractual relationships and make/buy decisions are not just about writing, monitoring, and enforcing a good contract[32]–which is sometimes the thrust of Williamson's analysis—but also about access to capabilities, systems integration issues, firm-level effects such as cultural alignment, learning, perceived fairness, and the judicial system(s) that are relevant to contractual engagements. In this regard, Williamson's framework is a bit sparse, as some scholars have pointed out (Foss, 1993; Hodgson, 1998; Hodgson and Knudsen, 2007). Also, while Monteverde and Teece (1982) is the first to show the statistical importance of asset specificity, the study also showed that the "big locomotive" in explaining organizational boundaries wasn't asset specificity. It was systems effects and firm-level factors.

Consider also Apple's very significant reliance on the outsourcing of manufacturing/production for almost all of its devices. At one point, imprinted on the back of some products such as iPhone and iPads, one could find the words "Designed by Apple in California. Assembled in China." It is well recognized that it would be close to impossible, and more expensive, to have these products made in the USA. More importantly for the Williamsonian question, it would also be very difficult for Apple to have its products built in China in a wholly owned Apple subsidiary. The scale, speed, and efficiency of Chinese manufacturing outstrips the USA and most of Europe, too. Moreover, Apple's ability to work government relations in China would be far inferior to Foxconn's. It is also highly unlikely that Apple could quickly switch suppliers from Foxconn (its main contract manufacturer) to anyone else—a Williamsonian "fundamental transformation" of the buyer supplier relationship has long ago occurred—but the relationship lives on. I believe the evidence suggests that it is Foxconn's capabilities—and Apple's need to access them—which is core. Williamson would probably acknowledge that, while at the same time stating that it doesn't imply that TCE issues are not present. I would agree; although I think this particular case is one where capabilities issues very much swamp TCE concerns. As with the Monteverde and Teece study cited earlier, TCE considerations are not the "big locomotive."

There is not a lot in the public record on the details, but the broad strokes of the Apple-Foxconn situation have been described by Liang (2016). He considers the relationship to be one of mutual dependence and "win–win" (p. 144). There definitely has been an evolutionary/learning path to the relationship. Apple chose to turn to Inventec Appliances to help produce the iPod Classic; Asustek for the iPod Mini, and Foxconn for the iPod Nano and iPod Shuffle. Foxconn was successful with the iPad, which enabled them to win Apple's confidence for the largest share of iPhone and iPad production. Liang estimates that Apple accounts for at least two thirds of Foxconn's total revenue. There is likely considerable amount of what Williamson calls "relationship specific investment" involved, with concomitant hold-up exposure; but the contractual relationship nevertheless appears stable. Perhaps what is going on is tantamount to what Williamson would call an "exchange of hostages" or credible commitments.

Flexibility and adaptability—qualities that Williamson typically attaches to internal organizations—are the very capabilities that Liang believes provides the rationale for Apple to outsource to Asia, mainly Foxconn.[33] The

31 Together with Kirk Monteverde (Monteverde and Teece, 1982), I was able to publish the first study (which used a probit model) to demonstrate a statistically significant relationship between a measure of asset specificity and the likelihood of in-house procurement of auto parts. However, it is little noticed that other variables in the model relating to individual firm level and systems effects yielded larger coefficients than asset specificity.

32 These in turn depend, as noted in the text, on the levels of asset specificity, uncertainty, and frequency.

33 Foxconn, in turn, sits at a nexus of contracts for other component producers in Asia that is, Foxconn also manages portions of Apple's supply chain.

Table 2. Categorization of dynamic efficiencies

Type of dynamic efficiencies (OECD)	Value creation	Value capture
Learning by doing	✓	✓
Upgrading management	✓	✓
Combining complementary distribution or marketing assets		✓
Elimination of duplicative R&D		✓
Economics of scale and scope in R&D	✓	✓
Joint exploitation of intellectual property		✓
Better R&D risk spreading	✓	✓
Better IP endorsement		✓
Increased financial resources for final R&D	✓	✓
Facilitation of standards and their adoption	✓	✓
Schumpeterian (appropriability) effect		✓

relationship, he claims, involves mutually beneficial and mutually dependent collaboration. To be clear, Williamson did not consider common ownership as the only solution when "hold up" risks were present. He always saw that the hazards in a contractual relationship could often be managed in creative ways.

A key element to recognize is that these costs/risks associated with external procurement are worth incurring if they allow one to access innovations and cost savings and quality enhancing (manufacturing) capabilities from outside the boundaries of the firm. Williamson always recognized that other factors are always at work even if he didn't say much about what they may be. Contract manufacturing is only a viable option because of the availability of capable contract manufacturers which can fulfill the increasingly sophisticated work of supply chain management, parts procurements, and product assembly.

6. Ecosystems, alliances, and platforms?

Oliver Williamson's scholarship on the business enterprise was not confined to markets and hierarchies. His research also embraced various other mixed organizational forms (such as joint ventures and alliances). He noted that "each generic model of governance is defined by an internally consistent syndrome of attributes. . .the challenge is to enumerate the relevant attributes for designing governance structures and thereafter to align different kinds of transactions with discrete modes of governance in an economizing way" (2002, p. 175). Although he didn't explicitly discuss ecosystem and platforms, there is certainly elements of these phenomenon that can benefit from TCE analysis.

Competition policy must look at complex networks and ecosystems with some understanding of how different actors can wield bargaining power and enhance or frustrate value creation. Strategic alliances/cooperation were the subject of much of my early work (Teece, 1992). Such arrangements support innovation and help make markets work. Competition policy economists and others need to recognize that these new organizational forms are very procompetitive. They not only impact value capture; they are also important for value creation as they are critical to bringing new innovative products and services to the customer (Teece and Coleman, 1998).

Competition plays out in new and different ways when ecosystems emerge (as they often do) in both digital and non-digital marketplaces. The boundaries between the focal firm as well as the complementors become blurred. Hence, the markets in which complementors compete are often quite ill-defined and difficult to define in a competitively meaningful manner. To assess competition, traditional antitrust analysis embeds the focal firm (or firms) in a "relevant" market. It is no longer clear that industries and relevant markets are a meaningful abstraction in the high technology sector. This can be illustrated by considering the role of ecosystems as an arena of cooperation and competition.

Consider Dolby Labs, a San Francisco based technology company. Ray Dolby, an independent inventor, founded Dolby Labs in 1965. It has provided audio and video technology to support Hollywood entertainment, cinema graphics, and entertainment more generally. Dolby licenses its technology and sells audio and video products too. However, its focus is on technology development, and it leaves the high-volume manufacturing distribution and marketing to others. It has a creative business model that positions manufacturers as customers, not competitors. This enables manufacturers to enthusiastically embrace Dolby technology, which was licensed non-exclusively. "Dolby worked with manufacturers as partners rather than competitors" (Sherman, 2019). Dolby was able to co-brand with the manufacturers, further strengthening its competitive position. Dolby's success is in large measure because it has built and managed an ecosystem around high quality audio and video for the entertainment industry. As Sherman (2019) notes:

> Ray Dolby and his team embarked on a years-long deep-dive into the film industry, trying to understand it as a complete ecosystem and establish mutually beneficial relationships. They studied how all elements of that ecosystem worked together—film makers, studios, distributors, and cinema exhibitors—and considered how Dolby could deliver value for each. They knew that any weak link in the chain. . .could lead to failure.

More recently, the ecosystem has expanded still wider to include streaming platforms and mobile devices. The point is that if one tries to understand how Dolby competes, and the markets in which one competes, one needs to employ an ecosystem framework. At minimum, one must consider Dolby's complementors and the relevant complementary assets and technologies. Traditional economic models from industrial organization provide little help in analyzing such phenomenon. Williamson's TCE framework, on the other hand, can provide important insight into the design and governance of such structures, with potential relevance to competition policy, especially relevant market determination.

7. Competition policy issues in high tech: efficiency versus monopoly and the New Brandeisians

7.1 Efficiency versus monopoly tradeoffs

Another major contribution of Oliver Williamson to competition policy, and, in particular, to merger policy, was his formalization in a partial equilibrium model of the welfare tradeoff (in the context of horizontal mergers) between lower costs of production and welfare losses associated with the higher prices due to a greater degree of monopoly power occasioned by a merger (Williamson, 1968). His framework has allowed enforcement agencies to think clearly and rationally about tradeoffs. Although most economists accept the model, competition authorities have been ambivalent, except possibly in Canada, where it is embraced.

The challenge that is faced today in the tech sector is to interpret which "efficiencies" are relevant, and how to measure them. In traditional (neoclassical) industrial organization textbooks, efficiency is generally of two kinds, both of which I would call static: (i) efficiencies that lower marginal production costs[34] and (ii) efficiencies that generate savings in fixed costs. The requirement for quantifying efficiencies bites hard when innovation is at issue. The agencies usually require efficiencies to be quantified; but innovation gains (or losses) are often hard to quantify with a high degree of reliability. The result is that the "reliable quantification" requirement *de facto* causes innovation gains or losses to be ignored, even if they are likely monumental in magnitude compared with that which can be measured. Administrability can no longer be the enemy.

The classic Williamson tradeoff model is a good starting point for tradeoff analysis, but it cannot be the ending point. Williamson would allow (and Canada has accepted) that the cost saving rectangle can offset welfare triangle losses. Innovation gains and losses should be brought to the table too. The effect of innovation is many fold:

1. Product improvements can be viewed as allowing the demand curve to shift to the right.
2. Entirely new products are created then entirely new demand curves are created.

However, adopting the Williamson model and accepting tradeoffs doesn't capture all that is needed. Because of very large spillovers when innovation is at issue, what is required is some measure of enhancement (or decrement) to

34 Including, of course, efficiencies that raise quality.

social returns. Only private returns, not social returns, are captured by the Williamson model. This is where Edwin Mansfield's (1977) social returns model[35] is likely relevant.

Developing support for a range of dynamic efficiencies and capability enhancements through merger ought to lie with the merging parties; but at the same time competition agencies must develop some level of proficiency in technology and strategic management if they are to have any chance of properly assessing these possibilities. Of course, even if these criteria can be assessed, there needs to be a way to connect them into welfare criterion. That will require some assessment of spillovers to competitors and the surplus to consumers. Methodologies exist for quantifying these effects.

Competition scholars and agencies must always keep in mind that dynamic efficiency (or dynamic efficacy) is a powerful driving force and social welfare generator[36] However, when dynamic efficiency is considered in neoclassical analysis, it's usually in terms of lower R&D costs. However, as the discussion above indicates, the "efficiencies" that are the most powerful are usually attached to new product/process developments and deployments. The types of transactions/interactions that are involved are not just about efficiencies; they are about building capabilities and driving growth and profitability.

Williamson's work on TCE also suggests that better organization arrangements also are likely to improve enterprise performance, although we have few studies which measure the impact. Several of my own research papers all show very considerable positive financial impact from new and better organizational arrangements (Armour and Teece, 1978; Teece, 1981; Monteverde and Teece, 1982; Teece *et al.*, 2020). Although not direct measures of "efficiency," these studies certainly indicate that the welfare improvements associated with organizational innovation are considerable.

There is now a need to revise the Williamson tradeoff model to take innovation into account, recognizing that mergers can forestall innovation and competition just as they can also enhance them. The characteristics noted in Table 1 are good proxies for how one can begin to think about "efficiencies" in the high-tech context. Table 2 is the OECD's effort to call out types of dynamic efficiencies which would supplement the more organizational issues in Table 1. I categorize OECD issues into value creation and value capture in the right-hand columns.

Towards the end of his career, Oliver Williamson observed that "economics seems to be emerging from an era dominated by overarching theories when economists did not feel the need to be drawn into particulars. But now the situation is rather different. The action, often, is in the details" (Williamson, 2007, p. 374). The details were not Williamson's forte, although it is the forte of the field of strategic management and of the capabilities framework. This article is trying to show how details matter, particularly details relating to organizational capabilities, when it comes to Coasian integration choices and many standard antitrust/competition issues.

7.2 Williamson and the New Brandeisians

Post the conferring of his Nobel Laureate, Oliver did not contribute much to the literature and enjoyed a quiet private life. Had he been aware of the New Brandeisians (e.g., Wu, 2018), I suspect he would be apoplectic—not so much because of its attack on the Chicago School as he himself crossed swords with Posner and Bork from time to time. However, he shared their view that economic analysis was critically important to a beneficial antitrust regime. Williamson favored a much more microanalytical approach, one that paid attention to the details and wasn't built on overly simplistic models from textbook price theory. Had this been followed, the New Brandeisians might never have emerged. Williamson was very much in favor of private ordering, which he defined as efforts to craft governance structure supports for contractual relations during the contract implementation interval. He would be critical of the New Brandeisians for the same reason that he would be critical of some early Chicago School views on antitrust: failure to look closely enough at the facts, and figure out "what is really going on here." To engage in competition policy in the Williamsonian way, one needs a multi-disciplinary perspective. As he himself put it: "pluralism has much to recommend it in the area of economic organization that is beset with bewildering complexity (2002, p. 192)."

35 Appealing to John Dunning's ownership-location-internalization (OLI) framework, internalization advantages don't exist (externalization advantages do) so contract manufacturing (outsourcing) is indicated, other things equal. Also, modularization has softened, to some degree, the transaction specificity of assets allowing outsourcing, with reduced contractual hazards.

36 The agencies often give lip service to innovation, but it is usually poorly honored in the breach, as I have argued elsewhere (Teece and Coleman, 1980; Sidak and Teece, 2009; Teece, 2012a)

One must note, first and foremost, that the Schumpeterian competition that regularly roils the tech space is generally very robust. America Online (AOL) looked good and possibly even dominant for a short period; then, failed rapidly when the landscape shifted. Similarly, Netscape rose, then fell, perhaps nudged out by Microsoft's ability to leverage its dominant position in operating systems. Pioneering social media company MySpace grew quickly then imploded. Search engines came and went with alacrity until Google finally got traction. Pisano and Teece (2007) mapped some of this chaos and tried to explain it.

Schumpeter's "perennial gale of creative destruction" view of the competitive process is a helpful framework for understanding both how competition drives innovation, but especially for how innovation drives competition. Schumpeter's framework was not in Williamson's comfort zone as Oliver's frameworks were generally static; although as discussed above they can be applied to dynamic situations, even if it wasn't something Oliver was inclined to do himself. He did not think about competition as a process in the way that evolutionary economists and others are inclined to do. He was generally focused on opportunism—and not opportunities. However, as noted in the introductory section above, Williamson rejected equilibrium analysis as the basis for understanding tech-oriented business firms. He saw the public and private benefits of large integrated enterprises and was critical of industrial organization economists who resorted to a market power explanation for anything they didn't understand—and he thought that there was much that industrial organization economists didn't understand. His focus was always on the design of organizations to protect/preserve wealth—and not as much on how to create it. As I have endeavored to show, the capability framework extends the TCE paradigm to more dynamic settings which, in turn, allows one to obtain better insights into complex competition policy issues in high technology settings.

Because of the absence of a robust model of innovation and dynamic competition, and a robust understanding of complex organization and big data, old shibboleths are reemerging in competition policy. There is now a widespread perception that we don't have good answers. Accordingly some believe that economic analysis should be abandoned, or at minimum competition policy should embrace political and social issues too. New Brandeisians favor new smaller firms; but they are not pro-innovation, at least not if it leads to bigness. They don't like efficiencies either—at least not if it hurts small business. It's not only Big Tech they have an aversion to; they also dislike the purchasing economies of a Walmart or of a Kaiser Permanente, if it results in the loss of competitors. This reaction is due in part to the non-Williamsonian narrow (static) microeconomic lens used by the vast majority of antitrust economists. The outmoded conceptual frameworks employed have left the mainstream poorly equipped to deal with the new circumstance. A more microanalytic approach of the kind favored by Williamson has been needed for some time. New Brandeisians also dislike leverage—that is, firms using advantages in one market to enter into another. Ironically, they don't like intellectual property rights either, despite the fact that today intellectual property is the friend of start-ups more than it is the friend of incumbents. Likewise, while they hint at the need for heavy-handed government intervention, some of them are also suspicious of the power of government.

In short, the New Brandeisians have little if anything new to offer. They seem quite unaware of Williamson's relevance and his contributions. They do not have a new framework for competition, merely different non-economic priorities. As Wilson and Klovers (2020) note the proposed antitrust interventions:

> are sold to the public as simple, obvious, and beneficial. Behind the curtain, however, there is little clarity on what the problem is, let alone why a given proposal is the best solution or how the agency would operationalize it (Wilson and Klovers, 2020).

If mainstream antitrust analysts don't start using a wider lens and become more intellectually pluralistic as Williamson advised, these ideas could well gain greater traction and become the new mainstream. In the absence of an understanding of (i) the digital economy and big data and (ii) what Williamson calls the bewildering complexity of economic organization—and I see organization capabilities as part of that bewildering complexity—then the chances that the New Brandeisians would get it right are low, and much lower than the Chicago School with their overly simplistic theories. Pitching overly simplistic theories against overly simplistic theories is unlikely to yield new insights and new knowledge. Time is of the essence—and forging a pluralistic framework may be difficult, but it's not impossible.

The ideas and concepts in this article provide the beginnings of a framework that can help antitrust/competition enforcement agencies fill the void. It will require looking into the details to figure out which tech-based mergers to clear, and which to block; and which business practices to favor, and which ones to be skeptical about.

Williamson always tried to anchor his work in the facts, and was not heavily swayed by doctrinal perspectives. He didn't necessarily see bigness as a curse; sometimes yes, but often not. He was perhaps rather unique in being able to bridge theory—simple theories yes—and practice. He never insisted that there was only one perspective, and he was adamant that one needed to draw one many of the social sciences to understand complex organizations—and Big Tech are very complex organizations. He readily admitted that it was necessary to take innovation and capabilities and dynamics into account, enabling others to put his approaches to good use as we struggle to understand the rise of Big Tech and opportunities and challenges it poses. Although not the subject of this tribute, he would insist that we look hard at Chinese businesses and Chinese firms, and systemic competition from China, if we are to formulate new policies and approaches. The Neo-Brandeisians have not done so, and he would be interested on that account too. That said, here are some propositions that a combined TCE-dynamic capabilities framework can help illuminate:

1. Firm boundary decisions —critical for merger analysis—require consideration of transaction costs, capabilities, learning, and the need for rapid coordination and asset orchestration that is, support and allow the exercise of dynamic capabilities. Those that think Big Tech is too big cannot credibly maintain such positions without an organizational economics framework to inform their analysis. Whatever framework is employed, it needs to be able to appreciate hybrid organizational structures and understand innovation ecosystems.
2. The "potential competition doctrine" needs to be resurrected and strengthened as a competition policy construct. Evolutionary economics is relevant, alongside capabilities approaches. The latter are themselves inherently evolutionary. Competition needs to be understood as a process.
3. The Williamson-tradeoff model needs to be revamped to take the impact on dynamic "efficiencies" into account, along with detriments to competition that might transcend short term price increases.
4. Learning effects, not just network effects, must be injected into the competition policy analysis—something which has been ignored for too long. Scale and network effects must now be supplemented by a deep understanding of learning, especially learning from large data sets. The benefits of learning and scale are not manna from heaven or benefits thrust upon the digital firm. They are brought about by the exercise of substantial managerial, engineering and commercial capabilities. A TCE-capabilities framework can help illuminate these issues.
5. Analysis needs to be forward looking. Antitrust too often looks backwards. The FTC case against Qualcomm with respect to modem chip sets was a classic case. The FTC and the court turned a blind eye not just to likely future developments in the chip markets, but even to current developments (see Teece, 2019a). Analysts must sense where the market is going; otherwise policy interventions look inept.
6. Innovation drives competition just as assuredly as competition drives innovation. Both linkages need to be better understood. Mainstream competition policy largely ignores the former.
7. Relevant market analysis and small but significant and non-transitory increase in price (SSNIP) tests[37] are not particularly helpful and are often misleading in the technology domain where product differentiation alone will lead to the conclusion that practically all technology-based goods and services markets are "monopolized"—despite the presence of vigorous Schumpeterian competition (Hartman *et al.*, 1993; Teece and Hartman, 1998). The US FTC marginalized the relevant market requirement for merger review in 2010. Capabilities (rather than market presence) is a concept also worthy of examination and measurement (or at least assessment) alongside markets.
8. Analysis must be more inductive than deductive; that is, it should be more evidence-based than theory-driven.[38]
9. Industrial organization economists and other competition policy professional need to get familiar with an extensive technology management literature, including much of what is published in this journal. Some might find my own research helpful (Sidak and Teece, 2009; Teece, 2012a,b).
10. The (short term *de facto*) consumer welfare standard of antitrust needs to be replaced with a long-term (consumer) welfare perspective. This seemingly small step can make room for a proper consideration of capabilities and innovation.

37 SSNIP is an antitrust tool for defining the boundaries of a market.

38 Good competition policy analysis—like all good policy analysis—should be evidence based, theory informed, and insight driven.

11. Dynamic competition rather than static competition needs to be the leitmotif of contemporary competition policy.

The principles and examples discussed above begin to provide a framework for thinking about antitrust/competition policy issues for the digital economy in a manner that is dynamic and forward looking. Powerfully, the principles integrate Williamson's contractual framework with capabilities issues.

The principles highlight important concerns about current about Mergers and Acquisitions policy. I have shown above how significant contractual problems would likely be encountered if the boundaries of Big Tech were drawn too narrowly, but that does not necessarily justify all the acquisitions that have been made and approved by regulators. Nor does it support everything that regulators have blocked.

7. Conclusion

Oliver loved to echo the French poet, Charles Péguy, by saying that the way to advance the fundamental understanding of complex business and economic organization is to implement a microanalytic research program in law, economics, and organization in a "modest, slow, molecular, definitive way." That is, the business to which we must attend to if we are to better understand Big Tech and antitrust. There are no easy answers, and those that pretend otherwise are delusional.[39] Let the hard work begin, taking inspiration and pointers from one of the very best organization economists of all times. By stringing two big locomotives together—asset specificity and capabilities—we can hopefully get deeper insights into the important competition policy issues of our time.

Acknowledgments

I would like to thank Charles Baden-Fuller, John Blair, Charles Clarke, John de Figueredo, Michael Katz, Greg Linden, Jackson Nickerson, Will Mitchell, David Mowery, and Nicolas Petit for significant ideas and input. I'd also like to thank Josef Chytry, Managing Editor, for expediting the process and helping Caroline Orille prepare the article for publication.

References

Armour, H. O. and D. J. Teece (1978), 'Organizational structure and economic performance: a test of the multidivisional hypothesis,' *The Bell Journal of Economics*, **9**(1), 106–122.

Baker, J. (2019), *The antitrust paradigm: restoring a competitive economy*. Harvard University Press: *Cambridge MA*.

Baldwin, C. Y. and K. B. Clark (2000), *Design Rules*. The MIT Press: Cambridge. MA.

Bell, M. and Pavitt K. (1995), 'The development of technological capabilities,' in Haque I. (ed.), *Trade, Technology, and International Competitiveness*. The World Bank: Washington DC, pp. 69–101.

Bond, S. (2020), 'Over 400 Advertisers hit pause on Facebook, threatening $70 billion juggernaut' (July 1), https://www.npr.org/2020/07/01/885853634/big-brands-abandon-facebook-threatening-to-derail-a-70b-advertising-juggernaut.

Broadley, J. F. (1983), 'Potential competition under the merger guidelines,' *California Law Review*, **71**(2), 376–381.

Capron, L. and W. Mitchell (2012), *Build, Borrow, or Buy: Solving the Growth Dilemma*. Harvard Business Review Press: Boston, MA.

Chesbrough, H. and D. J. Teece (1996), 'Organizing for innovation: when is virtual virtuous?,' *Harvard Business Review*, (January–February), 65–73.

Christensen, C. M. (1997), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press: Boston, MA.

Coase, R. H. (1992), 'The institutional structure of production,' *The American Economic Review*, **82**(4), 713–719.

Cornell University Networks course blog (2012), 'Apple maps: a failure explained by network effects' (November 7). https://blogs.cornell.edu/info2040/2012/11/07/apple-maps-a-failure-explained-by-network-effects/.

De Figueiredo, R. J. P. (2010), 'A Tribute to Oliver Williamson: Institutions, Politics, and Non-Market Strategy,' *California Management Review*, **52**(2), 123–131.

De Figueiredo, J. M. and D. J. Teece (1996), 'Mitigating procurement hazard in the context of innovation,' *Industrial and Corporate Change*, **5**(2), 537–559.

39 As noted, so-called Neo-Brandeisians write with great confidence about "Big Tech" phenomena without the care that Oliver Williamson would bring to complex organization issues (see, e.g. Williamson, 2010).

Dilger, D. E. (2015), 'How Intel lost the mobile chip business to Apple's Ax ARN Application Processes,' *Apple Insider (January 19)*. https://appleinsider.com/articles/15/01/19/how-intel-lost-the-mobile-chip-business-to-apples-ax-arm-application-processors.
Foss, N. (1993), 'Theories of the firm: contractual and competence perspectives,' *Journal of Evolutionary Economics*, **3**(2), 127–144.
Glick, R. and C. Ruetschlin. (2019), 'Big tech acquisitions and the potential competition doctrine: The case of Facebook,' *SSRN Working Paper #104*, Institute for New Economic Thinking.
Hartman, R., D. J. Teece, W. Mitchell and T. M. Jorde (1993), 'Assessing market power in regimes of rapid technological change,' *Industrial and Corporate Change*, **2**(3), 317–350.
Hayek, F. (1945), 'The use of knowledge in society,' *American Economic Review*, **35**(4), 519–530.
Helfat, C. E. (2007), *Dynamic Capabilities: Understanding Strategic Change in Organizations*. Blackwell: Malden, MA.
Hermalin, B. E (2010), 'A Tribute to Oliver Williamson: Holdup: Implications for Investment and Organization,' *California Management Review*, **52**(2), 132–137.
Hodgson, G. (1998), 'Competence and contract in the theory of the firm,' *Journal of Economic Behavior & Organization*, **35**(2), 179–201.
Hodgson, G. M. and T. Knudsen (2007), 'Firm specific learning and the nature of the firm: why transaction cost theory may provide an incomplete explanation,' *Revue Economique*, **58**(2), 331–350.
Holmström, B. and J. Roberts (1998), 'The Boundaries of the Firm Revisited,' *Journal of Economic Perspectives*, **12**(4), 73–94.
Hu, J. (2002), 'Yahoo sheds Inktomi for new search technology,' (January 12), https://www.cnet.com/news/yahoo-sheds-inktomi-for-new-search-technology/.
Knight, F.H. (1921), *Risk, Uncertainty and Profit*, Houghton Mifflin: Boston.
Kreps, D. M. and R. Wilson (1982), 'Sequential Equilibria,' *Econometrica*, **50**(4), 863 –894.
Liang, G. (2016), 'The 'Fox-Apple' partnership in the global value chain: how did foreign direct investment and contract manufacturing reshape the landscape of the electronics industry,' in Y. Xing (ed.), *Uncovering Value Added in Trade: New Approaches to Analyzing Global Value Chains*. World Scientific Publishing: Singapore.
Mansfield, E., J., Rapoport, A., Romeo, S., Wagner, and G., Beardsley (1977), 'Social and Private Rates of Return from Industrial Innovations,' *The Quarterly Journal of Economics*, **91**(2), 221–240.
Mingis, K. and Y. Kossovsky (2007), 'Update: jobs touts iPhone, "Apple TV",' Computer World. Jang, (January 9), https://www.computerworld.com/article/2549128/update–jobs-touts-iphone—appletv-.html.
Miller, R. (2016), *'How AWS Came to Be,'* Tech Crunch (July 2). https://techcrunch.com/2016/07/02/andy-jassys-brief-history-of-the-genesis-of-aws/.
Monteverde, K. and D. J. Teece (1982), 'Supplier switching costs and vertical integration in the automobile industry,' *Bell Journal of Economics*, **13**(1), 206–213.
Mowery, D. C. (1983), 'The relationship between intrafirm and contractual forms of industrial research in American manufacturing, 1900-1940,' *Explorations in Economic History*, **20**(4), 351–374.
Parmigiani, A. and W. Mitchell (2009), 'Complementarity, capabilities, and the boundaries of the firm: the impact of intrafirm and interfirm expertise on concurrent sourcing of complementary components,' *Strategic Management Journal*, **30**(10), 1065–1091.
Penrose, E. (1959), *The Theory of the Growth of the Firm*. Wiley: New York, NY.
Pisano, G. and D. J. Teece (2007), 'How to capture value from innovation: shaping intellectual property and industry architecture,' *California Management Review*, **50**(1), 278–296.
Shapiro, C. (2010), 'A Tribute to Oliver Williamson: Antitrust Economics,' *California Management Review*, **52**(2), 138–146.
Shapiro, K. and H. Varian (1998), *Information Rules: A Strategic Guide to the Network Economy*. Harvard Business School Press: Boston, MA.
Sidak, J. G. and D. J. Teece (2009), 'Dynamic competition in Antitrust Law,' *Journal of Competition Law and Economics*, **5**(4), 581–631.
Spiller, P. T. (2010), 'A Tribute to Oliver Williamson: Regulation: A Transaction Cost Perspective,' *California Management Review*, **52**(2), 147–158.
Sherman, A. (2019), 'Doing Intellectual Property the Dolby Labs Way,' Issue 93, IAM, p. 46. https://www.iammedia.com/Magazine/Issue/93 (accessed November 19, 2019).
Sutton, J. (2012), '*Competing in Capabilities: The Globalization Process*,' Oxford University Press: Oxford.
Tadelis, S. (2010), 'A Tribute to Oliver Williamson: Williamson's Contribution and its Relevance to 21st Century Capitalism,' *California Management Review*, **52**(2), 159–166.
Teece, D. J (2010), 'A Tribute to Oliver Williamson: Williamson's Impact on the Theory and Practice of Management,' *California Management Review*, **52**(2), 167–176.
Teece, D. J. (1980), 'Economies of scope and the scope of the enterprise,' *Journal of Economic Behavior & Organization*, **1**(3), 223–247.
Teece, D. J. (1981), 'Internal organization and economic performance: an empirical analysis of the profitability of principal firms,' *Journal of Industrial Economics*, **30**(2), 178–199.

Teece, D. J. (1982), 'Towards an economic theory of the multiproduct firm,' *Journal of Economic Behavior and Organization*, **3**(1), 39–63.
Teece, D. J. (1992), 'Competition, cooperation, and innovation: organizational arrangements for regimes of rapid technological progress,' *Journal of Economic Behavior and Organization*, **18**(1), 1–25.
Teece, D. J. (1993), 'The dynamics of industrial capitalism,' *Journal of Economic Literature*, **31**(1), 199–225.
Teece, D. J. (2007), 'Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance,' *Strategic Management Journal*, **28**(13), 1319–1350.
Teece, D. J. (2012a), 'Next generation competition: new concepts for understanding how innovation shapes competition and policy in the digital economy,' *Journal of Law, Economics & Policy*, **9**(1), 97–118.
Teece, D. J. (2012b), 'Dynamic capabilities: routines versus entrepreneurial action,' *Journal of Management Studies*, **49**(8), 1395–1401.
Teece, D. J. (2014), 'The foundations of enterprise performance: dynamic and ordinary capabilities in an (economic) theory of firms,' *Academy of Management Perspectives*, **28**(4), 328–352.
Teece, D. J. (2016), 'Dynamic capabilities and entrepreneurial management in large organizations: toward a theory of the (entrepreneurial) firm,' *European Economic Review*, **86**(c), 202–216.
Teece, D. J. (2017), 'Towards a Capability Theory of (Innovating) Firms: implications for Management & Policy' *Cambridge*,' *Journal of Economics*, **41**(3), 693–720.
Teece, D. J. (2019a), 'FTC V. Qualcomm should be viewed through a wider lens,' *Law360* (May 21).
Teece, D. J. (2019b), 'FTC's antitrust win against Qualcomm should not stand,' *Law360* (July 29).
Teece, D. J. and M. Coleman (1998), 'The meaning of monopoly: antitrust analysis in high-technology industries,' *The Antitrust Bulletin*, **43**(3–4), 801–857.
Teece, D. J. and S. Leih (2016), 'Uncertainty, innovation, and dynamic capabilities,' *California Management Review*, **58**(4), 5–12.
Teece, D. J., D. Lovallo, A. L. Brown and D. Bardolet (2020), *Resource Re-Allocation Capabilities in Internal Capital Markets: The Value of Overcoming Inertia*. John Wiley: New York, NY.
Teece, D., M. Peteraf and S. Leih (2016), 'Dynamic capabilities and organizational agility: risk, uncertainty and entrepreneurial management in the innovation economy,' *California Management Review*, **58**(4), 13–35.
Teece, D. J., G. Pisano and A. Shuen (1997), 'Dynamic capabilities and strategic management,' *Strategic Management Journal*, **18**(7), 509–533.
Vogelstein, F. (2013), *Dogfight: How Apple and Google Went to War and Started a Revolution*. Farrar, Straus and Giroux: New York, NY.
Williamson, O. E. (1968), 'Economics as an antitrust defense: the welfare tradeoff,' *American Economic Review*, **58**(1), 18–36.
Williamson, O. E. (1975), *Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*. The Free Press: New York, NY.
Williamson, O. E. (1985), *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. The Free Press: New York, NY.
Williamson, O. E. (1999), 'Strategy research: governance and competence perspectives,' *Strategic Management Journal*, **20**(12), 1087–1108.
Williamson, O. E. (2002), 'The theory of the firm as governance structure: from choice to contract,' *Journal of Economic Perspectives*, **16**(3), 171–195. Summer
Williamson, O. E. (2007), 'An Interview with Oliver Williamson,' *Journal of Institutional Economics*, **3**(3), 373–386.
Williamson, O. E. (2010), 'Transaction cost economics: the natural progression,' *American Economic Review*, **100**(3), 673–690.
Wilson, C. S. and K. Klovers (2020), 'The growing nostalgia for past regulatory misadventures and the risk of repeating these mistakes with Big Tech,' *Journal of Antitrust Enforcement*, **8**(1), 10–29.
Wu, T. (2018), 'The Curse of Bigness: Antitrust in the New Gilded Age,' Columbia Global Reports, 2018.

Appendix

A. (Fictional) conversation around Google's purchase of Youtube

In 2006, Google purchased YouTube for $1.65 billion. Some, at the time, said it was a crazy price; today many think it one of the best deals (for Google) of all time. YouTube was already well known. Google Video had already been launched but was struggling. YouTube had already found universal acceptance; it had more social features and extremely popular pirated TV clips. The Williamsonian question for Google would be twofold: (i) Should Google build an in-house video capability rather than acquire YouTube? It had already started with Google Video; but it wasn't

getting traction, in part because Google didn't want to have the legal risk associated with having pirated content on its servers. (ii) Did YouTube make sense as an acquisition?

We can illuminate some of these issues by casting our mind back to 2006, the time when Google was still contemplating the purchase. Imagine now a discussion between Google and its economic advisers Williamson and Teece.[40]

Williamson: "What advantage does Google look to gain by this acquisition? What's going on here? The costs are clear: not only the high purchase price, but also the considerable legal risk that Google will take on board due to the enormous amount of unauthorized copyrighted content that is on that site. Does YouTube need Google as its advertising partner to monetize its content? Shouldn't your default path be to enter into an advertising contract with YouTube? Won't that allow you to gain all of that benefit, and eliminate the costs? Are there specific contractual factors that worry you? To help you answer these questions, let me pose the key question: Do you believe that YouTube will be a dominant provider of consumer video hosting, i.e., are you on a trajectory to have what I call a 'small numbers' situation?"

Google: "Yes. Our experience indicates that once a dominant provider has been established in a market with strong network effects, then that dominance will likely continue as the market expands; unless the provider screws up."

Williamson: "Is there any reason why today Google cannot put in place a standard advertising contract between itself and YouTube?"

Google: "No, there's no reason why we couldn't craft a standard advertising relationship with YouTube. They are a content provider, like The New York Times. We can place advertising alongside their videos"

Williamson: "Then there's no reason to buy them. You can put in place a good contract, and Google and YouTube can each stick to their knitting. You're not looking at buying The New York Times, are you? This is no different, is it?"

Teece: "Olly, I've read your insightful work on integration. However, it's a bit static, isn't it? I believe when we are in high velocity markets we may need to make the analysis dynamic. You have taught me that the action is often in the details. First, let's look at the contractual difficulties that will inevitably emerge as YouTube's market and technology evolves. Consider search, which Google uses to anchor its advertising business: search and categorization of video content is complex and rapidly evolving. YouTube poses a unique challenge: its content is not from standard providers who tag the content with the metadata necessary for categorization—the interface between the two companies to manage search and categorization will be very complex. Further, that interface will be volatile—we can foresee the time, for example, when software can view the video content itself and categorize it directly, without human viewer intervention. As technology continues to evolve, so the contractual interface will need to evolve with it—in time it will become unmanageable by contract. As you have put it in the past, any contract will be horribly 'incomplete.'"

Google: "But, Prof Williamson has a point. We don't have the capabilities to manage a huge and growing video content site. As Prof. Williamson observes, that's not our knitting."

Teece: "I agree. But nonetheless you will need to develop those capabilities. Perhaps we could agree that there are three drivers of vertical integration here under the transaction cost-capability framework that I am advocating. First, we have a Williamson "small numbers" situation—Google will need to make specific investments to search and advertise in user-generated content, which will put it at risk with the dominant provider that Google believes YouTube will remain. Second, any contract between you and YouTube will inevitably be unstable and incomplete. Third and finally, YouTube is a strategic complement to your search asset. To illustrate this, imagine that five years from now, YouTube decides to prevent Google from searching its content, giving that right only to Google's primary competitor in search. This would degrade Google's ability to sell its advertising on the site."

Google: "Thanks, guys. I like the way you have both stretched each other's thinking to help address our problem. However, my smart tech buddies will tell me that you both just borrowed my watch to tell me the time. But thanks, anyway."

40 In response to a reporter's questioning in 2017, I remarked: "If you keep the opportunity to compete wide open, market forces will take care of dominance. . .it's hard to remain on top when you are a big company. Smaller companies are more entrepreneurial, more nimble. Supermarkets threatened corner stores, Walmart threatened supermarkets, now Amazon is threatening Walmart."